

RACIAL SCHOOL SEGREGATION
AND THE TRANSITION TO COLLEGE

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Abstract

Prior studies generally find that attending black-segregated schools is detrimental across a range of academic outcomes, but much research on the causes and consequences of school segregation rely on single time-point measures of student exposure. Demographic shifts and educational policy changes in the last two decades increase the possibility that students experience different racial compositions throughout their educational careers and underscore the need to better understand how different patterns of exposure over time affect student outcomes. This dissertation identifies distinct trajectories of exposure to racially segregated schools for a national sample of a student cohort, examines factors that predict trajectory membership, and estimates the consequences of different patterns of exposure on postsecondary college outcomes.

Using data from the National Longitudinal Survey of Youth (1997), Common Core Data, and the Private School Survey, I find that the vast majority of students belong to stable exposure trajectories, either consistently exposed or consistently non-exposed to black-segregated schools; a smaller proportion of students belong to dynamic trajectories, either exiting or entering black-segregated schools. The pattern of racial change (or stability) at the school level, as opposed to student school mobility, is the primary predictor of a student's own segregation exposure trajectory. I find a key difference in college outcomes along different temporal dimensions of segregation exposure, particularly that exposure *later* in high school, but not early in middle school, is detrimental to college enrollment and completion. These findings provide direction for educational policy and motivate future research to uncover the mechanisms responsible.

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Chapter 1: Introduction

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 average proportion of black students in white students' schools and an increasing percentage of black students attending predominantly minority schools (Reardon & Owens, 2014). As of 2010, close to three-quarters of black students attended majority-minority schools, about 40 percent of black students attended schools where 90 to 100 percent of the student body was non-white, and 15 percent of black students attended "apartheid" schools where white students comprised less than 1 percent of the student population (Orfield, 2014; Orfield, Kucsera, & Siegel-Hawley, 2012).

Students who attend minority-segregated schools, on average, are not receiving the same quality of education as those in majority-white schools. Since the *Brown* decision, a body of evidence has grown to show that students attending black- or minority-segregated schools are less likely to have access to the key building blocks of educational achievement including qualified teachers, small class sizes, and challenging curriculum (Betts, Reuben, & Danenberg, 2000; Boozer, Krueger, & Wolkon, 1992; Crosnoe, 2005; Darling-Hammond, 2004; Gamoran, 1987). In addition to offering fewer academic resources, minority-segregated schools have higher percentages of low-income students (Orfield et al., 2012), which can negatively affect academic achievement (Benson & Borman 2010; Coleman et al., 1966; Palardy, 2013; Rumberger & Palardy, 2005;). In short, black and Hispanic students are increasingly attending racially isolated

schools that have lower average academic achievement than schools that white and Asian students attend (Logan, Minca, & Adar, 2012). The U.S. educational system remains separate *and* unequal and, on average, exposes students in minority-segregated schools to lower quality schools than their peers in predominantly white schools.

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. 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 for two reasons. First, it ignores the possibility that students can experience *changing* school racial compositions over time and that different patterns of exposure may affect educational consequences. And second, even if students experience the same racial composition at a number of time points, 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.

This dissertation contributes to the literature on racial school segregation in two ways. First, I examine various trajectories of exposure to racial school segregation for a national sample of students throughout secondary school. I focus on key temporal aspects of segregation exposure, including the grade level at which students are exposed to

segregated schools, the stability or variability of exposure, and the total length of time exposed. The last several decades have seen large structural changes that may affect student exposure to segregated schools. These include shifts in educational policy, including transitions to district-wide school choice (Teske & Schneider, 2001), court decisions that eliminated race as a factor in admissions decisions, and the rollback of court-ordered desegregation plans (Lutz, 2011; Reardon, Grewal, Kalogrides, & Greenberg, 2012); and rapid demographic changes such as a rising proportion of minority students and the substantial migration of minority families to the suburbs (Frankenberg & Lee, 2003; Frankenberg & Orfield, 2012; Reardon & Yun, 2001). In addition to these structural changes, individual families decide where to live, where to send their children to school, and when to switch schools. All of these decisions shape children's trajectories of exposure to school segregation, a clearer understanding of which is necessary to inform policies that ensure diverse schools for all students.

Second, this dissertation contributes to literature on racial school segregation by examining the consequences of timing, duration, and stability of segregation exposure on college outcomes. 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. Despite large gains in the last thirty years, minority students continue to lag behind in college enrollment and completion (Fry, 2011). Recent educational policies including Race to the Top have started to focus 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 will provide evidence regarding the role of racial school composition throughout secondary school on the probability of enrolling in and completing college, indicating important directions for educational policy.

Perspectives, Objectives, and Analytic Strategies

This dissertation focuses on the concentration of black students within schools and refers to schools with high percentages of black students as the phenomenon of “black school segregation.” I define segregation in this way because of the historical importance and contemporary relevance of black segregation. Although unequal educational opportunities for black students drove the *Brown v. Board of Education* decision, black students today continue to be more residentially and educationally isolated than other minority students (Logan, Stults, & Farley, 2004; Orfield & Lee, 2005). Historic and current racial inequalities in this country mean that predominantly black schools often have fewer school resources, higher proportions of economically disadvantaged students, and lower average academic achievement—all factors shown to be detrimental for educational outcomes (Logan et al., 2012; Rumberger & Palardy, 2005).

The analyses have two primary objectives. *The first objective is to describe student exposure to black school segregation for a nationally representative sample of a recent cohort of students during middle and high school.* I first examine whether there are distinct groups of students who experience similar patterns of segregation exposure

between 7th and 12th grade. A distinct group of students is considered as belonging to the same “exposure trajectory.” For example, students who attended majority black schools every year between 7th and 12th grade would belong to one exposure trajectory, while students who started in predominantly black schools in 7th grade, but switched to predominantly white schools during high school would belong to a different exposure trajectory. Next, I determine why students belong to these trajectories. I examine how structural factors (racial changes within schools) and individual factors (student school mobility decisions) affect the shape of student trajectories, identifying whether each factor predicts membership in different exposure trajectories and which one is relatively more important.

Differences in exposure to segregation matter largely because they may differentially affect students’ life chances. *Therefore, the second objective of this study is to determine the effect of different exposure trajectories on postsecondary educational outcomes.* Segregation exposure during secondary school can directly and indirectly affect college enrollment and completion. High schools with high concentrations of black or minority students generally have fewer school resources, including guidance counselors, which may *directly* affect college outcomes by limiting the college information students receive thus diminishing their chances of enrolling in postsecondary education (U.S. Department of Education, 2003). But segregation exposure in early adolescence may also have an *indirect* affect on college outcomes by influencing secondary school coursetaking and behavioral development. Levels of coursetaking and problem behaviors are related to college enrollment and completion, and they can also

influence whether students experience school segregation in later grades, thereby affecting the probability of enrolling in and completing college. Traditional methods for analyzing the effect of school segregation on college outcomes do not account for the fact that students can be exposed to school segregation at different points and for different lengths of time, or that student characteristics related to segregation exposure (such as coursetaking and problem behaviors) and college outcomes also vary over time. Controlling for time-varying student characteristics on the causal pathway may “control away” part of the effect of exposure and underestimate the impact of exposure. This dissertation uses an innovative method of causal inference that estimates the total impact of secondary school segregation exposure on students’ college outcomes. While estimating the effect of segregation exposure on educational outcomes is essential, I also look into potential mechanisms. Being exploratory, this analysis will begin to illuminate how segregation exposure may impact college outcomes.

The guiding research questions for this dissertation are as follows:

- What does exposure to black school segregation look like for a recent national cohort of adolescents during middle and high school?
- How do changes in school-level racial composition and student-level school mobility predict membership in different exposure trajectories?
- What are the consequences of exposure to school segregation during middle and high school for college enrollment and completion?
- What are the potential mechanisms by which exposure to school segregation affects college outcomes?

Findings from this dissertation will contribute to the segregation literature by examining the causes and consequences of different patterns of segregation exposure over time. We have limited understanding of how variation in exposure affects educational attainment. This limitation is problematic given that educational attainment is critical to understanding social mobility by better predicting adult income and status differences than the more commonly measured short-term outcomes of grades or test scores (Wells & Crain, 1994).

While recent educational policies have started to focus on increasing college attendance and graduation among students, insufficient attention has been paid to how racial school segregation affects the likelihood of postsecondary education. If these analyses demonstrate that segregation exposure throughout adolescence affects college outcomes even after addressing dynamic selection into and out of segregated schools, it will suggest that current efforts will be ineffective if we do not also address persistent racial school segregation. Results from this study will provide evidence-based implications for federal, state, and district policy aimed at equalizing educational opportunity and improving college outcomes.

Organization of the Dissertation

In Chapter 2, I present background literature and my conceptual framework. I define and motivate the use of exposure trajectories and discuss the theoretical rationale for why differences in the timing, duration, and stability of segregation exposure may lead to different postsecondary educational outcomes. I derive the key hypotheses that

will be tested in subsequent chapters. Chapter 3 describes the data sources used in the analyses. In Chapter 4, I present the analyses that identify different patterns of exposure to black school segregation for a national cohort of students throughout secondary school using data from the National Longitudinal Survey of Youth, 1997 cohort; the Common Core of Data; and the Private School Survey. This chapter also presents evidence on which factors—school-level racial change or individual student school mobility—are the primary drivers of trajectory membership. Chapter 5 turns to the consequences of long-term exposure to black school segregation. I present evidence for how different patterns of segregation exposure affect college enrollment and college completion for students overall, as well as for black and non-black students separately. Chapter 6 investigates possible mechanisms underlying the effect of black school segregation on college outcomes, focusing on academic coursetaking and the development of problem behaviors. Chapter 7 summarizes the findings, discusses limitations of the overall project, and advances the major conclusions and implications.

Chapter 2: Background, Literature Review, and Conceptual Framework

This dissertation is guided by the life-course perspective which emphasizes the importance of following individuals over time in order to link experiences in early childhood and adolescence with experiences in adulthood (Elder, 1998, 1999). I argue that the temporal dimensions of segregation exposure in middle and high school—timing, duration, and stability—are important factors that not only differentiate the educational experiences of groups of students through secondary school, but may also affect college outcomes in early adulthood. To understand the temporal dimensions of segregation exposure and its consequences, it is necessary to follow students over time and identify exposure trajectories, and then to follow students as they transition from one period of their lives to another.

In the following sections, I first provide background on aggregate patterns of racial school segregation in the United States beginning with the *Brown* decision in 1954. I next define exposure trajectories and outline possible reasons that individual students might experience different trajectories throughout middle and high school based on factors related to school-level racial change and parent educational preferences. I then discuss potential mechanisms underlying the effects of black school segregation on postsecondary outcomes. I consider why differences in the timing, duration, and stability of exposure may lead to different probabilities of enrolling in or completing college. The section concludes with a figure modeling the conceptual framework and the major hypotheses derived from it.

Background

Since the beginning of formal education in this country, students have been unevenly distributed across schools by race. In the *Brown v. Board of Education* decision in 1954, the Supreme Court ruled that the separation of black and white students into different schools was unconstitutional. The decision stated that school districts must aim to achieve racial balance in public schools, but very little progress was made in desegregating schools in the decade immediately following the ruling. In the South, where segregation between whites and blacks was the worst, 99 percent of black students were still in nearly all-black schools as of 1963 (Orfield & Monfort, 1992). Once the Executive Branch of the federal government and the Supreme Court provided enforcement of the *Brown* decision—the former by supporting the passage of the Civil Rights Act in 1964, and the latter through decisions occurring between 1969 and 1973 that established busing as a remedy and ruled that no more delays in desegregation were permissible—school districts began to desegregate (Epperson, 2013; Orfield & Monfort, 1992). The 1970s and 1980s saw large declines in segregation, and the isolation of black students from white students declined sharply during these decades. Between 1968 and 1988, the percentage of black students in schools with 90–100 percent minority students plummeted from 64 to 32 percent (Orfield & Monfort, 1992). According to these isolation statistics, progress stopped in the late 1980s. By 2006, the percentage of black students attending a school that was 90–100 percent minority had climbed to 39 percent, indicating that black isolation was as pervasive towards the end of the first decade of the 21st century as it had been thirty years prior (Orfield, 2009).

However, isolation indices do not tell the whole story of segregation and desegregation in this country (Massey & Denton, 1988). Isolation measures are sensitive to the overall racial composition of the student body and increasing isolation may be mostly a reflection of the dramatic uptick in the share of Latino and Asian students and the decreasing share of white students over the past several decades. Studies that instead measure how evenly students of different races living within a district or metropolitan area are distributed across schools show more modest recent changes in segregation. For instance, Fiel (2013) finds that increasing segregation in the 1990s and 2000s is largely attributable to the changing demographic composition of students rather than how evenly they are distributed across schools.

Yet even if increasing racial isolation is due primarily to demographic changes, this phenomenon means that minority and white students are, in practice, increasingly attending different schools. And given the shift during the 1990s from segregation being primarily *within* districts to being primarily *between* districts, policymakers face almost insurmountable barriers to racial school integration (Bischoff, 2008; Fiel, 2013). They are unable to draw from a wider population of students across school districts to integrate students of different racial and socioeconomic backgrounds, resulting in continued racial disparities in educational opportunity.

Student Exposure Trajectories

Aggregate trends in racial school segregation provide one lens through which we can view the separation of students by race. Another way to understand racial school

segregation is to focus on individual students over time and the patterns of exposure to school segregation that they experience. Researchers often use the label “trajectories” to denote patterns of stability or change within a given domain as experienced by individuals (Elder and Johnson, 2003). Trajectories—which reflect the timing of events and transitions—are critical in shaping the life course, and are especially formative during the period of adolescence. Schools are an important social context in which youth spend a significant amount of time, and the racial and socioeconomic compositions of schools have implications for students’ educational opportunity and outcomes (Coleman et al., 1966; Palardy, 2013; Schwartz, 2011).

In this study, I construct “exposure trajectories” to describe how students experience exposure to black-segregated schools over time. Students who experience similar initial levels of exposure and similar changes in their exposure over time can be said to belong to the same exposure trajectory. In this analysis, exposure trajectories simultaneously express the timing, duration, and stability of exposure to black school segregation. *When* students attend black-segregated schools (e.g., early in middle school or late in high school), the *length of time* they spend in such schools, and whether the level of segregation they are exposed to is *stable* or *changing* over time are temporal elements critical for describing exposure over time.

What factors shape student exposure trajectories? The racial composition to which a student is initially exposed at school is related to two major factors—the racial composition of schools and a student’s (or family’s) own preference for where to attend school. Over the course of a student’s educational career, the racial composition he or she

experiences may change. Students will experience different racial compositions over time if they remain in a school where the racial demographics are shifting. Students can also experience a changing racial composition if they move to a school with a racial makeup different than their previous school. Students will have stable exposure if they remain in a school that has a stable racial composition, or if they move to a different school that closely resembles their previous school.

In the sections that follow, I first explore why the racial composition of schools can change over time. I then consider individual factors and review literature on families' school preferences and possible reasons for switching schools.

School-level racial composition changes. Several factors contribute to shifting racial composition at the school level. What drives these changes? Schools may experience shifting racial compositions because of demographic changes to the student population, internal migration patterns, and new or changing educational policies that affect student attendance. Each will be considered in the context of how it potentially affects student-level exposure.

Demographic Changes. The student population has grown increasingly diverse in the past thirty years. Between 1980 and 2010, the percentage of non-Hispanic white children under 18 years old decreased from 74 to 54 percent; the population of Hispanic children increased from 9 to 24 percent over the same period; and the percentage of non-Hispanic black children remained relatively consistent (Child Trends Databank, 2014). These changes are due in large part to the immigration patterns of Latinos after the

passage of the 1965 Immigration and Nationality Act as well as higher birth rates for racial and ethnic minority groups compared to whites (Frey, 2011a).

The increasing share of Latinos and decreasing share of whites meant that over this period, on average, minority students had diminishing opportunity to attend schools with white students (Fiel, 2013). Yet all schools did not experience these changing demographics equally. There continues to be moderate-to-high residential segregation throughout the United States. The neighborhoods where the average black, white, Hispanic, or Asian individual lives are very different. In 2010, the average white person lived in a neighborhood that was 75 percent white (Logan & Stults, 2011). In contrast, the typical black person lived in a neighborhood that was 35 percent white and close to 45 percent black, and the typical Hispanic person lived in a neighborhood that was also just 35 percent white and 46 percent Hispanic. The experiences in neighborhoods and schools are indeed quite different for individuals of different races.

How do these changes affect the racial composition of students' schools? Because the large majority of students attend their neighborhood public school (Grady, Bielick, & Aud, 2010), students whose neighborhood undergoes racial changes may experience parallel composition change at school. Similarly, students who live in neighborhoods with stable racial compositions will likely experience little racial change in their school. Research on patterns of neighborhood racial change suggests that not all neighborhoods experience change, with some neighborhoods having stable racial compositions for many decades (Logan & Zhang, 2010). As a result, although there has been a large increase in diversity for the population overall, strong and enduring patterns of racial residential

segregation suggest two primary groups of students—those who are largely unaffected by the changing demographics because they live in racially stable neighborhoods, and those who experience changing racial compositions in their schools because they live in neighborhoods that are undergoing demographic changes.

Internal Migration. School-level racial composition changes can also result from migration patterns. Neighborhood demographics are affected by the in- and out-migration of different racial groups. The urban core and ring of suburbs comprised primarily of minorities and whites, respectively, has been waning for more than three decades (Farley, Schuman, Bianchi, Colasanto, & Hatchett, 1978). Although the suburbs are still majority white in many metropolitan areas, the past decades have seen a large suburban migration among blacks and Hispanics. In 1990, 37 percent of blacks living in the largest metro areas lived in the suburbs; by 2010, 51 percent of blacks were suburbanites (Frey, 2011b). The rate for Hispanics was even higher: Hispanic suburbanites increased from 47 percent in 1990 to 59 percent in 2010. This large minority movement from city to suburb can be attributed to several factors, including the passage of the Civil Rights Act, which lessened barriers to economic progress that once prevented blacks from affording housing in suburban locations; the Fair Housing Act, which made housing discrimination more difficult; and changing racial attitudes that made multi-racial neighborhoods more likely (Alba & Logan, 1993; Frey, 2011b).

Public school enrollment in suburban schools has reflected the suburbanization trends of minorities. Between 1993 and 2006, the percentage of suburban students that were black increased from 12 to 15 percent and the percentage that were Hispanic

increased from 11 to 20 percent (Fry, n.d.). The increasing enrollment of minorities in suburban schools does not translate to an even distribution of minorities across all suburban schools. The majority of minority students in the suburbs attend majority-minority schools (68 percent of black and 73 percent of Hispanic suburban students), while the majority of white suburban students attend majority white schools (ibid.).

In addition to minority movement to suburban spaces, there has been increasing movement of middle class and white families into city centers since the 1980s (Brueckner & Rosenthal, 2009). Some research has found that these families can rapidly alter the racial and socioeconomic composition of public city schools, while others find that gentrifying neighborhoods have little effect on school composition (Cucchiara & Horvat, 2009; Keels, Burdick-Will, & Keene, 2013).

Internal migration trends have implications for the racial composition of schools. On the one hand, there are predominantly white suburban schools to which minority students do not move and predominantly minority city schools to which white students do not move. Students attending these schools will likely experience stable racial compositions over time. On the other hand, there are suburban schools that will experience large increases in the minority student enrollment as a result of minority movement to suburbs and city schools that may see increases in white student enrollment as a result of white middle class families moving (or staying) in city centers with school-age children.

Educational Policies. Educational policies also impact school segregation levels and school racial composition changes. These include desegregation policies in the wake

of *Brown* as well as the lifting of desegregation orders in the 1990s and beyond. The rise in school choice policies also can impact overall segregation patterns and the racial composition changes of individual schools.

The *Brown* decision ruled unconstitutional the separation of blacks and whites into different schools, but provided no method of enforcing the ruling. It took two cases in the two decades following (*Green v. County School Board of New Kent*; *Swann v. Charlotte-Mecklenburg Board of Education*; see Reardon et al., 2012 for review) for enforcement mechanisms to be established, including busing and required racial quotas for schools. All together, researchers have identified 755 school districts as ever being under court order to desegregate, and they generally find that the court orders were effective in reducing racial school segregation and had the intended effects of improving educational outcomes for black students (Lutz, 2011; Reardon et al., 2012).

Starting in the 1990s, however, many districts applied to have their court orders lifted. Once lifted, districts were no longer subject to oversight from the court and were declared to have “unitary status,” meaning that they did not operate a racially dual school system (Lutz, 2011). Reardon and colleagues (2012), in the most complete evaluation of the lifting of court ordered desegregation to date, write that of all of the 483 districts with more than 2,000 students under court oversight in 1990, over half have been released from the desegregation order. Scholars find that the lifting of desegregation orders increased racial school segregation, with many schools returning to their pre-order racial composition, usually predominantly white or predominantly minority (Clotfelter, Ladd, & Vigdor, 2005; Lutz, 2011; Reardon et al., 2012). Students attending schools in these

districts, particularly districts that do not put in place any alternative student assignment policies to maintain diverse schools (e.g., socioeconomic integration plans (Kahlenberg, 2012)) will experience a changing racial composition at school (Reardon et al. 2012).

As court-ordered desegregation plans have been lifted across the country, some school districts have put into place alternative strategies to maintain diverse schools. Socioeconomic-based student assignment is one option that school districts have employed with some success (Kahlenberg, 2006, 2012). In particular, the *Sheff v. O'Neill* case in Connecticut successfully provided large percentages of low-income students access to more socioeconomically mixed schools. But some scholars are less optimistic that socioeconomic integration plans can play a significant role in racially integrating students. Reardon and colleagues show that income-based student assignment policies will not be able to integrate students by race given the entrenched residential racial segregation in this country (Reardon, Yun, & Kurlaender, 2006).

School choice is another significant educational policy that is often cited as a strategy able to influence the racial composition of schools. These policies—generally defined as the ability of parents or students to select public or charter schools that are not zoned by residential address—have expanded in the past several decades. A growing body of literature finds that school choice has implications for the sorting of children into schools by race. Nationwide, as the number of charter schools grew, so did the overrepresentation of minority students in such schools (Finnigan et al., 2004; Frankenberg & Lee, 2003). The percentage of black charter students attending schools that were 90–100 percent minority was far higher than the percentage of black regular

public school students in similarly segregated schools (70 vs. 34 percent) (Frankenberg & Lee, 2003; Miron, Urschel, Mathis, & Tornquist, 2010). Studies by Saporito (2003) and Bifulco and colleagues (Bifulco & Ladd, 2007; Bifulco, Ladd, & Ross, 2009) report that racial isolation increases in districts following the introduction of school choice policies and that the increasing segregation is primarily driven by the choices made by advantaged students.

Students in districts with newly instated school choice policies may experience racial composition changes as students sort into different schools. Prior research suggests school choice policies will tend to increase white and minority isolation, leading students at a given school to experience an increasing concentration of white or minority students over time.

Family decisions and student school mobility. Structural factors, including residential segregation, school segregation, and educational policies, affect racial change or stability in schools and shape student exposure to different school racial compositions. At the same time, the schools that children attend are determined to varying degrees by personal preferences. Within certain constraints, parents can choose where to send their children to school initially, and they also can choose to switch their child from one school to another for a variety of reasons. Parents make these decisions “within the opportunities and constraints of social structure and culture” (Elder, 1998:2).

The residential segregation literature has highlighted preferences for where to live as an individual-level factor causing residential segregation for many decades. This perspective states that residential segregation is a result of some groups desiring to “live

among their own” (Charles, 2000, p. 380). The reasons for these preferences are debated, with some scholars arguing that racial prejudice is responsible (e.g., Massey & Denton, 1993), and others believing it to be a desire of certain groups to maintain status advantages (e.g., see (Charles, 2000, 2003) for a review). Studies found whites were the least tolerant of racial diversity and desired the highest percentage of same-race neighbors. Blacks were the most tolerant of racial diversity and desired the lowest percentage of same-race neighbors (Charles, 2000; Krysan, 2008; Krysan & Bader, 2007; Lewis, Emerson, & Klineberg, 2011). Although racial attitudes have evolved in the past 60 years, racial preferences remain a salient factor—whether consciously or unconsciously—in how families make residential decisions. These preferences in turn shape school attendance patterns.

Families choose neighborhoods and schools for their children in multiple ways. Some families are able to marshal financial resources to move to a neighborhood with desirable public schools. This move often happens as their children reach school age (Bayoh, Irwin, & Haab, 2006; Renzulli & Evans, 2005). Jennifer Jellison Holme (2002) studied this advantaged group of parents and found that predominantly white middle- and upper-middle class parents relied on social networks to determine acceptable schools for their children. This reliance meant that families sought out neighborhoods and schools where “people like them” lived and went to school, all but guaranteeing that the schools their children attended would be similarly advantaged and majority white. Lareau (2014) found similar results: in the unofficial choice market where families made residential moves to obtain their school of choice, upper-income white parents did minimal

searching for an optimal school option for their child and instead made decisions based on where their friends or family lived and attended school. This reliance on networks was usually a means of gaining access to what these parents saw as the highest-status schools, which were almost always predominantly white. Using national survey data, Sikkink & Emerson (2008) confirmed these patterns. They found that as the percent black of the residential neighborhood increased, white families attended alternate schools with higher percentages of white students. The same was not true for black families. This disparity between black and white preferences has implications for the racial segregation of schools.

Not all parents choose to move in order to find schools for their children, but research finds that the actions of advantaged parents staying in urban districts are similar to those who make suburban moves (Roda & Wells, 2013; Saporito, 2003; Saporito & Lareau, 1999). Advantaged parents—middle- or upper-class and white—sought the highest-status schools for their children. These schools were typically mostly white and low-poverty. Therefore, even in a “colorblind” choice system of an urban district, wealthier and white parents sought out ways to have their children attend schools with other similarly advantaged students.

The same search for high-status schools is not apparent among minority and low-income parents. This is in part because many lower-income families do not have the resources to make residential moves to access better schools (H. B. Johnson, 2014). Goyette (2008) found that minority families, primarily lower or working-class, did not relocate and instead chose the best non-neighborhood schools they could find for their

child. The different school destinations of low-income students also resulted from lower-income families having different social networks with different collective information on school options (Horvat, Weininger, & Lareau, 2003; Neild, 2005; Rhodes & DeLuca, 2014). These initial school preferences suggest a bifurcated school decision process in which middle-class and white families seek out predominantly white and advantaged schools and lower-income students of color attend predominantly minority schools that tend to be located in urban districts with high minority enrollments (Goyette, 2008).

In addition to initial preferences, student exposure to racial compositions may be affected by switching schools. Students make standard promotional grade transitions between elementary and middle school and between middle and high school, but they also switch schools for a variety of other reasons. According to data from the National Assessment of Educational Progress (NAEP) in 1998, one in five 8th graders and one in ten 12th graders made a non-promotional school change in the previous two years (R. W. Rumberger, 2003). A study of public school children in California found that 75 percent of students made a non-promotional school change between grades 1 and 12. Higher rates of mobility are found among black and Hispanic students, low-income students, and students attending urban schools (R. W. Rumberger, 2003; Xu, Hannaway, & D'Souza, 2009).

How might student school mobility affect exposure to different racial compositions? Students may switch schools for “strategic” reasons, including making a school change with the purpose of improving the educational opportunity for the student (R. W. Rumberger, 2003). Often referred to as “Tiebout” moves in the economic

literature, they are seen as moves that are “achievement-enhancing” for students (Hanushek, Kain, & Rivkin, 2004). For families with financial resources, this type of school move could be a result of a residential move to a neighborhood with a desirable school district. On average, school districts with the highest achievement ratings—a factor often considered desirable by parents—are located in predominantly white suburban areas (H. B. Johnson, 2014; Logan et al., 2012). Students moving from more diverse or urban schools into schools in suburban areas for the purpose of finding high-performing school districts may experience a changing racial composition in their school.

In urban areas, school choice is often seen as a way for parents to find the best school for their child. Charter schools are one of the most prevalent options for school choice. Research finds that black students are more likely to transfer into charter schools than their white peers, and that these schools are even more racially isolated than their previous schools (Booker, Zimmer, & Buddin, 2005; Bifulco and Ladd 2007). Students moving into charter schools will likely experience a racial composition at least as minority-isolated as the one at the previous school.

Students might also switch schools for “reactive” reasons, including unplanned residential moves because of divorce, eviction, or other financial hardships (Rumberger, 2003; Rumberger, Larson, Ream, & Palardy, 1999). Residential moves that result from financial hardship may move students from relatively advantaged neighborhoods and schools into relatively disadvantaged neighborhoods and schools. Because of the strong relationship between poverty and race in the United States (Logan et al., 2012; Orfield & Lee, 2005), disadvantaged schools will likely have higher concentrations of black and

Hispanic students. Students making these types of school moves may experience a changing racial composition from schools with lower concentrations of minority students into schools with higher concentrations.

Students may also switch schools in order to escape a negative school environment. Issues with suspension or expulsion, overcrowding, or safety might prompt a school move. In a study of over 14,000 Chicago 6th-graders, Kerbow (1996) finds that the most cited reasons for making non-promotional school changes were safety concerns or dissatisfaction with the previous school. Forty percent of parents reported switching their student's school because of these concerns. Yet these types of moves do not suggest that students will experience a changing racial composition in their school given the racial composition of many large urban districts. Even parents looking for a better alternative to a current school are likely limited to schools with similar racial and socioeconomic composition (Kerbow, Azcoitia, & Buell, 2003).

Linking school-level racial changes and student school mobility. School-level changes and family decisions about where to live and send children to school are not independent. Whether or not families decide to keep their children in the same school over time may depend on the dynamic process of racial change occurring at the school. In the 1970s, for instance, researchers found that desegregation orders led to white flight—the rapid withdrawal of white students from those schools (Coleman, Kelly, and Moore, 1975; Farley, Richards, & Wurdock, 1980; Wilson, 1985). Although there was some disagreement about the conditions under which and the extent to which white flight occurred, there was general agreement that this process was occurring across the country.

Changing school-level demographics that resulted from desegregation triggered white families to move their children into private schools or different districts, demonstrating the interaction between school-level changes and individual-level decisions.

Although white flight initially occurred in larger, urban districts where families could flee to smaller, more homogeneous suburbs, similar patterns are increasingly evident across suburban districts. Holme, Welton, and Diem (2012) have documented families moving out of schools in suburban areas that are experiencing rapid racial transitions into more homogeneous schools for their children in other suburbs. They find that families whose children attended a school with a growing minority population specifically cited the changing demographics as the reason they moved their child out of the school.

School-level racial changes are increasingly likely given demographic changes, internal migration patterns, and shifting education policies. These fluctuations will continue to influence family decisions about where to live and send their children to school. Studies about student exposure to school segregation must incorporate the dynamic process of racial composition changes occurring at the school level and its relationship to individual-level decisions.

Consequences of Segregation Exposure on Postsecondary Education

The consequences of school segregation for children across a variety of developmental periods and outcomes have been well studied. Research focused on short-term educational outcomes, particularly academic achievement measured by standardized

tests, generally finds a negative effect of attending black- or minority-isolated schools on academic achievement (C. Bankston & Caldas, 1996; Dawkins & Braddock, 1994; Lleras, 2008; Mickelson, 2008; Rossell, Armor, & Walberg, 2002; R. W. Rumberger & Willms, 1992). Although findings from these studies are largely consistent, some scholars are skeptical of their ability to isolate the effect of racial composition on achievement (Reardon & Owens, 2014). But researchers examining the consequences of segregation on achievement that have capitalized on natural yearly variation in the racial composition of students' schools—yielding a more rigorous research design than prior studies—also find that as the percentage of black students increases, black achievement declines but white achievement remains largely unaffected (Hanushek et al., 2009; Hoxby, 2002).

Most studies have focused on short-term educational outcomes. But test scores and other proximal outcomes are less consequential for student well being and future labor market outcomes than are long-term outcomes such as high school graduation or college completion (Wells & Crain, 1994). Research on longer-term outcomes that have the possibility to affect social mobility is needed, but obtaining unbiased estimates of the effect of school segregation on long-term outcomes is particularly challenging because individual students are sorted into schools with different racial compositions in a non-random way. As discussed in the previous section, families have preferences for where to live and send their children to school. These preferences are “unobserved” and, as such, are difficult to account for when trying to isolate the effect of segregation exposure on student outcomes. One way to circumvent this non-random sorting is to find naturally occurring randomness and leverage it to understand differences in outcomes.

Studies that take advantage of random variation in the timing of court-ordered desegregation are one example of this. Several studies have employed such an approach to estimate the effect of school desegregation on educational attainment and generally find that desegregation is beneficial for black students and has no effect on white students (Boozer et al., 1992; Guryan, 2001; R. C. Johnson, 2011; Reber, 2010). Boozer and colleagues (1992) found that high school students attending schools with higher percentages of black students, regardless of race, obtained fewer years of total schooling. Johnson (2011) capitalized on the wide variation in when and how districts implemented desegregation across the country. He identified a substantively similar result: black students in districts with desegregation orders attained more total years of school. Guryan (2001) found that the black dropout rate declined by about three percentage points (and the white dropout rate was unaffected) during the 1970s at the height of the implementation of desegregation orders, and Reber (2010) found that the black graduation rate increased when desegregation orders went into effect.

One drawback of these studies is that they are many decades old. Although many factors have persisted in the intervening decades, including racially isolated schools and racial inequalities in test scores and school resources, many factors have changed. For instance, school funding has changed such that, at least in dollar amounts from federal and state governments, there are fewer disparities in spending at predominantly minority versus predominantly white schools (Johnson, 2011; Murray and Reuben, 2008).

An update on the consequences of school segregation with more recent data is needed. In the past two decades, hundreds of school districts have been lifted from court

oversight, providing opportunities to examine what happens when desegregation is reversed. Saatcioglu (2010) used data from Cleveland and found that when desegregation orders were lifted, the dropout rate among Blacks and Hispanics increased. Similarly, Lutz (2011) found that black students dropped out at higher rates in all locales across the country except the South. Using data from Charlotte-Mecklenberg after boundaries were redrawn in 2001, Billings, Deming, Rockoff (2014) found that whites attending schools with larger proportions of minorities were less likely to graduate from high school or attend four-year colleges, despite district efforts to reallocate school resources more equitably.

Recent studies that examine the relationship between the racial composition of students' schools and educational attainment have generally found that attending minority-segregated high schools is negatively associated with college attendance and completion. California students attending minority-segregated high schools were far less likely to apply, be admitted to, or enroll in the University of California than were students at predominantly white and/or Asian schools (Martin, Karabel, & Jaquez, 2005; Teranishi, Allen, & Solarzano, 2004; Teranishi & Parker, 2010). Other studies using national data found that when both the racial *and* socioeconomic composition of the high school were included in analyses, the socioeconomic composition of students' high schools was a stronger predictor of postsecondary outcomes than racial composition, although there typically continued to be an independent negative association between minority concentration and college enrollment (Engberg & Wolniak, 2010; Hill, 2008; Palardy, 2013; Perna & Titus, 2005).

What factors are responsible for the negative relationship between minority concentration in secondary schools and college attendance? Although identifying factors specifically responsible for the impact of racial composition on student outcomes is not the focus of this dissertation, it provides theoretical reasons for why we might expect attending schools with high concentrations of black students to be detrimental for college outcomes.

The factor studied most often in the desegregation literature is school resources. If the distribution of school resources is correlated with student racial composition, then attending schools with different racial composition will lead to different student outcomes (Reardon & Owens, 2014). For instance, research finds that minority-concentrated schools have fewer highly qualified teachers and are less able to retain them, have fewer rigorous course-offerings and are less able to adequately staff them, and suffer from larger class sizes (Betts, Reuben, & Danenberg, 2000; Boozer et al., 1992; Darling-Hammond, 2004). If these school resources affect student educational outcomes, then students attending minority-concentrated schools will have diminished educational outcomes relative to their peers at majority white schools.

School resources—course offerings, teachers, and class sizes—are important components of academic preparation. Academic preparation, whether conceptualized and measured through student coursetaking, academic achievement on standardized tests, or placement in “college preparatory” tracks, is one of the strongest predictors of college enrollment (Cabrera & Nasa, 2001; Perna & Titus, 2005). Students with higher academic preparation, such as more rigorous mathematics and science course sequences, are more

likely to enroll in college (Engberg & Wolniak, 2010; Mortenson, 1991; Schneider, Swanson, & Riegle-Crumb, 1997). Minority-segregated schools have, on average, fewer course offerings and fewer Advanced Placement courses (Zarate & Pachon, 2006), thereby limiting the level students attending such schools can reach prior to graduation and, in turn, diminishing the likelihood of college attendance.

School resources can also include the availability of school personnel, guidance counselors, and formal within-school organizational structures that assist students during the transition between high school and college. Early studies that compared schools with different characteristics—not necessarily focused on the racial composition of the school—found that students’ college-going behaviors were related to resources within the school, including guidance counselors, as well as formal practices of the school such as counseling programs (Hill, 2008). McDonough (1997) found large variation between high schools in the resources and structures available to prepare students for navigating the college application and enrollment process, and found that this was strongly related to a successful transition from high school to college.

Some of the deficits in resources are correlated with minority concentration. High minority schools were less likely to have “hands-on” strategies (e.g., counseling sessions, one-on-one help to complete applications and financial aid) to help students transition to college, and college enrollment rates for students at these schools was far lower than for students at schools with more proactive, hands-on strategies (Hill, 2008). If black-segregated schools generally have less availability of guidance counselors and counseling programs and can give less time and attention to individual students to facilitate college

applications, and if these resources are strongly correlated to successful transitions between high school and college, then we would expect students attending black-segregated schools to have lower probabilities of entry into postsecondary institutions than their peers at predominantly white schools.

Peer effects are another way through which the racial composition of secondary schools might affect student educational outcomes, including achievement, attitudes, and attainment. The theory of peer effects posits that the school social composition shapes the peer environment by affecting the educational values, norms, attitudes, and academic skills of students. Interactions between students transmit these values, norms, attitudes, and skills and can affect an individual student's educational achievement, expectations, and attainment (e.g., Coleman et al., 1966; Hanushek, Kain, Markman, & Rivkin, 2003; Jencks & Mayer, 1990; Palardy, 2013).

Peer effects during secondary school may play a powerful role in shaping students' postsecondary experiences. McDonough (1997) found that having strong postsecondary aspirations early in high school was predictive of college enrollment, much more so than having such aspirations later in high school. If peers affect individual student aspirations, then attending school with many high-aspiring peers would lead to increased personal aspirations, which would in turn enhance the probability of attending college. Linking these peer effects to school racial composition would require evidence that postsecondary aspirations differ by race. Prior studies, however, do not find strong differences by school racial composition in the aspiration of students to attend college

(Goldsmith, 2004), suggesting that peer effects are not the primary way that racial school segregation affects educational attainment.

Other studies of peer effects focus on how the average achievement of the student body affects individual students above and beyond their own prior achievement and background characteristics. The student bodies in black- or minority-concentrated schools tend to have lower average academic achievement (Logan et al., 2012). Prior research has found that, through peer effects, attending schools with higher concentrations of black students lowers academic achievement (Hanushek et al., 2009; Hoxby, 2002). Because overall school achievement is related to college-going behavior (Cabrera and La Nasa, 2001; Perna & Titus, 2005), students at black-segregated schools would be disadvantaged through the mechanism of peer effects.

In addition to college aspirations and academic achievement, peer effects could influence individual student behavior through the development of behavioral norms. If black-segregated schools concentrate students who engage in behaviors that are negatively associated with college attendance, then peer effects operating through behavioral pathways may explain segregation's negative effect. Some prior researchers have noted that problem behaviors, including delinquency and substance use, have not received much attention in their relationship to student outcomes, but that they have profound and distinct impact on social consequences including educational attainment (McLeod, Uemura, & Rohrman, 2012). Black-segregated schools have generally higher concentrations of low-income students and students from single-parent families, populations that generally have higher rates of problem behavior with the potential to

disrupt classroom instruction (C. L. Bankston & Caldas, 1998; Massey & Denton, 1993; Orfield, 2009). Diminished instruction time may compromise student academic preparation, and a norm of problem behavior may also lead individual students to be influenced by this peer culture and themselves adopt problem behaviors. Prior work has found that student delinquency is negatively associated with educational attainment, net of other background characteristics (McLeod et al., 2012).

Finally, though not a focus in this dissertation, social networks may be a factor through which racially segregated schools affect educational attainment. As students form postsecondary aspirations, they need practical information about opportunities in postsecondary education or the labor force in order to take the necessary steps following high school. Attending black-segregated schools may provide students with one set of information, while attending schools with a more diverse set of peers may avail students of a broader social network. Because of the strong correlation between race, poverty, and educational attainment in the United States, attending black-segregated schools generally means attending schools with higher proportions of low-income students who have less-educated parents. Students with this network may have less access to information needed to successfully transition from high school to college and to persist in college through graduation.

Empirical findings on consequences of segregation exposure. To date, few studies have examined the temporal dimensions of exposure to segregated schools to understand whether differences in the timing, duration and stability of exposure to black-segregated schools have implications for later life outcomes. We know very little about

whether exposure to black-segregated schools earlier or later in one's educational career is more consequential, whether attending black-segregated schools for longer periods cumulates disadvantage, and whether stable exposure has different outcomes than moving into and out of schools with different racial compositions. In short, although prior work has generally found a negative relationship between segregation exposure and educational outcomes, we have little information on how the timing, duration, and stability of exposure over the early life course affect later life outcomes.

Measuring the racial composition of students' schools at a single point in time is problematic because the educational experiences of students cannot be captured in any one moment. Students can move in and out of schools with different racial compositions, which means they could experience black-segregated schools for different total lengths of time and at different points in time. Therefore, considering each temporal dimension alone is an important step forward in understanding the consequences of racial school segregation on educational attainment. But considering each one alone is insufficient for understanding how exposure to segregated schools throughout a student's educational career—that is, a student's exposure trajectory—matters for postsecondary educational outcomes. For instance, if we only examine the *timing* of exposure, we conflate students who experience consistently high exposure with students who experience exposure in just one single, isolated period. Grouping these two students likely attenuates the expected negative consequences of black school segregation on college outcomes. Similarly, if we just examine the *duration*, we risk grouping students who are consistently exposed to segregated schools for a period of time with students who move in and out of segregated

schools but still end up experiencing the same total duration. Alternatively, we may group students who experience the same total duration of exposure but at different periods of development. Given the developmental stages of children, exposure to segregated schools at different times (middle school versus high school) could have different effects on educational outcomes. In short, potential confounding of different temporal dimensions is problematic because it is not reasonable to assume that they operate independently (Lee, 2014). To avoid this problem, it is necessary to examine the timing, duration, and stability of exposure simultaneously by estimating the impact of different segregation exposure trajectories on college outcomes.

Prior literature on temporal dimensions of segregation exposure. There are three notable exceptions to the lack of attention to temporal dimensions. Two studies have examined the effects of duration. Johnson (2011), exploiting variation in the timing of when desegregation orders were first implemented in districts, found that the longer students spent in desegregated schools, the better their educational attainment. His results indicated a dose-response relationship, with each year of exposure to segregated schools translating to a three percentage-point increase in the likelihood of graduating from high school and an almost 0.1 of a year increase in education attainment. Mickelson (2001) found results in similar direction using data from the Charlotte-Mecklenburg school district. Her study included a longitudinal measure of exposure to segregated black schools and found that the longer a child attended racially isolated black elementary schools, the larger the direct negative effect on achievement and academic track placement.

One study has looked specifically at the timing of exposure. Billings et al. (2014) took advantage of the rezoning of school attendance boundaries in Charlotte-Mecklenburg after the desegregation order was lifted in 2001 and examined whether high school students were more affected by the resegregation of schools than middle school students. They found that attending a school whose share of minority students increased was more detrimental for students already in high school when the order was lifted compared to students who were in middle school at the time. Those in high school had a lower probability of attending college. This study suggests that the *timing* of exposure to minority-segregated schools is important for educational attainment.

These studies underscore the need to broaden our measure of exposure to school segregation by demonstrating that differences in timing and duration of exposure translate to different educational consequences for students. Not only should each temporal dimension be considered alone, but temporal dimensions must also be considered simultaneously so that we can better understand whether and how different exposure trajectories are consequential for later life outcomes.

Considering mechanisms in a temporal framework. Why might measuring exposure over time reveal effects that are larger or differ across temporal dimensions? The discussion below reconsiders consequences for segregation exposure and suggests possible mechanisms for illustrative purposes. The goal of this section is not to set up testable hypotheses related to mechanisms; instead, these suggested mechanisms illustrate the need to look longitudinally at students' segregation exposure. My primary objective is

to test whether and how differences in patterns of segregation exposure affect college enrollment and completion.

There are two plausible hypotheses with respect to how *timing* of exposure may matter for college outcomes. Because black concentrated schools generally have fewer resources, including challenging curriculum and highly qualified teachers, early exposure may set students on a lower coursetaking trajectory early in their educational careers that is difficult to deviate from in later grades. Alternatively, exposure to black segregation in later grades may be most harmful for college enrollment because access to academically oriented peer climates and extracurricular resources such as guidance counselors may be essential for successfully transitioning from high school to college. I expect early exposure may be more detrimental than later exposure because of the lasting effects of early disadvantage on later academic coursework, which will limit students' academic preparation and in turn affect their college-going intentions and ability to succeed academically in a postsecondary environment.

Longer *duration* represents more exposure to the disadvantages of black-segregated schools, including fewer educational resources and less academically-focused peer climates. Because these disadvantages have been shown to, on average, negatively influence educational outcomes, longer durations of exposure will likely lead to worse college outcomes. Prior research on cumulative exposure to disadvantage in non-school environments suggests this will be the case (Duncan, Brooks-Gunn, & Klebanov, 1994; Lee, 2014; Wheaton & Clarke, 2003; Wodtke, 2013).

In terms of *stability* (whether students experience stable exposure to segregation or move in and out of segregated schools), changing exposure may be most detrimental due to inconsistencies in teaching, curriculum, and peer environments. Children who are moving into and out of black-segregated schools must constantly adapt to changing contexts which disrupts learning and may prevent the formation of meaningful relationships with teachers or guidance counselors who may be instrumental for the transition from high school to college.

Differential effects by race. The sorting of students by race occurs not only across schools with different racial compositions, but also *within* schools of similar racial compositions. As a result, how changing segregation exposure affects college outcomes likely depends on student race. Prior research finds that minority students benefit the most from integrated school contexts (Mickelson & Nkomo, 2012), with minority students in integrated schools having structural advantages—including improved peer climate, access to better school resources, and postsecondary and job information—over their peers in segregated schools. Moving into less segregated schools may be most beneficial for black and Latino students if attendance at non-black-segregated schools grants them access to resources and information that they would otherwise not have. However, whether or not students benefit from moving into a non-black-segregated school may depend on whether they are able to enroll in higher-level courses, be taught by better-qualified teachers, experience more academically-oriented peer climates, and be privy to useful information on postsecondary education.

Research finds that minority students and low-income students in high-SES schools are often at a disadvantage in accessing academic resources compared to their more advantaged peers (Attewell & Domina, 2008; Crosnoe, 2009; Tyson, 2011). Similarly, the network effects hypothesis is contingent on students of different races being able to gain access to information from individuals who can facilitate entrance into college and labor market positions. Although a significant amount of research finds that minority students benefit from larger networks in integrated schools (Wells & Crain, 1994), some prior research shows that even in completely integrated schools, the way networks connect students to employment or future education varies tremendously by race, with white students receiving more direct support (Royster, 2003). All mechanisms point to improved educational outcomes for students of all races when moving out of black-segregated schools (and similarly, diminished educational outcomes when moving into black-segregated schools) and previous work suggests that black students may benefit most from increased access to integrated or predominantly white schools (e.g., Hoxby, 2002). However, these benefits may be attenuated if the student does not have access to more-advantaged peers, resources, and networks in the new school, which may be related to the student's own race.

Conceptual Model

Figure 1 depicts the conceptual model. Student trajectories of exposure to school segregation result from racial composition changes occurring at the school level (shown by the stylized figure of school-level racial change patterns) and family decisions

surrounding school mobility. A student's trajectory membership is determined by these two dynamic factors as well as student and family background characteristics, including race and parental education. The top section shows that time-varying segregation exposure affects and can be affected by trajectories of adolescent development, including academic coursetaking and problem behaviors. These trajectories, together with time-varying segregation exposure, affect postsecondary educational outcomes.

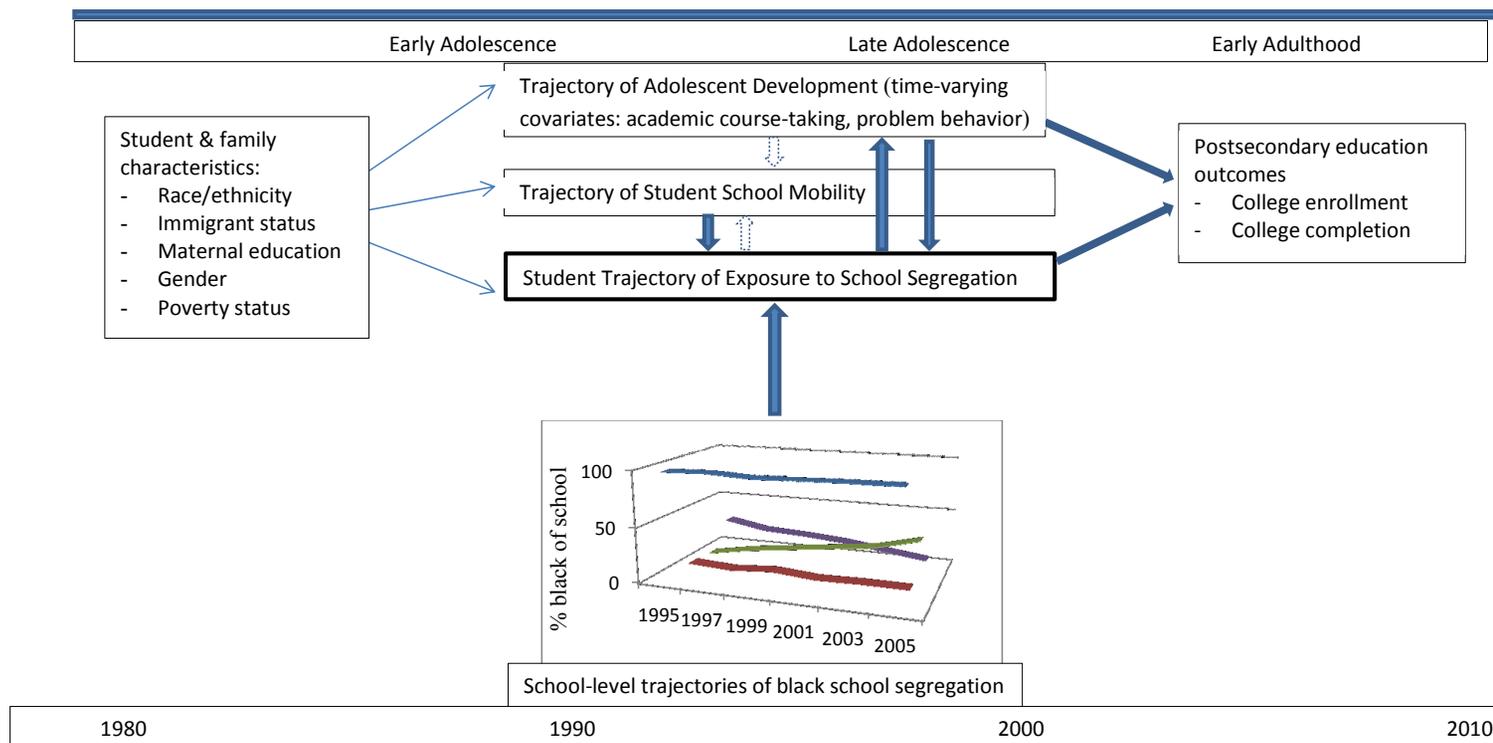
Hypotheses

I expect to find four distinct trajectories of exposure to black school segregation: *stable high exposure* and *stable low exposure* based on high levels of residential and school segregation; *increasing exposure* due to the growing minority population, movement of minorities to the suburbs, the dismantling of court-ordered desegregation programs, and rising school choice options; and *decreasing exposure* resulting from parents seeking out improved educational opportunities as a result of residential mobility or options available through policy changes (H1). School-level changes will significantly predict trajectory membership and will likely be more influential than students' mobility across schools given the entrenched residential and school segregation over the period of interest and families' differential ability to access schools with low black segregation (H2).

Exposure to black-segregated schools will have a negative effect on college enrollment and college completion (H3). Early exposure will be more detrimental than later exposure—i.e., belonging to an increasing versus decreasing exposure trajectory—

because of the lasting effects of early disadvantage on later academic coursework (H3a). Longer periods of segregation exposure will result in lower likelihood of college enrollment and completion because of the longer duration of disadvantage, suggesting that the effect of stable exposure to black-segregated schools will be most harmful (H3b). I expect negative effects of exposure to black-segregated schools for both black and non-black students (H3c). The consequences of exposure for black students may appear less detrimental than those for non-black students, however, because of racial disparities in accessing resources within integrated schools. The resources available in black-segregated and non-black-segregated schools may be more similar for black students than for their non-black peers, leading to smaller differences in the outcomes. I expect that the negative effect of segregation exposure will operate primarily through reduced academic resources, resulting in lower levels of academic coursework for students in black-segregated schools and preventing students in those schools from being sufficiently academically prepared for college. I additionally expect that the negative effect of segregation exposure may operate through peer climates and the development of problem behaviors, which detracts from educational attainment.

Figure 2.1. Conceptual Model.



Student trajectories of exposure to black school segregation are the result of racial composition changes that occur at the school-level and switching schools, as shown by bold arrows pointing from school-level trajectories and trajectory of student school mobility to the student trajectory of exposure. These factors, together with student and family background characteristics determine membership in student trajectories of exposure to school segregation. ◇ Students experience interlocking developmental trajectories during adolescence (Elder, 1998). Developmental trajectories, including academic course-taking and problem behaviors, predict college success, but they can also affect and be affected by segregation exposure, as shown by the two bold reciprocal arrows between trajectories of exposure and adolescent development. This conceptual model incorporates the direct and indirect effects of time-varying exposure to segregation on college outcomes.

Chapter 3: Data Sources

The analyses in this dissertation employ data from three sources: the National Longitudinal Survey of Youth 1997 (NLSY97), the Common Core of Data (CCD), and the Private School Survey (PSS). The NLSY97 is administered by the Bureau of Labor Statistics and the CCD and PSS are administered by the National Center for Education Statistics.

National Longitudinal Survey of Youth 1997

The National Longitudinal Survey of Youth 1997 (NLSY97) 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. Eligible youth and their parents were administered questionnaires that asked about work experiences, schooling experiences and school history, background characteristics, and attitudes. They were also given aptitude tests, including the Armed Services Vocational Aptitude Battery (ASVAB).

Sampling Design. The NLSY97 survey contains two samples—a cross-sectional sample that represents the overall target population and a supplemental sample that oversamples Hispanic and non-Hispanic black youth to provide statistically efficient estimates for this group. Both samples were selected in a three-stage design. First, primary sampling units (PSUs) were defined and sampled (100 PSUs each for the cross-sectional and supplemental samples). The PSU for the cross-sectional sample were Metropolitan Statistical Areas (MSAs) or single counties or county clusters for

nonmetropolitan areas. The PSUs for the supplemental sample were single counties. Second, PSUs were divided into single census blocks or groups of census blocks and sampled (1,151 for cross-sectional and 600 for supplemental). After enumerating all addresses within the selected census blocks, the third stage of sampling selected addresses from the list. The supplemental sample sampled addresses in areas identified as high density of black or Hispanic youth at 10 times the rate of sampling as in the areas identified as having low density of black or Hispanic youth. There were 9,808 age-eligible youth who were screened into the NLSY97. There were 8,894 who completed an interview, and 7,168 who completed the Armed Services Vocational Aptitude Battery (ASVAB) test (Moore et al., 2000).

Weighting. Weights are provided in the NLSY97 to account for issues that arise in survey samples that may introduce bias to estimates. These issues include differences in selection probabilities of individual cases due to oversampling of certain groups (e.g., black and Hispanic youth); subgroup differences in participation rates; sampling-induced deviation from known population totals; and survey under coverage. The NLSY97 provides two broad sets of sampling weights—cross-sectional weights for a given year and panel weights for longitudinal analysis for respondents who are in every round of data collection from the initial round through a given round.

The analyses in this study use the sampling weights for descriptive statistics in order to produce estimates of population characteristics. As suggested by the NLSY97 documentation and many social scientists, the sampling weights are not included in any of the analytic models because using weights to correct potential biases in standard errors

often introduces additional bias in estimates (Center for Human Resource Research, n.d.; Winship & Radbill, 1994).

Survey Components and Questionnaires. The first round of data collection occurred in 1997 and as of 2014, 15 waves of data were available from follow-up interviews through 2011. During the first round, all parents were asked about the respondent's complete schooling history beginning in 7th grade, regardless of how old the respondent was at the time of the first interview. In all subsequent rounds, youth respondents reported all schools they attended since the date of the last interview. The combination of parent retrospective and student follow-up questions on schooling make the NLSY97 data ideally suited for identifying and predicting trajectories of exposure to school segregation. Although other data sources contain student school information, including studies from the National Center for Education Statistics, no other national studies record a complete schooling history with the level of detail present in NLSY97. The survey also included modules on a variety of topics that provide detailed contextual information about youth and their families. This study uses yearly information collected from youth on their schooling, employment, family structure, and program participation.

The NLSY97 is well suited for studying the consequences of exposure to black school segregation on college outcomes for two major reasons. First, it contains unusually rich background information on adolescents and their families that are helpful for avoiding confounding in quasi-experimental methods. In addition to rich data from baseline interviews, respondents were interviewed annually, which allows me to account for time-varying confounding. Estimates from analyses that do not include such detailed

contextual variables may be biased. Second, the NLSY97 contains 15 waves of data. In 2011, the most recent year for which NLSY97 data is available, the youth from my sample were between 26 and 30 years old. This length of follow-up is appropriate for studying college completion, because over three-quarters of bachelor's degree recipients complete their degrees within six years and the median time to completion for students who begin at a 2-year institution and transfer to 4-year institutions is just over 5 years (National Center for Education Statistics, 2011).

In order to calculate the racial composition of students' schools, it was necessary to merge the NLSY97 data to data sources outside the NLSY97, including the National Center for Education Statistics' Common Core of Data (CCD) and Private School Survey (PSS). The CCD and PSS data sources were merged to the NLSY student data using the school identification variable for every school the student ever attended between 7th and 12th grade.

Common Core of Data

Data on the racial composition of students' schools is drawn from the Common Core of Data Public Elementary/Secondary School Universe Survey. The CCD is an annual universe survey of public schools in the United States that contains descriptive information about each school, including demographic characteristics of students and staff.

The target population for the CCD includes all elementary and secondary schools in the 50 states and the District of Columbia that provide free education to children.

Information from Bureau of Indian Affairs (BIA) and Department of Defense (DoD) schools as well as data from schools in outlying areas, including American Samoa, Guam, the Commonwealth of the Northern Mariana Islands, Puerto Rico, the Virgin Islands, are also collected but are not used in this analysis. I rely on CCD data from the 1992-93 academic year through the 2010-11 academic year. Prior to 1993, many states did not collect racial/ethnic data on their public school populations, including Georgia, Idaho, Maine, Missouri, Virginia, Wyoming, South Dakota, and Montana. Where possible, values were imputed using data from the academic year immediately following.

Private School Survey

The Private School Survey (PSS) is a biennial universe survey of private schools in the United States that began in 1989-90. The survey collects information on the total number of private schools, including the school size, grades served, religious orientation, and teacher and student characteristics. The target population for the PSS is all schools in the 50 states and the District of Columbia that are not primarily supported by public funds, that serve children in grades K–12, and that employ classroom teachers. Schools that serve homeschooled children are not included if they do not have classroom-based instruction. The survey population is drawn from a few sources. The first is a list of respondents from the original 1989-90 survey (the first year the survey was fielded). The second source updates the original list by comparing it to school lists provided by private school associations, state departments of education, and other private school guides.

Racial composition data was not collected for private schools until the 1993-94 survey year. Because the survey is collected only every other year, values for the racial composition for the off years are imputed with the values in the previous survey year.

Methods

The three different analytic methods used for each of the three analyses are described in detail within each analytic chapter. As a brief introduction, the first analysis uses longitudinal latent class analysis (LLCA) to identify and describe the patterns of exposure to black-segregated schools that secondary students experience over time (Feldman, Masyn, & Conger, 2009; Muthén & Muthén, 2000). The second analysis relies on marginal structural models (MSM) to estimate the consequences of different patterns of segregation exposure on postsecondary educational outcomes. These models use inverse probability of treatment (IPT) weights to estimate weighted regression models (Hernán, Brumback, & Robins, 2002; Robins, Hernán, & Brumback, 2000). The third analysis again uses LLCA to identify longitudinal patterns of segregation exposure in conjunction with developmental trajectories in order to investigate possible mechanisms underlying the effects of segregation exposure on college outcomes.

Chapter 4: Student Exposure to Black School Segregation

This chapter describes student exposure to black school segregation during middle and high school by identifying exposure trajectories. As outlined in the conceptual framework, segregation exposure can result from several factors. Structural factors—including neighborhood segregation and educational policy—contribute to the racial composition of schools. Students who remain in a given school will experience any racial composition changes it undergoes. Individual factors—including family school preferences and decisions to switch schools—also determine an individual student’s exposure. The analyses explore whether school-level changes and student school mobility significantly predict membership in different exposure trajectories and which factor is relatively more important.

Rationale for Multiple Distinct Trajectories

Previous segregation literature and the scenarios outlined in Chapter 2 suggest there is heterogeneity in the student population with respect to segregation exposure over time. Specifically, the school segregation literature suggests two dominant exposure trajectories. I expect a stable high exposure trajectory for students who consistently attend predominantly black schools through middle and high school. Many urban schools have large concentrations of black students for whom moving out of the city and into more integrated suburban schools is unlikely without assistance from housing mobility or

voucher programs.¹ Conversely, the segregation literature suggests a second trajectory marked by stable exposure to low black school segregation. These students either attend predominantly white schools that do not experience racial change or they switch to schools that are predominantly white when their original school experiences racial change (e.g., “white flight”).

There is also support for the existence of dynamic trajectories. The literature on school mobility and family decision-making suggest that families will seek out the best educational opportunities for their children which are often schools with higher average academic achievement (Hanushek et al., 2004). These schools tend to have larger percentages of white or Asian students (Logan et al., 2012), suggesting a third trajectory of decreasing exposure to black school segregation composed of students who begin in schools with high concentrations of black students and change schools. Finally, from the demographic perspective, the large movement of minorities to the suburbs and the resulting transition of suburban schools from white or integrated to predominantly minority suggests a fourth trajectory of exposure for students remaining at those schools—one marked by increasing exposure to black segregation. Desegregation and school choice policies also support the existence of dynamic exposure trajectories. Students who remain in schools in districts where desegregation policies have been lifted or where school choice is introduced may experience either increasing or decreasing

¹ Even when families are given the opportunity to move to more suburban locations with less racially segregated schools, they often do not change their children’s school or they move back to segregated neighborhoods and schools after the initial relocation (DeLuca & Rosenblatt 2010; Clampet- Lundquist & Massey, 2008).

exposure to black racial composition depending on whether the student population becomes increasingly black or white, respectively.

Data and Methods

Analytic Sample. The analytic sample for this analysis includes 6,844 students from the National Longitudinal Survey of Youth, 1997 cohort (NLSY97). The sample was restricted to include respondents who were missing no more than one year of school racial composition data and who attended at least one school between 7th and 12th grade.² The data were truncated to keep a maximum of six years of secondary school data, which represents the standard grade progression from 7th through 12th grade.³ Missing data are imputed with multiple imputation using the `mi impute chained` command in Stata12 (White, Royston, & Wood, 2011). All imputed datasets are analyzed separately; results presented in this chapter are from the first imputed dataset.

Measures. The dependent variable is student exposure to black school segregation. Students are classified into distinct exposure trajectories based on their exposure to black school segregation between 7th and 12th grade. For each grade, a child is considered to be exposed to a segregated school if he attends a school that is 50–100 percent black. Various cutoffs have been used to define segregated schools (Hoxby, 2002; Mickelson, 2001; Orfield, 2009). I chose to define black-segregated schools as those that were majority black because this includes schools with a large over-

² The decision to limit the analysis to respondents with no more than one year of missing school racial composition data was made because of the multi-level complexities associated with accurately imputing the outcome variable (racial composition of students' schools).

³ There were 726 respondents in the analytic sample with more than six years of secondary school data. These students repeated one or more grades during secondary school.

representation of black students (more than three times the overall national percentage of black students). This designation also permits an analysis that includes black and non-black students. A more restrictive definition of black-segregated schools (e.g., 90–100 percent black) would have limited the analysis to so few non-black students that race could not be incorporated as a control variable.⁴

Calculations were based on data from the CCD, PSS, and NLSY97 data files that contain racial composition information for all students' schools. For students remaining in the same school for several years, racial composition calculations were made for each academic year. Data from these time points were used to construct student exposure trajectories.

Explanatory variables. The first key variable used to explain student membership in different exposure trajectories is the type of racial change that occurred at the student's 7th grade school during the 1990s and 2000s.⁵ School-level trajectories of racial change were constructed using racial composition data from CCD and PSS. Each student's 7th grade school was classified into a trajectory based on its pattern of percentage black during the 1990s and 2000s. The trajectory of the school's racial composition was modeled using growth mixture modeling (GMM) (Muthén, 2004; Muthén & Shedden, 1999).⁶

⁴ While the main results presented define black-segregated schools as those that are 50–100 percent black, robustness checks using different cutoffs for black segregated (33–100 percent black; 90–100 percent black) are included in the Results section.

⁵ Racial composition data is not available in the PSS until 1993–94. School-level segregation trajectories were constructed using data from 1993–2007. Racial composition data from 1990–2007 was used to construct segregation trajectories for public schools.

⁶ See Appendix A for additional details on growth mixture modeling.

Analyses were run separately for private and public schools. In order to create one categorical variable that could be merged back to the NLSY respondent, results from the public and private school GMM were combined. The resulting four classes were (1) *stable low* for schools with consistently very low percentage of black students; (2) *mid-low increasing* for schools with a moderate percentage of black students that increased over time; (3) *mid-high decreasing* for schools with a moderately high percentage of black students that decreased over time; and (4) *stable high* for schools with consistently very high percentage of black students.⁷ Tables A.1 and A.2 provide results from the GMM analysis.

Each school was classified into its most-likely latent class and then merged back to the NLSY student file, such that every respondent had an indicator for the trajectory of racial change that their 7th grade school experienced. For instance, a student who attended 7th grade at a school that was 90 percent black in the early 1990s and experienced a declining proportion of black students over time would be coded as “3” for attending a *mid-high decreasing* school in 7th grade.

The second key explanatory variable for student trajectory membership is the student’s school mobility. A student was coded as changing schools every time there was report of attending a new school. A categorical variable was created from the total number of times the student ever changed schools: 1: one school change; 2: two school changes; 3: three or more school changes; and 4: zero school changes. One school change

⁷ The GMM identified four latent classes as the optimal number of distinct trajectories for private schools and five latent classes as the optimal number for public schools. For public schools, the two latent classes with positive slopes were combined to create the *mid-low increasing* class.

serves as the reference category since the majority of students experience one school change between 7th and 12th grade, typically when high school begins in 9th grade.

Control Variables. The analysis included several time-constant control variables that are related to racial segregation. These include student race/ethnicity, immigrant status, highest parental education, whether the parent ever received government aid, region of country when child was 12 years old, and whether the student attended 7th grade at a public or private school. Race/ethnicity was dummy-coded 1 for non-Hispanic black and 0 for non-black; immigrant status was dummy-coded 1 for respondent and/or his parents being foreign born and 0 for not; highest parental education was dummy-coded as 1 for receiving more than a high school diploma and 0 for receiving a high school diploma or less; and ever receiving government aid was coded as 1 for yes and 0 for no. Region is a four-category variable (1: Northeast, 2: North Central, 3: South, and 4: West). Attending a private school in 7th grade is a dummy variables coded as 1 if the respondent attended a private school in 7th grade and 0 otherwise. Including these variables assists in isolating the effects of key explanatory variables of interest.

Analytic Strategy. The analytic tasks in this chapter are to (1) describe exposure to black school segregation for a recent national cohort of adolescents during middle and high school; and (2) explain the relative importance of school-level changes and student mobility in predicting membership in different exposure trajectories. I accomplish this by first using latent class analysis to model latent classes of segregation exposure.⁸ I identify

⁸ There exist other mixture-modeling strategies in addition to latent class analysis, including growth mixture modeling. Latent class analysis uses response patterns to categorical variables to detect distinct latent classes, while growth mixture modeling uses continuous variables. Latent class analysis is used in this analysis to avoid imposing a functional form (linear, quadratic, spline) as is necessary in growth

qualitatively distinct patterns of exposure to black-segregated schools between 7th and 12th grade. I then simultaneously model the trajectory classes as latent nominal outcome variables using the multinomial logit modeling framework.

The overall objective with LCA is to identify subgroups within a larger population of individuals. LCA models a categorical latent variable C based on multiple observed indicators ($Y_1, Y_2, Y_3, \dots, Y_j$) and each individual belongs to one of the C latent classes ($C_1, C_2, C_3, \dots, C_C$) (Muthen, 2001; 2004). Within each latent class, individuals demonstrate similar response patterns among the observed indicators (Collins & Lanza, 2013). For instance, there may be one latent class with a low probability of endorsing all of the indicators, while another class has a high probability of endorsing all indicators.

The two parameters of primary interest when fitting an LCA model are the posterior probabilities of latent class membership, and the conditional item probabilities. The posterior probability of latent class membership is the probability that a given individual with an observed pattern on the indicators belongs to latent class c . The conditional item probabilities are defined as the probability of endorsing an item conditional on class membership. Let $j = 1, \dots, J$ observed variables such that each observed variable has $r_j = 1, \dots, R_j$ response categories. This leads to a contingency table with $\prod_{j=1}^J R_j$ cells such that each cell corresponds to a complete response pattern for the j variables. Then, $y = (r_1, \dots, r_j)$ and $P(Y = y)$ is probability of response pattern y . The posterior probabilities are then denoted $\gamma_{c|y} = \Pr(C = c|Y = y)$ and defined as the

mixture modeling. Theoretically, this allows for the identification of a latent class that has multiple moves into and out of segregated schools over the course of secondary school. Robustness checks for the findings presented here were made using various cutoffs for the definition of black-segregated (33 percent, 90 percent) as well as a linear growth mixture model.

probability of membership in latent class c given response pattern y . The conditional probabilities for binary indicators are then denoted $\rho_{j,r_j|c} = \Pr(Y_j = 1|C = c)$ and defined as the probability of response r_j to variable j conditional on membership in latent class c .

Figure 4.1 illustrates the LCA model. The Y s in the figure represent time-ordered dichotomous measures for exposure to black-segregated schools that equal 1 if the student attended a school at time t that was 50–100 percent black and 0 otherwise. C represents a latent categorical variable with c trajectory classes ($c= 1, \dots, C$) that are estimated by the model, where $c_{ci}=1$ for individual i who is most likely to fall into latent class c . X represents covariates, including baseline covariates (student race/ethnicity; parental education; immigrant status; government aid; U.S. region of residence at age 12; private school attendance in 7th grade) and explanatory variables (segregation trajectory of students' 7th grade school and student school mobility). Covariates are incorporated into LCA within the multinomial logistic regression framework, with one latent class designated as the reference class. The latent class variable is regressed on the covariate(s) X .

$$P(C = c|X = x) = \frac{e^{\beta_{0c} + \beta_{1c}x}}{1 + \sum_{c=1}^{C-1} e^{\beta_{0c} + \beta_{1c}x}}$$

The parameter $e^{\beta_{0c}}$ can be interpreted as the odds of membership in latent class c in relation to the reference latent class C when $X=0$. The effect of covariate X , $e^{\beta_{1c}}$, is the change in odds of membership in latent class c in relation to latent class C associated with a one-unit change in X .

Model building proceeded by first estimating the number of distinct trajectory classes, determining the optimal number of latent classes by step-wise increasing the number of classes estimated under a given measurement model. I began with one latent class and added an additional latent class in each successive model run, comparing four indices of relative model fit across model runs (Muthén & Muthén, 2000). I first examined the Bayesian Information Criteria (BIC) for which the lowest value indicates the best-fitting model. I next examined the Lo-Mendel- Rubin Likelihood Ratio Test (LMR-LRT) which compares the model fit of the current model to a model with one fewer class. In this test, p-values higher than 0.05 indicate that adding the additional class does not significantly improve the model fit. Third, the quality of classification is determined by the entropy value, which ranges from 0 to 1. Higher values indicate better classification of individuals into their most likely latent class. Finally, I considered the substantive interpretability of the model with an additional class versus the model with one fewer class.

I then added covariates to the model and verified the stability of latent classes in models with and without covariates (Petras & Masyn, 2010). I present results for the final model, which includes baseline covariates, the school-level racial changes occurring at the student's 7th grade school, and student school mobility. In the presentation of results, I first examine whether school-level racial change impacts the exposure trajectories of students. Significant coefficients indicate whether the student's 7th grade school trajectory is predictive of the student's own exposure trajectory, controlling for all other covariates. Second, I look at whether student school mobility is a significant predictor of

student segregation exposure trajectories. Coefficients for student school mobility as a predictor will indicate whether, net of all other covariates, school mobility significantly influences student exposure trajectories. Finally, the size of the coefficients will determine the relative importance of school mobility and school trajectories in shaping students' exposure trajectories. All models are estimated using Mplus v7.1.

Results

Table 4.1 presents the summary statistics for the analytic sample. About half (51 percent) of all students made only one school change between 7th and 12th grade, while 20 percent changed schools twice, and 20 percent changed schools three or more times. Just 8 percent of students never changed schools between 7th and 12th grade, indicating attendance at schools serving middle and high school grades. These percentages differed by race, with black students experiencing more mobility than non-black students (48 percent of black students made two or more school changes compared to 39 percent of non-black students).

Focusing on the racial changes occurring in the schools students attended in 7th grade, we find that in the overall sample, a majority (79 percent) of students attended a 7th grade school that had *stable low* black concentration. Thirteen percent attended a school in 7th grade that had an *increasing* black concentration, 6 percent attended a school with a *stable high* black concentration, and 3 percent attended a school in 7th grade that had a *decreasing* black concentration. There is a striking disparity between black and non-black students in the racial composition changes of their 7th grade schools.

A substantial proportion of black students (30 to 31 percent each) attended *stable high* black concentration schools, *stable low* black concentration schools, and *moderate-low increasing* black concentration schools. In comparison, an overwhelming majority of non-black students attend *stable low* black concentration schools (88 percent), while 2 percent of non-black students attend schools with *decreasing* black concentration and 1 percent attend schools with *stable high* black concentration.

There are differences across other covariates by student race. Black students are more disadvantaged in several domains: they were more likely to have parents who had received government assistance, less likely to have parents with more than a high school diploma, and less likely to attend private school in 7th grade. Regional differences also exist. Non-black students are relatively evenly distributed across the Northeast, North Central, South, and West regions; blacks, in contrast, are more heavily concentrated in the South and underrepresented in the West.

Exposure to black-segregated schools in secondary school. Overall, 10 percent of students attended a school that was 50–100 percent black during 7th grade, as shown in Table 4.1. However, about 53 percent of black students attended such a school in 7th grade compared to only 3 percent of non-black students. Similar differences by race maintained throughout secondary school. Based on the types of 7th grade schools students attended, it is not surprising that only 5 percent of non-black students ever attended a majority black school compared to 63 percent of black students. Non-black students have far less exposure to segregated black schools throughout secondary school.

Exposure over time: identifying distinct trajectory classes. The overall

percentage of students attending majority-black schools is relatively stable over time, but it is unclear whether the overall percentage is masking students who are exiting majority-black schools while others are entering. That is, it does not reveal underlying groups of students who may follow different trajectories of segregation exposure.

The model fit results from the latent class analysis (LCA) for models with and without covariates included are presented in Table 4.2. For the models with covariates, the BIC declined with each increasing class through four latent classes, and then increased when the fifth class was added. The p-value for LMR-LRT was significant through all latent classes indicating that adding an additional latent class fit the data statistically significantly better than the model with one fewer class. The entropy (probability of classification into each latent class) was very high throughout. The BIC criterion points to the 4-class model fitting the data best. Furthermore, because the 5-class model did not identify a latent class with substantively different meaning than the 4-class model, the 4-class model proved the best and more parsimonious choice.

Figure 4.2 displays the estimated probability of attending a majority black school during each year of secondary school for each of the four identified classes. The majority of students have a very small probability of attending a majority black high school throughout the entire period. Seventy-nine percent of students belong to the class I label *consistently non-exposed to black-segregated schools* (or *consistently non-exposed*). The second largest class, in contrast, experiences an extremely high probability of attending a majority black school throughout secondary school. Thirteen percent of the sample belong to the *consistently exposed to black-segregated schools* (or *consistently exposed*)

class. The remaining two classes have a smaller proportion of students, but contain students whose probability of exposure to black-segregated schools is dynamic. The third class—*exiting black-segregated schools (or exiters)*—contains about four percent of the sample. These students begin 7th grade with an extremely high probability of attending a majority black school, but this probability falls precipitously through 12th grade, when the mean probability of attending a majority black school is about 0.20. The final latent class—*entering black-segregated schools (or enterers)*—represents the opposite experience of students in the *exiters* class. Approximately four percent of the sample population belongs to this class, and they begin with extremely low probability of attending a majority black school in 7th grade, but every year the probability of attending such a school increases. By 12th grade, the probability of attending a majority black school is about 0.80.

Characteristics of the latent classes. The bivariate relationships between latent class membership and student characteristics are presented in Table 4.3. I expect that the distribution of students will vary across the different latent classes by student and family characteristics. I focus first on the bivariate relationship between student latent class membership and 7th grade school-level racial change. Students in the consistently non-exposed class most often attended 7th grade at a school with stable low black concentration over time (89 percent). Likewise, students who belonged to the consistently exposed class most often attended 7th grade schools with stable high black concentration (58 percent), while another 36 percent attended schools with increasing black concentration. Students who entered black-segregated schools (*enterers*) or exited black-

segregated schools (*exiters*) were more split in the type of racial change their 7th grade school experienced. For instance, *enterers* were about equally likely to attend 7th grade schools with stable low or moderate-low increasing black concentrations. About half (47 percent) of *exiters* attended schools with stable high black concentration and about one-third (33 percent) attended schools that had moderate-low increasing black concentration. Students in this class also had the highest proportion of students attending schools with moderate-high decreasing concentration of black students (14 percent).

School mobility also was associated with latent class membership. The modal number of school moves for all latent classes except the *enterers* was one school change. However, students who entered or exited black-segregated schools more often made two or more school moves.

Other characteristics behave in expected directions. The percentage of black students increased from *consistently non-exposed* (6 percent), to *enterers* (47 percent), to *exiters* (56 percent), to *consistently exposed* (85 percent). Lower parental education, ever receiving government aid, and living in the South were associated with more exposure to black school segregation.

These relationships demonstrate that the distribution of certain characteristics differs across latent class membership. However, they do not control for other characteristics. For instance, students who make more school changes are more likely to belong to the *enterers* or *exiters* class. This bivariate relationship may be driven by the student's socioeconomic status or race, but we cannot know without controlling for other student characteristics. I now turn to the multivariate results that examine the relationship

between each characteristic and latent class membership, net of all other covariates.

Predicting trajectory membership: student mobility and school-level changes.

Enterers, exiters, consistently exposed versus consistently non-exposed classes. I

predicted that exposure trajectory membership would be associated with school-level racial changes. I hypothesized that student school mobility would also influence trajectory membership, but that school-level factors would wield greater influence. By modeling trajectory classes simultaneously as latent nominal outcome variables through a multinomial logit framework, I am able to directly answer these questions. Table 4.4 displays the coefficients (log odds) for covariates in predicting latent class membership. The first three columns compare membership in the *exiters*, *enterers*, and *consistently exposed* latent classes, respectively, versus the *consistently non-exposed* latent class as reference. I first examine the importance of racial change at the student's 7th grade school in predicting his/her own exposure trajectory, focusing on schools with *increasing*, *decreasing*, and *stable high* black concentration, with the *stable low* black concentration as the reference. I then report on the importance of student school mobility in predicting latent class membership. All other covariates serve as controls.

Compared to students who attended 7th grade in schools with *stable low* black concentration, those in *increasing*, *decreasing*, or *stable high* schools were more likely to belong to the *enterers*, *exiters*, or *consistently exposed* classes versus the *consistently non-exposed* class, net of all other covariates. For instance, the odds of students at *increasing* schools were about 4 ($e^{1.40} = 4.04$) times that of their peers at *stable low* schools to belong to the *enterers* class compared to the *consistently non-exposed* class.

Among all students who attended 7th grade in majority non-black schools and controlling for all other covariates, attending a 7th grade school that undergoes *increasing* black concentration strongly predicts that the student himself will experience increasing exposure to black segregation over time. In this sense, the students' experiences mirror the broader change happening around them. The odds were even larger for belonging to the *exiters* and *consistently exposed* classes for students who attended *increasing* black concentration schools in 7th grade relative to those who attended *stable low* schools. The odds of students at *increasing* schools were about 24 times their peers at *stable low* schools to belong to the *exiters* class and 534 times their peers at *stable low* schools to belong to the *consistently exposed* class. The large coefficients indicate that school-level racial change is highly predictive of a student's own trajectory of exposure to black-segregated schools. Attending a school that has anything other than a consistently low concentration of black students greatly raises the odds that students belong to a latent class that experiences exposure to black-segregated schools. Attending 7th grade at a school with *stable high* black concentration translated to the highest odds of belonging to the *enterers* or *consistently exposed* class, with the *consistently non-exposed* as the reference. These results suggest that the racial change patterns of schools matter for student exposure trajectories, and that the types of school students attend in 7th grade is highly predictive of the racial composition they will experience in the following six years.

I also hypothesized that student school mobility would predict membership in exposure trajectories. Net of other covariates, I focus on whether making two school

changes, three or more school changes, or zero school changes predicts trajectory membership, with making one school change (the standard promotional school change between middle and high school) as the reference. Table 4.4 shows that compared to students who made just one school move between 7th and 12th grade, students who made two or more school moves were more likely to belong to the *enterers* or *exiters* classes versus the *consistently non-exposed* class. The most mobile students' odds were about 3 times that of their peers who moved once to belong to the *enterers* class and 2 times to belong to the *exiters* class. These results indicate that, among all students who start 7th grade at non-black-segregated schools and controlling for all other covariates, school mobility (moving two or more times versus just once) significantly predicts membership in the *enterers* class compared to the *consistently non-exposed* class. This suggests that school mobility is negative in the sense that it moves students from non-black-segregated schools into black-segregated schools. Students who never changed schools during secondary school (as compared to students who moved once) were less likely to belong to a dynamic segregation exposure trajectory class (*enterers* or *exiters*) versus the *consistently non-exposed* class. Furthermore, school changes were just marginally predictive of membership in the *consistently exposed* class versus the *consistently non-exposed* class and only for the most mobile students.

Other covariates were also predictive of latent class membership, particularly student race, immigrant status, and the U.S. region the student lived in at age 12. Compared to non-black students, black students were more likely to belong to the *enterers*, *exiters*, and *consistently exposed* classes versus the *consistently non-exposed*

class. Even for students beginning 7th grade at a school with low black concentration, on average, black students are more likely to move into a majority black school by 12th grade than their non-black peers (black students' odds are about 7 times those of non-black students). Relative to students in the Northeast, students in the West were less likely to belong to a class with black segregation exposure (*enterers*, *exiters*, and *consistently exposed*), net of all other covariates. Interestingly, after controlling for other covariates, parental education and parental receipt of government aid were not predictive of latent class membership, suggesting that socioeconomic factors cannot explain student segregation exposure patterns.

Exiters versus consistently exposed. This section addresses whether there are significant predictors of membership in the *exiters* class versus the *consistently exposed* class. That is, what characteristics distinguish students who start at black-segregated schools and leave from students who stay in black-segregated schools throughout middle and high school? Table 4.5 presents results only for the *exiters* class versus the *consistently exposed* class as the reference. To better isolate the relevant relationship between school-level racial change for these two latent classes, I switch the reference category for the school-level racial change categorical variable from *stable low* to *stable high*.

Relative to students in *stable high* schools, students in schools with *decreasing* black concentrations are more likely to belong to *exiters* class than the *consistently exposed* class. The odds of students in *decreasing* schools were about 3 times that of their counterparts at *stable high* schools to be a member of the *exiters* class versus the

consistently exposed class. These findings suggest that student exposure reflects the racial change that is happening around them—attending a school in 7th grade that is undergoing decreasing black concentration strongly predicts that the student also experiences decreasing exposure to black concentration throughout secondary school. In terms of student school mobility, I find that relative to students who change schools just one time, the most mobile students are more likely to belong to the *exiters* class versus the *consistently exposed* class. This may suggest that some families are able to use school mobility as a way to move their children from black-segregated schools into more integrated school settings. Consistent with the results that found black students more likely to belong to the *enterers* versus *consistently non-exposed* class, these results find that black students are less likely to belong to the *exiters* class versus the *consistently exposed*, net of all other covariates. Even among students who begin at schools with similar racial compositions (i.e., majority black or non-majority black), being black is a strong predictor of never leaving black-segregated schools (if starting 7th grade in such a school) or entering black-segregated schools (if not starting 7th grade in such a school). Finally, students who attend private school in 7th grade are more likely to leave black-segregated schools than are their public school peers.

Relative importance of structural and individual factors. The analyses presented here suggest that school-level racial change is substantial and the primary predictor for student exposure trajectories. While the number of school changes is predictive of whether students belonged to a dynamic trajectory (*enterers* or *exiters* classes) controlling for all other covariates, the relative importance of student school mobility was

less than school-level racial changes. Consistently across all latent classes, the results for student school mobility were just a fraction of the size of school-level racial change suggesting that changing schools may not be sufficient to counteract the force of school-level racial composition changes.

Average black composition of schools in different latent classes. The outcome for exposure examined in this analysis was defined as whether the student attended a school that was 50–100 percent black. One limitation of such a definition is that it does not reveal the actual concentration of black students within the school from the latent class results alone. Students attending a school that is majority black could attend one with a simple black majority (51 percent) or attend a school that is hyper-segregated (greater than 90 percent). Similarly, students who attend non-majority black schools could attend a school that has anywhere from 0 to 49 percent black students. It is useful to examine the average black composition of schools among students belonging to each latent class to get a sense of the extent of black segregation in schools attended by students belonging to the different latent classes. Table 4.6 shows that students in the *consistently non-exposed* class attend schools that are, on average, about 8 percent black between 7th and 12th grade. Students in the *enterers* class begin at schools that average about 31 percent black, but by the time the students are in 12th grade, their schools are on average about 66 percent black. Students in the *exitors* class have the opposite experience, with their 7th grade schools averaging about 67 percent black and their 12th grade schools averaging about 32 percent black. Students who belong to the *consistently exposed* class are in schools that average between 78 and 80 percent black.

Descriptive analysis of dynamic latent classes: Who are the enterers and exiters? One concern with the *enterers* and *exitors* classes is that their movement into or out of black-segregated schools could be driven by promotional grade transitions from a relatively more-homogenous middle school to a relatively more-diverse high school. That is, the two dynamic classes identified in the LCA may simply be a function of standard grade promotion from a smaller, more homogenous catchment area (middle school) to a larger, more heterogeneous catchment area (high school). Previous studies of school racial composition raise this as a possible concern (Reardon et al., 2012). My focus here is to examine whether students in these dynamic classes—*enterers and exitors*—are making moves above and beyond standard promotional changes.

Table 4.7 presents the distribution of latent classes across three ways that students might make school moves that are in addition to the traditional promotional transition between middle and high school. First, I find that almost one-third of *exitors* and *enterers* (30 and 32 percent, respectively) change *districts*, not just schools, sometime during middle and high school, a significantly higher percentage compared to *consistently exposed* and *consistently non-exposed* classes. Second, higher percentages of students in the dynamic classes switch school sector—moving from public schools to private schools or vice versa—than their peers in the stable exposure classes. Third, I find that among students who did *not* change districts, significantly higher percentages of students in the dynamic classes made more than one school change between 7th and 12th grade than their peers in stable exposure classes. This suggests that students in dynamic classes are not merely making the single, standard promotional change from middle to high school.

Finally, I consider all three possibilities for mobility together—whether the students changed districts, changed school sector, or made more than one school change—and define students who fall into at least one of these three possibilities as a “mover.” Taken together, I find that 69 and 70 percent of *exiters* and *enterers*, respectively, make some sort of school change that is beyond a standard promotional move, lessening the concern that the previous findings are simply a result of standard school transitions.

Sensitivity analysis. The main results presented above demonstrate that students who are consistently exposed to black-segregated schools have exposure to a much higher concentration of black students, even compared to students who enter or exit black-segregated schools. Using three additional specifications, I explore whether these results are contingent on the particular cutoff definition of 50 percent. I first examine two different cutoff definitions for designating a school as black-segregated—33 percent and 90 percent. Next, I model the student’s school percent black as a continuous variable using growth mixture modeling. In all cases, I test whether the same number of latent classes emerge as the optimal number and whether the average black composition in each latent class is similar to that identified with the four-class model using a 50 percent cutoff.

A much less restrictive cutoff for black-segregated schools (33 percent) has been found in prior research to have negative educational consequences for black and white students (Hoxby, 2002). I conduct the same analysis as before but now define a student as being exposed to black school segregation if he attends a school that is at least 33 percent black. I find similar results to those presented earlier. The four-class model fit the data

best, exhibiting the lowest BIC while still maintaining conceptually distinct classes. The latent classes are identical in their substantive meaning—*consistently exposed*, *consistently non-exposed*, *enterers*, and *exiters*—but differ in the percentage of the sample allocated to each. As we might expect with a lower cutoff, 22 percent of the sample now belongs to the *consistently exposed* class as opposed to 13 percent with the 50 percent cutoff. The black composition of students’ schools in each latent class is substantively similar with the lower cutoff, but is slightly lower. For instance, students in the *consistently exposed* class attend schools that range, on average, from 68–69 percent black for the 33 percent cutoff compared to 78–80 percent for the 50 percent cutoff. Students in the *consistently non-exposed* class attended schools that averaged about 6 percent black throughout secondary school with the lower cutoff compared to about 8 percent black with the higher cutoff.

The term “intensely segregated” often refers to schools that have 90–100 percent minority students (e.g., see Orfield, 2009). These schools are the most disadvantaged on a variety of measures – particularly on the proportion of students attending who live in poverty (ibid.). Using a cutoff of 90 percent black to define exposure to black-segregated schools, I continue to find that the four-class model fit the data best. The BIC was lowest for this class and increased with the five-class model. I find substantively similar classes as in the original analysis, but a much smaller proportion of the sample falls in the *consistently exposed* class (4 percent). Similarly, smaller proportions of students enter and exit these schools (1 and 2 percent, respectively). The black composition of these schools differs as we would expect, given the more stringent definition of black-

segregated. Students in the *consistently exposed* class attend schools that average 96-97 percent black throughout; students in the *non-exposed* class attend schools that are consistently about 16 percent black on average. Within the dynamic classes, students remain on average in majority black throughout secondary school (93 to 59 percent black for *exiters*; 61 to 94 percent black for *enterers*) even though the concentration of black students changes.

Switching from a dichotomous outcome variable to a continuous outcome variable may allow latent classes to emerge that were previously obscured in the transformation of the continuous variable (percent black) into a dichotomous one (black-segregated or not). The use of a continuous outcome requires a different modeling strategy—growth mixture modeling (GMM). I conduct the GMM with a linear functional form. Similar to results from the LCA, I identified four latent classes as the optimal number, with the classes having a substantively similar meaning. The average black composition of schools in the different latent classes also closely mirrored the results from the LCA with a 50 percent cutoff. Students in the *consistently exposed* class attended schools that were average 77–78 percent black; those in the *consistently non-exposed* class attended schools that were about 9 percent black throughout secondary school. The black composition in the *enterers* and *exiters* classes also closely mirrored the results from the original analysis for these two classes. The *enterers* class for the GMM increased from 25 percent black to 68 percent black (compared to 32 to 66 percent black in the original LCA); the *exiters* class in the GMM decreased from 74 percent black to 30 percent black (compared to 67 to 32 percent black in the original analysis).

Discussion and Conclusions

The majority of studies of racial school segregation measure student exposure at a single point in time, thereby unrealistically simplifying student experiences. Many policy and demographic changes have occurred in the past several decades that suggest students may be exposed to schools with varying racial compositions throughout their education. Studies using snapshot measures cannot account for these possible changes in exposure. They also fail to capture important temporal dimensions of exposure, including whether the highest levels of segregation are experienced in earlier or later grades, whether exposure is stable or changing over time, and the total length of time exposed. This analysis attends to the temporal dimensions of exposure to black school segregation by examining whether and why students follow different exposure trajectories.

The analysis contributes two major findings to our understanding of racial school segregation. First, I have identified four distinct trajectories of exposure to black-segregated schools and their black composition. The *consistently exposed* class (13.4 percent of the sample) attends schools that average between 78 and 80 percent black throughout middle and high school; the *enterers* class (3.6 percent of the sample) moves from schools that average 31 percent black in 7th grade to those that average 66 percent black in 12th grade; the *exiters* class (3.5 percent of the sample) goes from 67 percent black in 7th grade to 32 percent black in 12th grade; and the *consistently non-exposed* class (79.4 percent of the sample) attends schools that average 8 percent black throughout secondary school. Students in the United States experience vastly different exposure to

black school segregation between 7th and 12th grade. Although the two largest latent classes, which together account for over 90 percent of the sample, are stable in their (non)exposure, the other two classes enter and exit black-segregated schools over time. Membership in different trajectories translates to very different experience of timing, duration, and stability of black school segregation. For instance, although students in the *exitors* and *consistently exposed* class both have high probability of attending black-segregated schools in 7th grade, the duration of exposure varies greatly for these two groups. Studies that use only exposure at 7th grade as the measure of school segregation exposure conflate students who experience consistently high exposure with students who experience exposure in one single, isolated period. Grouping these two students likely attenuates the expected negative consequences of exposure to black school segregation on educational outcomes. The classes identified in this analysis will allow for more nuanced examination of the effects of different timing on outcomes by separating students who are exposed to black-segregated schools early in middle school versus later in high school.

Second, this analysis provides evidence on the importance of school-level racial change and student school mobility in predicting exposure to segregation. The trajectory of racial change at students' 7th grade schools is the primary predictor of the student's own segregation exposure trajectory, net of other covariates. Student school mobility patterns also matter: students who make more school changes are more likely to belong to the *enterers* or *exitors* classes compared to students who change schools only once. However, the size of the effect for school mobility is not nearly as large as the effect for

school-level changes. Structural factors in the form of school-level racial changes are a much stronger driver of students' experiences of exposure to black school segregation than are student school moves. The results suggest that individual level actions to garner advantage for children by moving to less segregated schools cannot overcome the larger patterns that seem to underlie demographic changes and perhaps residential decisions among the most advantaged. Student exposure to black school segregation appears to be less determined by family socioeconomic characteristics and instead primarily determined by student race and the racial changes occurring in their schools.

Although this analysis extends the literature on school segregation, it does have limitations. One key limitation is the restriction of the analytic sample to students with nearly complete school level racial data. Students who had missing racial data on more than one of their schools were dropped from the analysis. Slightly different proportions in each latent class may be discovered if it were possible to include students for whom racial data on their schools was unavailable. For instance, if schools missing racial data were disproportionately majority-black, then I may have underestimated the proportion of students in who were exposed to majority black schools. In addition, the analysis is simplified by only counting one school per student per academic year. It is possible that some students attended a majority black school for a portion of an academic year that was not included because it was the second school he attended that year. Estimates of exposure to black school segregation may be slightly attenuated because of this. Second, the analysis presented here focuses on the concentration of black students in schools and treats non-blacks as one group. This prevents a full accounting of the racial composition

of students' schools. A school that is 50 percent black and 50 percent white will, on average, have a more advantaged student body than a school that is 50 percent black and 50 percent Latino (Logan et al., 2012). Focusing on the concentration of black students only is unable to distinguish these two different school contexts. Future analyses should consider whether and how exposure to segregated Latino schools, or segregated minority students more broadly, differs from exposure to black-segregated schools.

Despite these limitations, these findings provide a new lens through which we can understand school segregation, particularly from the student perspective. Prior work has shown that 60 years after the *Brown v. Board of Education* decision, there is a rising proportion of racially isolated schools (e.g., see Orfield, 2009). This study finds that some students are so racially isolated that they exclusively attend black-segregated schools, while others are never exposed to such schools. Still others spend some, but not all, of their secondary school career in black-segregated schools. Whether students are ever exposed to such schools is primarily determined by the racial composition changes occurring in the schools around them. As a result, this study points to the need to focus on school-level racial composition changes as the source for student exposure to black school segregation. Efforts to reduce black segregation in schools will be reflected in the students' own exposure. In this respect, many of the policy implications for preventing *student exposure* to black-segregated schools are the same policy implications for reducing racial school segregation more generally.

Figure 4.1. LCA model.

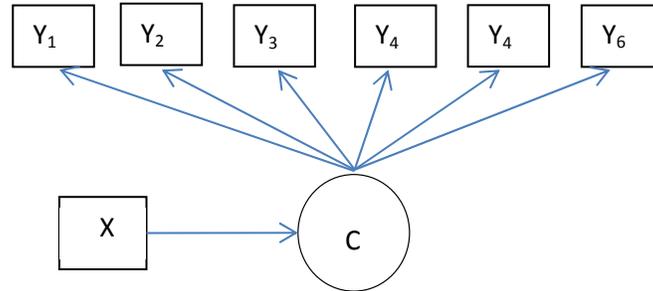


Figure 4.2. Estimated probability of exposure to black-segregated schools for 4-class longitudinal latent class model.

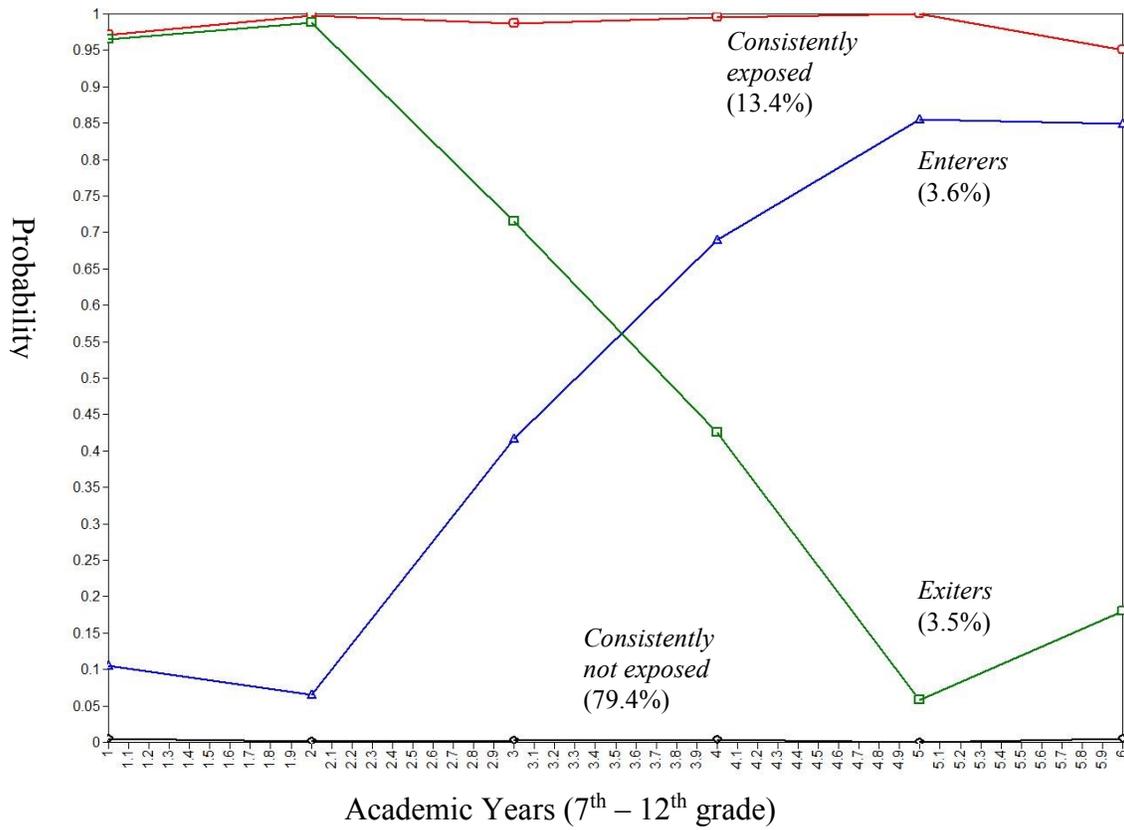


Table 4.1

Sample characteristics

Characteristics	Overall (n=6844) Mean	Black (n=1748) Mean	Non-black (n=5096) Mean
Black	0.148	1.000	0.000
Parent received government assistance	0.439	0.677	0.397
Student and/or parent(s) foreign born	0.114	0.063	0.122
Highest parental education more than high school	0.562	0.380	0.594
Northeast	0.185	0.128	0.195
North Central	0.266	0.186	0.280
South	0.341	0.620	0.292
West	0.208	0.065	0.233
Private school in grade 7	0.076	0.043	0.081
Student school mobility			
0 changes	0.080	0.081	0.080
1 change	0.514	0.435	0.527
2 changes	0.203	0.225	0.199
3 or more changes	0.203	0.259	0.194
Racial change of 7th grade school			
Mid-high decreasing	0.026	0.066	0.019
Stable high	0.057	0.315	0.012
Stable low	0.791	0.306	0.875
Mid-low increasing	0.126	0.313	0.093
Attended black-segregated school			
Grade 7	0.100	0.527	0.026
Grade 8	0.100	0.524	0.026
Grade 9	0.101	0.523	0.028
Grade 10	0.103	0.529	0.030
Grade 11	0.101	0.512	0.030
Grade 12	0.100	0.511	0.029
Ever attended black-segregated school	0.135	0.630	0.050

NOTE: Sample descriptives presented for first imputed dataset and weighted using r1wtcc. Black-segregated school defined as having 50-100 percent black students.

Table 4.2

Model fit for longitudinal latent class models

Number of classes	AIC	BIC	Number of parameters	LMR-LRT (df)	LMR-LRT p-value	Entropy
Without covariates in model						
2	15265	15353	13	21596	<.001	0.989
3	13970	14107	20	1288	<.001	0.971
4	13074	13258	27	896	<.001	0.992
5	13024	13256	34	63	<.001	0.992
6	-- ¹	--	--	--	--	--
With covariates in model						
2	11050	11234	27	26049	<.001	0.99
3	9006	9334	48	2075	<.001	0.98
4	8015	8486	69	1027	<.001	0.989
5	7877	8492	90	179	0.0025	0.96
6	-- ¹	--	--	--	--	--

NOTE: Analysis to assess model fit conducted with first imputed data set.

LMR-LRT is Lo Mendel Rubin Likelihood Ratio Test.

¹ Log-likelihood was not replicated. Model failed to converge.

Table 4.3

Student characteristics, by latent class membership

Characteristics	Exiters	Enterers	Consistently	Consistently
	(n=242)	(n=250)	Exposed	Non-exposed
	Mean	Mean	(n=920)	(n=5432)
			Mean	Mean
Black	0.555	0.474	0.854	0.064
Parent received government assistance	0.624	0.551	0.704	0.407
Student and/or parent(s) foreign born	0.127	0.135	0.050	0.118
Highest parent education > high school	0.402	0.470	0.348	0.589
Northeast	0.309	0.150	0.125	0.188
North Central	0.109	0.206	0.189	0.279
South	0.526	0.598	0.683	0.297
West	0.057	0.045	0.003	0.235
Private school in grade 7	0.054	0.067	0.023	0.081
Student school mobility				
0 changes	0.007	0.018	0.111	0.082
1 change	0.379	0.347	0.432	0.530
2 changes	0.328	0.248	0.218	0.196
3 or more changes	0.286	0.387	0.240	0.192
Racial change of 7th grade school				
Mid-high decreasing	0.139	0.086	0.059	0.018
Stable high	0.473	0.002	0.580	0.001
Stable low	0.056	0.445	0.002	0.893
Mid-low increasing	0.333	0.467	0.359	0.088

NOTE: Latent class descriptive statistics presented for first imputed dataset and weighted using r1 wgtcc.

Table 4.4

Estimated coefficients for multinomial logistic regression model estimating latent class membership

	Exiters		Enterers		Consistently exposed	
Black	1.83	**	1.98	**	3.06	**
Parent received government assistance	0.18		0.07		0.25	
Student and/or parent(s) foreign born	0.06		0.70	*	0.00	
Highest parent education > high school	0.00		-0.07		-0.06	
North Central	-1.61	**	-0.45		-0.30	
South	-0.65	*	0.08		0.15	
West	-0.89	#	-1.53	**	-2.77	*
Private school in gr7	0.22		0.36		-0.70	
Student school mobility (<i>One change as ref.</i>)						
No school changes	-2.42	#	-1.27	#	0.27	
2 school changes	0.75	*	0.47	#	0.30	
3+ school changes	0.81	**	0.97	**	0.39	#
Racial change of 7th grade school (<i>Stable low as ref.</i>)						
Mid-high Decreasing	3.95	**	1.46	**	6.08	**
Stable high	7.55	**	1.33		10.38	**
Mid-low Increasing	3.17	**	1.40	**	6.28	**

p<.05; * p<.01; ** p<.001

NOTE: The consistently non-exposed class is the reference class.

Table 4.5

Estimated coefficients for multinomial logistic regression model estimating latent class membership

	Exiters	
Black	-1.224	**
Parent received government assistance	-0.071	
Student and/or parent(s) foreign born	0.062	
Highest parent education > high school	0.058	
North Central	-1.312	**
South	-0.793	**
West	1.882	#
Private school in grade 7	0.925	#
Student school mobility		
No school changes	-2.694	*
2 school changes	0.453	*
3+ school changes	0.421	#
Racial change of 7th grade school (<i>Stable high as ref.</i>)		
Mid-high decreasing	1.057	**
Stable low	3.187	*
Mid-low increasing	0.073	

p<.05; * p<.01; ** p<.001

NOTE: The consistently exposed class is the reference class.

Table 4.6

Average percent black of schools attended, by latent class membership

	Exiters n=242	Enterers n=250	Consistently exposed n=920	Consistently non-exposed n=5432
Grade 7	67.2	30.6	80.1	7.6
Grade 8	60.0	34.9	80.2	7.6
Grade 9	49.6	47.8	79.8	7.8
Grade 10	39.1	61.0	79.2	8.0
Grade 11	30.7	65.7	79.5	7.9
Grade 12	32.1	65.8	77.8	8.1

NOTE: Grade 8 through grade 12 should be interpreted as the number of years after grade 7 (e.g., grade 8 is the year after first attending grade 7, grade 9 is two years after first attending grade 7, etc.).

Table 4.7

School mobility patterns, by latent class membership

	Exiters n=242	Enterers n=250	Consistently exposed n=920	Consistently non- exposed n=5432
Moved Districts ¹				
No	69.8	67.6	88.4	75.9
Yes	30.2	32.4	11.6	24.1
Changed School Sector ²				
No	87.6	92.0	97.1	94.5
Yes	12.4	8.0	2.9	5.5
Number of school changes among those who did <i>not</i> change districts ^{3, 4}				
0	1.2	2.4	13.4	10.2
1	49.1	44.4	45.5	58.1
2	27.8	26.0	19.4	17.5
3 or more	21.9	27.2	21.7	14.2
Unweighted N	169	169	813	4,124
Moved district, school sector, or made >1 school change ⁵				
No	31.4	30.0	51.0	49.4
Yes	68.6	70.0	49.0	50.6

NOTE: Estimates are unweighted.

¹ Pearson chi-square=90.3, Probability<0.001

² Pearson chi-square=36.8, Probability<0.001

³ Pearson chi-square=113.3, Probability<0.001

⁴ Moving more than once indicates a move beyond the standard promotional transition from middle school to high school.

⁵ Pearson chi-square=66.3, Probability<0.001

Chapter 5: Consequences of Exposure to Black School Segregation

The previous chapter identified distinct trajectories of exposure to black school segregation and the primary predictors of trajectory membership. This chapter examines how different patterns of segregation exposure during middle and high school influence college enrollment and completion. To do so, I model selection into black-segregated schools, exposure to such schools, and the effects of exposure on student and family characteristics that may predict later exposure. The results speak to the role of time-varying covariates in the relationship between exposure patterns and postsecondary outcomes. Findings presented in this chapter extend prior work by first estimating the effect of different temporal dimensions of exposure to black-school segregation (timing and duration) separately, and then estimating their effect simultaneously using the exposure trajectories described in Chapter 4.

Exposure Trajectories and the Role of Concurrent Developmental Processes

Many interdependent and complex processes define the adolescent period during middle and high school (Elder, 1998). These processes are not only developmental, including academic growth and behavioral patterns, but are also contextual and include characteristics of family life (economic status and family structure) and characteristics of the school environment (racial composition). Many of these processes have dynamic relationships with one another. One developmental or contextual process can affect and be affected by another. To estimate how exposure patterns to racial school segregation affect college outcomes, the relationship between time-varying exposure and the time-

varying student and family processes that also predict educational attainment must be considered.

To illustrate this, consider the relationship among three interdependent processes: exposure to black-segregated schools, academic coursetaking, and delinquent behavior patterns. Prior literature on the mechanisms of racially segregated schools suggests that students' schools can influence their behavior through peer relationships and their academic development through curricular offerings. The resulting impact on academic preparation or behavioral development may have implications for the schools students can attend in the future, and may ultimately affect educational attainment. Although exposure to black-segregated schools during adolescence can *directly* affect college enrollment and completion through school resources or information networks, segregation exposure in early adolescence may also *indirectly* affect college outcomes through its influence on other developmental processes, including academic and behavioral, that also affect the probability of enrolling in and completing college. To accurately estimate the role of exposure trajectories on college outcomes, the analyses in this chapter account for how exposure trajectories can affect and be affected by other developmental processes during adolescence and young adulthood by relying on a method of causal inference that incorporates the direct pathways through which segregation exposure affects students' college outcomes as well as the indirect pathways.

Data and Methods

Analytic Sample. The analytic sample includes 2,132 students from the NLSY97. The sample was restricted in three ways. First, only students who were currently enrolled in 8th grade or lower in 1997 were included. Because not all ages and/or grades were asked all questions during the interviews, this restriction ensures that complete data was available for the students' academic coursetaking, behavior and substance use variables.⁹ Second, the sample was restricted to include respondents who were missing no more than one year of school racial composition data and who attended at least one school between 1997 and 2010.¹⁰ Third, the sample was restricted to only those respondents living in metropolitan areas at baseline with a black population that was at least six percent of the total population. This final 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. Having a non-zero probability of treatment exposure (i.e., attending a black-segregated school) is an assumption that must be met in the marginal structural models employed in this chapter's analysis. Six percent represents approximately half of the national proportion of black residents in 2000 (McKinnon, 2001), and thus omits locations where there are too few black residents to

⁹ There were 131 respondents who were not reported as having attended 8th grade at all. These students may have skipped 8th grade, or the roster file may have been completed with errors. Regardless, because there was no year and no school identification number reported for the respondent for grade 8, academic-year racial composition data could not be merged. These cases are dropped from the analysis.

¹⁰ Students could be missing school racial composition data for a variety of reasons. Some students refused to provide the name of the school they were currently attending during the interview, which precluded the interviewer from successfully identifying the school. Some students provided the name of the school and the interviewer was able to identify the school, but the school did not provide its racial composition data to the CCD or PSS. Some students provided racial composition data, but no match in the CCD or PSS survey could be found, which prevented merging in racial composition data to the youth's school for that year. Respondents who fell into any of these situations in more than one year were dropped from the analytic sample.

have schools that are majority black. The data were truncated to keep a maximum of five years of secondary school data, which represents the standard grade progression from 8th through 12th grade.¹¹

Measures. The analysis considers two primary outcomes in postsecondary education—college enrollment and college completion. Using all rounds of available data, I code each respondent as ever having enrolled in a 2- or 4-year college and ever having completed a 2- or 4-year college degree.

Explanatory Variables. The main explanatory variables are patterns of exposure to black school segregation throughout middle and high school. I investigate three aspects of exposure. First, I examine the *timing* of students' exposure—whether they experienced early exposure by attending a black-segregated school in 8th or 9th grade, or experienced late exposure by attending a segregated school in 11th or 12th grade. This measure focuses only on when students were exposed to the treatment, regardless of the 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 black-segregated schools—regardless of the timing of exposure. The third and final measure incorporates the timing and duration together by examining the impact of trajectories of exposure to black-segregated schools throughout secondary school. Although estimates for the timing and duration provide information on the consequences of specific temporal aspects, temporal dimensions do not operate independently (Lee, 2014), requiring the more holistic approach of exposure trajectories. The construction of

¹¹ There were 726 respondents in the analytic sample with more than six years of secondary school data. These students repeated one or more grades during secondary school.

exposure trajectories is described in detail in Chapter 4. Although the number of optimal trajectories identified in both chapters was identical, the specific trajectory membership is re-estimated for this analysis because of differences in the analytic sample. The distribution of students exposed to black-segregated schools according to each of these three definitions is presented in Table 5.2. The inclusion of these three aspects of exposure—timing only, duration only, and the complete longitudinal trajectories of segregation exposure—allows a comprehensive analysis of consequences of segregation exposure.

In any given year, students are counted as being exposed to black-segregated schools if they attended a school with a percentage black above the given threshold. I investigate two definitions of annual black-segregation based on previous research—schools that are 33–100 percent black and those that are 50–100 percent black.¹² These definitions allows me to pool students of all races into one analysis. Insufficient numbers of non-black students are exposed to black-segregated schools when higher cutoffs are used to define black-segregated.

Time-constant control variables. The primary goal of this analysis is to estimate the causal effect of segregation exposure on college outcomes. Therefore, I include a broad array of covariates that are potential confounders. The time-constant baseline characteristics are from round 1 interviews conducted with students and parents. *Sex* is dichotomous and coded 1 for male, 0 for female. *Race/ethnicity* is also a dichotomous

¹² Brown-Jeffy (2009) finds that attending school with 50 percent or more Black and/or Hispanic students is harmful for individual academic achievement. Hoxby (2002) finds nonlinearities in the effect of peer racial composition on academic achievement, with as low as 33 percent or more black peers being harmful for academic achievement.

variable, coded 1 for non-Hispanic Black and 0 for other. *Parental education* is a dichotomous variable coded according to the highest education level of either parent, with 1 for some education beyond high school and 0 for earning a high school diploma or less. *Mother's age at first birth* was recoded to be a dichotomous variable with 1 if the respondent's mother had her first child as a teenager (less than 20 years old) and 0 if the mother was 20 years old or older. *Poverty* is a continuous variable that measures the ratio of the household income to the official poverty measure in the previous year. *ASVAB* score is the percentile score (0 to 99) students received on the math and verbal portions.

Time-varying covariates. Time-varying covariates that are related to segregation exposure as well as college outcomes are also included in the models. These include family variables—number of household members, family structure, and residential moves. They also include student characteristics of academic and social/behavior development—academic coursetaking, delinquent behavior, substance use behavior, and school suspensions.

Number of household members is a continuous variable that was determined through the household rosters in every wave and indicates the total number of individuals living in the respondent's household. It was top-coded at 5, so that respondents with more than five members living in their household were coded as 5. *Cumulative number of residences* is the total number of residences that the respondent has lived in through the given survey round. This variable was top-coded at 7 so that respondents who reported living in more than seven residences were coded as 7. *Family structure* was coded as a three-category variable with 1 for 2-parent families, 2 for single-parent families, and 3

for “other” family types, including grandparents, foster parents, adopted parents, or other relatives.

Academic coursetaking was measured using student reports of mathematics and science courses completed in 7th through 12th grade. Math courses include no math, general math, algebra I, geometry, algebra II, trigonometry, pre-calculus, calculus, other advanced math, and other math. Science courses included no science, biology, chemistry, physics, other science, and AP courses in biology, chemistry, and physics. Following measurement construction outlined by Hao and Woo (2012), I used the standard progression of math and science coursetaking during middle and high school and create a scale from 0–7 for mathematics (no math, general math, algebra I or geometry, algebra II, trigonometry or other advanced math, pre-calculus, and calculus) and 0–5 for science (no science, other science, biology or chemistry, physics, AP science courses). I standardized the science sequence to the math sequence and then combine the two scores, weighting the math sequence for $\frac{3}{4}$ of the score and the science sequence for $\frac{1}{4}$ of the score. Every student has a score of academic progress for the period before high school (prior to 9th grade) and for each year of high school.

Delinquent behavior was measured using youth responses to ten questions about running away, lying, cheating, stealing, destroying property, hurting or attacking others, selling drugs, using weapons, involvement with gangs, arrest and conviction record. Answers were coded yes (1) for engaging in the behavior and 0 otherwise. The original index ranged from 0 to 10, with higher values indicative of more delinquent behavior. The variable was recoded to 0 if the respondent engaged in no delinquent behavior and 1

if the respondent engaged in at least one delinquent act. *Substance use behavior* was measured using youth responses to whether s/he smoked cigarettes, drank alcohol, or used other drugs. Answers were coded yes (1) or no (0) with scores on the original index ranging from 0 to 3. The index was recoded to 0 for respondents who used no substances and 1 for respondents who used at least one substance. For each of these two measures, respondents have an annual measure of problem behavior from 8th grade through the end of high school.

School suspensions were measured using youth reports of having been suspended since the date of the last interview. Respondents were coded 1 for having been suspended and 0 otherwise.

Covariates with missing values were imputed with multiple imputation using the *mi impute chained* command in Stata12 (White et al., 2011). For students with one missing racial composition value, I logically imputed the value using the previous year's value. All imputed datasets were used to produce the final point estimates and standard errors in order to appropriately account for the uncertainty associated with the missing values (Little & Rubin, 2014; Schafer, 1997). Descriptive statistics are presented for the first imputed dataset only.

Analytic strategy. This section outlines how I estimate the effect of exposure to black-segregated schools during secondary school on the postsecondary outcomes of college enrollment and college completion. I begin by first briefly describing the challenges in estimating such an effect when students can move in and out of treatment and when student characteristics that are affected by prior treatment, predict subsequent

treatment exposure, and predict 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-dependent confounding and obtain unbiased treatment effects in a way that studies using cross-sectional data or standard regression methods cannot. The following section presents a brief overview of the method.

Challenges in estimating time-varying treatments with time-varying confounders. Obtaining a causal estimate for the effect of exposure trajectories on college outcomes is made difficult by the presence of time-varying treatments (segregation exposure that changes throughout middle and high school) and time-varying covariates (student characteristics that change over time). There are two main conditions that make causal estimates in the presence of time-varying treatment and covariates problematic. First, many time-varying characteristics predict both eventual postsecondary outcomes as well as subsequent exposure. These are referred to as time-dependent confounders (Robins et al., 2000). Second, previous exposure may predict subsequent levels of the time-varying confounder.

Traditional regression methods cannot provide unbiased estimates of time-varying exposure to school segregation in the presence of time-varying covariates. Regression methods would suggest controlling for all confounders—any variable that predicts future exposure to school segregation and also predicts college outcomes—to avoid biased estimates of the effect of exposure on college outcomes. But traditional regression methods would also suggest *not* controlling for variables that occur post-treatment

exposure because doing so might eliminate part of the indirect effect we want to estimate if previous exposure to school segregation affects college outcomes through the confounders. Controlling for these mediating variables would “control away” part of the effect and bias the estimates. Because we obtain biased estimates if we control for confounders and biased estimates if we do not control for confounders, an alternate strategy is required.

Through the use of inverse probability of treatment weighting (IPTW), marginal structural models (MSMs) provide a way to eliminate these sources of bias (Robins, 1999; Robins et al., 2000). IPT weights are estimated by modeling the probability that each respondent at each time period receives his or her own observed treatment conditional on his or her prior treatment and covariate history. Each respondent is weighted by the inverse probability of his or her exposure history. These weights create a “pseudopopulation” in which treatment status at every time point is unconfounded by observed variables (Robins, 1999). The process removes the direct effect of confounders on treatment status, and the weighted data mimic an experiment that randomizes students to receive the treatment of exposure to school segregation or not at each time point. Then, similar to analyzing a randomized experiment, modeling the treatment on the outcome no longer requires controlling for time-varying confounders and traditional regression models can be used to obtain unbiased estimates, under several key assumptions discussed in Appendix B.

Estimating the effect of segregation exposure on college outcomes. The causal effects of segregation exposure on college enrollment and completion are estimated in a

two-stage process.¹³ 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 at $k-1$, and time-varying covariates at waves k and $k-1$:

$$\text{logit}(P(a_k = 1)) = \alpha_j + \beta_1 L_0 + \beta_2 A_{k-1} + \beta_3 L_{k,k-1} \quad (1)$$

where a_k is whether the student attended a school that was 50–100 percent black at wave k , L_0 is a set of time-constant background characteristics (race, sex, parental education, mother’s age at first birth, poverty status, ASVAB score), A_{k-1} is the treatment exposure at wave $k-1$, and $L_{k,k-1}$ is a set of time-varying covariates (student academic coursetaking, problem behavior, substance use, family structure, cumulative number of residential moves, household size, and suspension) from waves k and $k-1$.¹⁴ By including variables measured in the current wave (which often asked students about events that happened since the date of the last interview) and the prior wave, these regression models assume that these covariates are useful predictors for the probability of segregation exposure. For the probability of segregation exposure in 8th grade, only current variables are included since any lagged variables occurred prior to the start of the study.

Results from the logistic regression are used to predict each student’s probability of attending the type of school he or she actually did (i.e., black segregated or not) at each of the five waves. The inverse product of these five probabilities is the student’s final IPT

¹³ Additional details on the notation and counterfactual framework used in MSMs be found in Appendix C.

¹⁴ I tried a variety of model specifications in order to choose the best weights based on bias and variance (Cole & Hernán, 2008). In general, I wanted a mean weight that was close to 1, to include a large number of covariates (confounders) to reduce bias in the estimated effect, and to have a small spread of weights to reduce the variance in my estimated effect. I will also explore the possibility of truncating weights, such as at the 1st and 99th percentile.

weight, which effectively removes the confounding between the treatment and prior measured covariates. Because weighting increases the standard errors of the estimates, stabilized weights are often recommended to reduce variance (Hernán et al., 2002). The numerator is estimated as the probability of exposure conditional on prior exposure (Cole & Hernán, 2008), while the denominator is the probability of exposure conditional on time-constant and time-varying covariates. The final stabilized weight for the i th student at the end of K waves is

$$sw_i = \prod_{k=1}^K \frac{P(A_k=a_{ki}|\bar{A}_{k-1}=\bar{a}_{(k-1)i})}{P(A_k=a_{ki}|\bar{A}_{k-1}=\bar{a}_{(k-1)i}, \bar{L}_k=\bar{l}_{ki}, L_0=l_0)} \quad (2)$$

In the second step, the effect of treatment on college enrollment and college completion is estimated in a logistic regression model that is weighted using the final stabilized IPT weights. Under the assumptions of no unmeasured confounding, the weights allow me to 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 causal effect of segregation exposure on postsecondary outcomes.

I model two postsecondary outcomes separately – enrollment in a 2- or 4-year college and completion of a 2- or 4-year degree at the end of 15 follow-ups, when respondents were between 26 and 30 years old.

Model one: Effect of timing only. I estimate the effect of exposure to black school segregation using three different, but related models. The first model considers the effect of attending a black-segregated school in each academic year separately:

$$\text{logit } Pr[Y_{\bar{a}} = 1] = \beta_0 + \beta_1 a_1 + \beta_2 a_2 + \beta_3 a_3 + \beta_4 a_4 + \beta_5 a_5 \quad (3)$$

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 $k = 1,2,3,4,5$). The trajectory \bar{a} is a combination of five indicator variables (e.g., 11111 corresponds to a student who is exposed to black school segregation every year between 8th and 12th grade). The intercept β_0 estimates the student's mean probability of college enrollment (or college completion) if all students experienced no segregation exposure. The sum $\beta_0 + \beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5$ estimates the student's mean probability of the outcome if all students experienced exposure to black school segregation throughout middle and high school. Each β_k coefficient can be interpreted as the change in log odds of enrolling in or completing college if all students were exposed to a black-segregated school at wave k relative to the reference group of all students not being exposed to a segregated school, holding exposure level at all other time points constant.

To isolate the effect of different timing of segregation exposure on postsecondary outcomes, I compare whether the causal effect of early exposure is more detrimental to college enrollment or completion than later exposure (i.e., attending black-segregated schools in 8th and 9th grade only compared to not at all; and attending black-segregated schools in 11th and 12th grade versus not at all).

Model two: Effect of duration only. The second model estimates the effect of cumulative duration of exposure on the outcomes, regardless of when that exposure occurred:

$$\text{logit } Pr[Y_{\bar{a}} = 1] = \beta_0 + \beta_1 \sum_{k=1}^K a_k \quad (4)$$

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. The coefficients from β_1 are the log odds representing the effect of attending a black-segregated school for 1, 2, 3, 4, or 5 years relative to 0 years on the probability of enrolling in or completing college.

Model three: Effect of exposure trajectory membership. The third model estimates the effect of membership in different exposure trajectories on postsecondary outcomes:

$$\text{logit } Pr[Y_{\bar{a}} = 1] = \beta_0 + \beta_1 C \quad (5)$$

where C is membership in the latent trajectory class. This is a 4-category variable with the *consistently non-exposed* class as the reference category. The coefficients in this model can be interpreted as the effect of different latent class membership on the probability of enrolling in or completing college.

I first estimate the effects of segregation exposure using the three models above for the entire sample of students for treatment definitions of schools that are greater than 33 percent black and schools that are greater than 50 percent black. I then repeat them for black and non-black students separately.

Results

The results are summarized in three sections. I first describe the sample of students across time-constant and time-varying characteristics. I then describe the weight construction and weight diagnostics. The final section outlines the results of the marginal structural models using two definitions of segregation exposure. I present results for the

overall sample, comparing estimates of the effect of exposure to black-segregated schools from unadjusted regression models, adjusted regression models, and marginal structural models. I then present results separately for black and non-black students.

Sample characteristics. Table 5.1 presents the distribution of time-constant and time-varying covariates for the sample overall and by race. The table shows that overall about one in five respondents is black, about 54 percent have a parent with at least some college education, approximately 19 percent were living at the poverty level or below during the baseline interview, and about 23 percent of respondents had a mother who had her first child as a teenager. The black sample is significantly more disadvantaged than the non-black sample, with larger percentages living in poverty and born to teenage mothers and lower percentages with college-educated parents.

The bottom half of Table 5.1 presents the distribution of time-varying covariates for the first, third, and fifth year for which the respondent could be exposed to treatment. For all respondents, the first year corresponded with the year they attended 8th grade. For most respondents, the third year corresponded with 10th grade and the fifth year with 12th grade. The table shows that throughout secondary school the percentage of students reporting delinquent behavior decreases, from about 40 percent in grade 8 to 20 percent in grade 12, while the percentage of students reporting substance use (alcohol, tobacco, other drugs) increases over time. Across all years, black students were less likely to use substances than were non-black students. Coursetaking levels increased as expected over the period, with black and non-black students reporting similar levels. The mean is just over 5 by 12th grade, corresponding to physics in science and pre-calculus in math. The

percentage of students receiving suspensions declined over time, but black students were much more likely to be suspended than were non-black students, particularly in 8th grade. The majority of non-black students lived in two-parent families throughout secondary school; black students were more evenly split among two- and single-parent families.

Table 5.2 displays the percentage of students attending black-segregated schools during each wave of follow-up using two different definitions of black-segregated: 33–100 percent black and 50–100 percent black. For students overall, about 25 percent attend schools that are more than 33 percent black during each year of secondary school and about 30 percent of students overall *ever* attend such a school. There are large differences in percentages of students exposed by race. Between 13 and 14 percent of non-black students attend a school that is more than one-third black in any given year between 8th and 12th grade, and over the course of secondary school, about 18 percent of non-black students ever attend such a school. The percentages are far larger for black students. About 70 percent of black students attend schools that are more than one-third black in any given year of secondary school and more than 77 percent of black students ever attend such a school.

The patterns of exposure are similar for schools that are majority black (50–100 percent black). Between 14 and 15 percent of students overall attend a majority black during any given year of secondary school, while just 4 percent of non-black students do. Over half of all black students attend schools that are majority black during any given year of secondary school, and fully 64 percent are ever exposed to such a school.

In terms of cumulative years of exposure, I find that across different definitions of black-segregated, the majority of students either had zero years of exposure or five years of exposure. Smaller percentages of students experienced between one and four total years of exposure to black-segregated schools. Overall, about 12 percent of students had between one and four total years of exposure to schools with more than 33 percent black students and 8 percent of students had similar length of exposure to majority black schools.

As shown in the previous chapter, one benefit of exposure trajectories is that they simultaneously describe the timing, duration, and stability of student segregation exposure. Table 5.2 presents results from latent class analyses that identified student exposure trajectories using the 33–100 percent and 50–100 percent definitions of black-segregated schools. Both LCA models included five binary indicators, coded as 1 if the student attends a black-segregated school that year and 0 otherwise. Similar to the analyses presented in Chapter 4, the LCA models identified four latent classes as the optimal number. For the least stringent treatment definition (33–100 percent black), overall 72 percent of students are *consistently non-exposed* to these schools; 22 percent are *consistently exposed*; and 3 percent each are either *enterers* into or *exiters* out of such schools. The distribution differs for non-black and black students, with black students far more likely to belong to the *consistently exposed* class (65 percent) than the other three classes.

With the more stringent threshold of majority black, just 2 percent each of the sample belong to the *enterers* or *exiters* classes, 12 percent to *consistently exposed*, and

84 percent belongs to the *consistently non-exposed* class. Black students again differ dramatically in their class membership, being almost evenly split between the *consistently exposed* and *consistently non-exposed* (47 and 42 percent, respectively).

Constructing inverse probability of treatment weights. The stabilized weights used in the MSMs model respondent selection into black-segregated schools at each time point. All of the variables presented in Table 5.1 were included in the models. Table 5.3 presents descriptive statistics of the weights. The overall stabilized weight and the stabilized weights by race were well behaved with means close to one and small standard errors (Hernán & Robins, 2006). The stabilized weights for the overall and non-black sample for the 33–100 percent black and 50–100 percent black treatment definitions were truncated at the 1st and 99th percentile to get the mean closer to one, though effect estimates were similar with the truncated and non-truncated versions. The range of weights is narrower in the subgroup samples than in the sample overall. This is also noted in the work of Sharkey & Elwert (2011), who write that this indicates that exposure to black school segregation is “less endogenous within each race group than in the sample overall” (2011:1959)—confirming, as seen in the weighting models, that race is a very powerful predictor of exposure to black school segregation.

Results for students overall. Estimates for the effect of segregation exposure on college enrollment and college completion for the overall sample are presented in Tables 5.4a and 5.5a. (Estimates obtained from an unadjusted model including only the segregation exposure variable, and an adjusted model including baseline covariates and the average of all time-varying covariates are presented as reference in Tables 5.4b and

5.5b.) Results from three models are shown. In the first, I examine the *timing* of segregation exposure by presenting the effect of experiencing each individual year of exposure, as well as two linear combinations of exposure years (early and late). In the second, treatment exposure is measured by the cumulative number of years of exposure. No exposure (0 years) is the reference while five years indicates that a respondent consistently attended black-segregated schools from 8th through 12th grade. This model describes the consequences of exposure *duration* on college outcomes. In the third model, treatment is defined as latent class membership, and the *consistently non-exposed* class is the reference group. Trajectory membership as the treatment definition allows for simultaneously considering the timing, duration, and stability of exposure on college enrollment and completion.

Effects of exposure to black-segregated schools (33–100 percent black). Tables 5.4a and 5.4b presents findings for the entire sample defining exposure to black-segregated schools as those that are 33–100 percent black.

Timing. Across the three estimation methods—unadjusted, adjusted, and weighted—the relationship between attending a black-segregated school and college enrollment is generally negative at the beginning and end of secondary school. The estimates from the unadjusted model are usually larger than the adjusted estimates. Estimates from the marginal structural models are generally similar to the adjusted estimates. The MSM results indicate that the effect of exposure to black-segregated schools *later* in high school (i.e., 11th and 12th grade) is detrimental for enrolling in a 2- or 4-year college. Among all students, attending black-segregated schools in the last two

years of high school reduces the odds of enrolling in college by 58 percent ($1 - e^{-0.87} = 0.58$). The findings for college completion are less conclusive; the point estimates for both early and late exposure are negative but with wide confidence intervals.

Duration. Across the three estimation methods, attending black-segregated schools is consistently negative for exposure lengths of one through five years relative to no exposure on the probability of college enrollment. The findings from the MSM suggest that attending a black-segregated school for all five years between 8th and 12th grade reduced the odds of college enrollment by 34 percent relative to those who never attended black-segregated schools ($1 - e^{-0.41} = 0.34$).

The results for the effect of segregation exposure on college completion are similar in direction, but with smaller magnitude and larger standard errors. Interestingly, although not statistically significant, the results for both college completion and college enrollment indicate that increased length of time spent in a black-segregated school does not translate to larger reductions in the probability of enrolling in or completing college. Instead, the size of the effect is similar for attending one year and for five years, with smaller and non-significant effects for being exposed to two to four years of black-segregated schools.

Trajectory membership. The final set of results provides insight into how distinct trajectory membership affects college outcomes. Results from the marginal structural models indicate that belonging to the *enterers* class is associated with a 44 percent drop in the odds of enrolling in college in comparison to belonging to the *consistently non-exposed* class ($1 - e^{-0.58} = .44$). Membership in the *consistently exposed* class

translates to a 30 percent decrease in the odds of college enrollment ($1 - e^{-0.36} = .30$). Membership in the *exiters* class is non-significant, suggesting that students who exit black-segregated schools do not have probabilities of college enrollment that differ from their peers belonging to the *consistently non-exposed* class. For college completion, the unadjusted estimates are consistently negative, but once controlling for the time-constant and time-varying covariates through weighting, the effects are smaller and no longer statistically significant.

Effects of exposure to black-segregated schools (50-100 percent black). The results do not change substantially when defining black-segregated schools as those that are majority black.

Timing. The weighted models indicate that the effect of exposure to black school segregation in later grades is detrimental for college enrollment (Table 5.5a). Attending majority black schools in 11th and 12th grade reduces the odds of enrolling in college by 62 percent ($1 - e^{-0.97} = 0.62$) and reduces the odds of college completion by 66 percent ($1 - e^{-1.08} = 0.66$). In contrast, the effect of early exposure to black-segregated schools (in 9th and 10th grade) is positive in direction, but highly non-significant.

Duration. The results for the duration of exposure are mixed. Although the direction of the relationship between years of exposure and the probability of college and enrollment and completion is generally negative, the results are almost all non-significant. One marginally significant effect ($p < 0.10$) is that the effect of spending all years in a black-segregated school reduces the odds of enrolling in college by 33 percent.

Similar to the results using the 33–100 percent black definition, there is not a monotonic relationship between time spent and the magnitude of the effect.

Trajectory membership. Membership in the *enterers* and *consistently exposed* classes reduce the odds of enrolling in or completing college compared to membership in the *consistently non-exposed* class. Belonging to the *consistently exposed* trajectory reduced the odds of enrolling in college by 32 percent, while belonging to the *enterers* class was negative for college completion in comparison to membership in the *consistently non-exposed* class, reducing the odds of finishing a 2- or 4-year degree by 81 percent.

In summary, for the sample overall, I generally find negative effects of exposure to black-segregated schools on the odds of enrolling in college and completing college. This general finding held when black-segregated schools were defined as those with more than 33 percent black students and as those that were majority black. In terms of *timing*, attending black-segregated schools later in high school (i.e., 11th and 12th grade) reduces the odds of enrolling in college. The findings for cumulative exposure are less clear—the effect of attending a black-segregated school all five years is negative, but there does not appear to be a linear relationship between the size of the effect and the number of years exposed. When I consider the temporal dimensions of exposure simultaneously through latent class membership, I consistently find that membership in the *enterers* and the *consistently exposed* classes translates to a reduction in the odds of college enrollment and college completion in comparison to membership in the *consistently non-exposed* trajectory. For many of these estimates, the standard errors are large, but the direction of

the effect is consistently negative. 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).

Results by student race. One of the most powerful determinants of exposure to black-segregated schools, beyond whether the student attended a black-segregated school in an earlier wave, is the student's race. Black students are far more likely to attend black-segregated schools, net of their previous exposure to such schools. The next set of results examines whether the effects of exposure to black-segregated schools are different for black and non-black students.

Tables 5.6 and 5.7 present findings from the marginal structural models for black and non-black students, respectively, for the two outcomes – college enrollment and completion. I again examine the three models of treatment exposure: timing of exposure, duration of exposure (cumulative years), and membership in exposure trajectory. The results by student race can be interpreted as the student's mean probability of the outcome if all black (or non-black) students experienced the exposure history compared to if all black (or non-black) students experienced the reference exposure history.

The effect of timing of segregation exposure was different for black and non-black students. For black students, exposure to black-segregated schools later in high school in 11th and 12th grade reduced the odds of enrolling in college by 62 and 66 percent for the 33–100 percent and 50–100 percent definitions, respectively. The findings for exposure to black-segregated schools early in high school were less conclusive. When the segregated schools were defined as majority black, the effect of early exposure for

black students was positive in direction but with large standard errors. Findings were highly inconsistent for non-black students with respect to timing, drawing into question the reliability of the estimates.

The effect of duration also varied by student race. Among black students, the effect of exposure *duration* is not conclusive. Findings for any given number of years are in both directions (positive and negative) and with wide confidence intervals. For non-black students, the effects of each year of exposure to black-segregated schools were more consistently negative, although still with large standard errors.

When considering the temporal dimensions together, the effect of belonging to the *exiters* class, regardless of the threshold for black-segregated (33–100 percent or 50–100 percent) was positive in direction though not significant, suggesting that it *increased* the odds of enrolling in or completing college compared to the *consistently non-exposed* for black students. Belonging to the *enterers* class generally reduced the odds of college enrollment and completion for black students, as did being *consistently exposed*.

Similar patterns of results were obtained for non-black students. Interestingly, the negative effects for being consistently exposed were larger for non-black students than for black students. Belonging to the consistently exposed class (for schools that were 33–100 percent black) for non-black students decreased the odds of enrolling in college by 41 percent. When the threshold was 50 percent black, the odds were reduced by 53 percent for enrolling in college.

Discussion and Conclusions

Measuring exposure to racial school segregation at a single time point precludes an understanding of how various temporal dimensions of exposure may affect postsecondary attainment. By examining exposure over time, this analysis considers whether exposure to black-segregated schools early or late in secondary school is more consequential for postsecondary outcomes, whether the duration of exposure matters, and whether membership in different trajectories of exposure (i.e., patterns of exposure that simultaneously capture the timing, duration, and stability) affect educational attainment.

The results confirm earlier research on school segregation that finds that exposure to black-segregated schools is generally negative for educational outcomes. But this analysis provides additional insights into how exposure to the concentration of black students in schools over time affects college enrollment and completion. First, the timing of exposure to black-segregated schools matters. Exposure *later* in high school, particularly at majority black schools, 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 black school segregation, regardless of when that exposure occurred, are negative in direction suggesting it is detrimental to enrolling in or completing college. But the effect does not monotonically increase with the number of years exposed. Third, and consistent with the findings about time, students who *enter* black-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. These findings are consistent with recent work by Billings, Deming, and Rockoff (2013) that takes advantage of a natural experiment in the Charlotte-Mecklenberg district. They find that students who moved into high minority schools—particularly in the final years of high school—experienced lower achievement and lower likelihood of college enrollment. My analysis provides the evidence for a national cohort of youth.

The analysis points to several key differences in the effects of exposure to black-school segregation for student of different racial backgrounds. These findings are discussed cautiously because of the wide confidence intervals associated with the estimates. For black students, exposure later in high school reduces the odds of college enrollment and completion more strongly than for non-black students. Estimates for black students for the consequences of late exposure on college enrollment and completion are consistently and significantly negative for both treatment definitions (33–100 and 50–100 percent black). Interestingly, for black students, there is some suggestive evidence that there is a positive effect of limited exposure to black-school segregation early in high school or for the duration of just one year (regardless of the timing). This finding should be explored further in future work. Some existing research suggests that black-segregated schools may have differential effects for students of different racial backgrounds, with minority students, and particularly low-income minority students, faring worse in higher-SES and predominantly white schools (Crosnoe, 2009; Owens, 2010; Palardy, 2013). Other research with younger children, finds the opposite to be true (Schwartz, 2011).

Additional work in this area is needed, particularly to understand the underlying mechanisms.

Although the proposed analyses move the literature on racial school segregation forward conceptually and methodologically, they are not without limitations. Most importantly, causal inferences on how temporal dimensions of segregation exposure affect college outcomes rely on strong assumptions about having no unobserved confounders given observed covariates at a given time point. This assumption cannot be measured directly, but I attempt to mitigate the likelihood of violating it by including many variables that affect both the treatment and the outcome. If students select into schools for reasons that are unmeasured or unobserved and these reasons also affect college attendance or completion, then the estimates will be biased.

Second, the postsecondary education outcome was defined as enrollment in a 2- or 4-year college degree program and completion of a 2- or 4-year degree. These outcomes encompass a wide range of programs with different practical values in the labor market. In general, 2-year degrees are not as beneficial in the labor market as 4-year degrees (Aud et al., 2011), with associate-degree holders' average earnings about 50 percent lower than the average earnings of those with a bachelor's degree. This analysis kept the definition of postsecondary enrollment and completion broad, but future analyses should explore these two outcomes separately. In addition, important differences in the quality of education, graduation rates, and debt burdens differ by the public, private non-profit, or private for-profit status of the institution. Because minority students are over-represented in the private for-profit sector (U.S. Department of Education, 2013), future

research should also examine whether attendance at segregated secondary schools has different consequences for the sector of the postsecondary institution attended.

Despite this important limitation, the focus on effects of multiple temporal dimensions of segregation exposure pushes the segregation literature forward in key ways and also points to future research and policy implications. First, this analysis found important differences in the effect of segregation exposure based on the *timing*. This distinction is lost when researchers look only at a single time point, or even when looking longitudinally, only examine the effect of *cumulative* years of exposure. Although the precision of estimates is low, the results consistently show that exposure later in high school is worse than exposure earlier in secondary school. This is true for students overall, black students, and largely true for non-black students. This analysis stops short of discussing the mechanisms responsible for the effects of black-segregated schools on future educational attainment, but prior work on the socio-economic composition of high schools finds that peer influences are the primary mediator for the association between high school composition and educational attainment (Palardy, 2013). In line with this study's findings, prior work indicates 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; Sung Joon Jang, 2002). Future work should investigate the process of college enrollment to better identify the mechanisms responsible in the final two years of high school. 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.

Second, the effect of exposure differed slightly for black and non-black students, suggesting that additional research is needed to uncover the dynamics *within* schools with various racial compositions. For instance, the negative effects of exposure to black-segregated schools *later* in high schools were stronger for black students than for non-black students. For non-black students, the effect of belonging to the *consistently exposed* compared to the *consistently non-exposed* class was more detrimental than for black students. These findings are merely suggestive, as the standard errors were very large. What they do suggest, however, is that there may be different within-school dynamics occurring for black students than for non-black students in black-segregated schools. This is an area of research that warrants additional attention.

Table 5.1.

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 5.2

Exposure to black-segregated schools, by treatment definitions and race

	Treatment >33% Black			Treatment >50% Black		
	All	Black	Non-black	All	Black	Non-black
Attended black-segregated school						
8th grade	0.247	0.703	0.129	0.145	0.553	0.039
9th grade	0.251	0.695	0.136	0.139	0.527	0.039
10th grade	0.251	0.699	0.135	0.139	0.531	0.037
11th grade	0.246	0.691	0.130	0.137	0.517	0.038
12th grade	0.247	0.689	0.133	0.138	0.521	0.039
Ever attended black-segregated school	0.303	0.768	0.182	0.183	0.640	0.064
Total years attended black-segregated school						
0 years	0.697	0.232	0.818	0.817	0.360	0.936
1 year	0.025	0.030	0.023	0.027	0.060	0.018
2 years	0.027	0.030	0.026	0.017	0.050	0.009
3 years	0.027	0.040	0.024	0.019	0.049	0.011
4 years	0.039	0.076	0.029	0.019	0.061	0.008
5 years	0.185	0.593	0.080	0.101	0.420	0.019
Exposure Trajectory						
Exiters	0.034	0.044	0.031	0.022	0.065	0.011
Enterers	0.030	0.046	0.026	0.018	0.047	0.011
Consistently Exposed	0.217	0.650	0.105	0.119	0.469	0.028
Consistently NonExposed	0.719	0.260	0.838	0.841	0.419	0.950

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

Table 5.3

Characteristics of IPT weights

	Mean	SE	Min	Max
33-100% Black				
Overall	1.01	0.02	0.11	7.63
Black	1.00	0.02	0.01	6.32
Non-Black	1.00	0.01	0.25	2.42
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 of 33–100 or 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 5.4a

Estimated effects of time-varying exposure to black-segregated schools on college enrollment and completion for all students (33–100 percent black)

	Enroll		Complete	
	Est	SE	Est	SE
Model 1: Timing Only				
Timing of Exposure				
8th grade	-0.23	0.227	-0.28	0.244
9th grade	0.23	0.320	0.15	0.351
10th grade	0.47	0.406	0.25	0.482
11th grade	-0.25	0.461	-0.19	0.602
12th grade	-0.62 *	0.373	-0.16	0.461
Early (9th and 10th)	0.00	0.296	-0.14	0.326
Late (11th and 12th)	-0.87 **	0.347	-0.35	0.422
Model 2: Duration Only				
Cumulative Years of Exposure (<i>0 years as ref.</i>)				
1 year	-0.45	0.295	-0.33	0.344
2 years	-0.32	0.353	-0.07	0.392
3 years	0.18	0.327	-0.01	0.382
4 years	-0.22	0.278	-0.02	0.279
5 years	-0.41 **	0.162	-0.24	0.188
Model 3: Exposure Trajectory				
Latent class membership (<i>Cons. Non-Exposed as ref.</i>)				
Exiters	0.16	0.342	0.06	0.351
Enterers	-0.58 *	0.305	-0.22	0.356
Consistently Exposed	-0.36 **	0.151	-0.19	0.171

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

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.

Table 5.4b

Estimated effects of time-varying exposure to black-segregated schools on college enrollment and completion for all students (33–100 percent black)

	Enroll				Complete							
	Unadjusted		Adjusted		Unadjusted		Adjusted					
	Est	SE	Est	SE	Est	SE	Est	SE				
	<u>Model 1: Timing Only</u>											
Timing of Exposure												
8th grade	-0.45	**	0.189	-0.18	0.225	-0.70	***	0.209	-0.33	0.255		
9th grade	0.33		0.236	0.23	0.270	0.05		0.263	-0.09	0.316		
10th grade	0.16		0.293	0.08	0.332	0.20		0.324	0.13	0.387		
11th grade	0.04		0.367	-0.01	0.409	-0.10		0.411	-0.05	0.482		
12th grade	-0.70	**	0.319	-0.71	*	0.363		0.354	-0.14	0.410		
Early (9th and 10th)												
Late (11th and 12th)												
	<u>Model 2: Duration Only</u>											
Cumulative Years of Exposure (<i>0 years as ref.</i>)												
1 year	-0.68	***	0.259	-0.60	*	0.314	-0.58	*	0.301	-0.30	0.362	
2 years	-0.37		0.260	-0.20		0.300	-0.62	**	0.300	-0.16	0.343	
3 years	-0.25		0.260	-0.46		0.306	-0.58	**	0.292	-0.56	0.344	
4 years	-0.24		0.224	-0.26		0.266	-0.25		0.234	0.01	0.283	
5 years	-0.64	***	0.104	-0.66	***	0.159	-0.82	***	0.122	-0.51	***	0.185
	<u>Model 3: Exposure Trajectory</u>											
Latent class membership (<i>Cons. Non-Exposed as ref.</i>)												
Exiters	-0.04		0.243	0.08		0.285	-0.51	*	0.264	-0.21	0.309	
Enterers	-0.60	**	0.239	-0.63	**	0.279	-0.55	**	0.276	-0.20	0.325	
Consistently Exposed	-0.54	***	0.099	-0.52	***	0.147	-0.70	***	0.113	-0.38	**	0.169

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

NOTE: Coefficients presented are log odds. Adjusted models include the following 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.

Table 5.5a

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
<u>Model 1: Timing Only</u>				
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
<u>Model 2: Duration Only</u>				
Cumulative Years of Exposure (<i>0 years as ref.</i>)				
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
<u>Model 3: Exposure Trajectory</u>				
Latent class membership (<i>Cons. Non-Exposed as ref.</i>)				
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.

Table 5.5b

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

	Enroll				Complete			
	Unadjusted		Adjusted		Unadjusted		Adjusted	
	Est	SE	Est	SE	Est	SE	Est	SE
	<u>Model 1: Timing Only</u>							
Timing of Exposure								
8th grade	-0.12	0.231	0.38	0.248	-0.12	0.231	0.33	0.295
9th grade	0.06	0.300	-0.16	0.310	0.06	0.300	-0.01	0.365
10th grade	0.16	0.373	0.23	0.397	0.16	0.373	0.27	0.432
11th grade	-0.82 *	0.482	-0.25	0.495	-0.82 *	0.482	-0.91 *	0.530
12th grade	-0.05	0.395	-0.54	0.416	-0.05	0.395	0.08	0.432
Early (9th and 10th)								
Late (11th and 12th)								
	<u>Model 2: Duration Only</u>							
Cumulative Years of Exposure (<i>0 years as ref.</i>)								
1 year	-0.24	0.270	-0.06	0.317	-0.24	0.270	-0.10	0.340
2 years	-0.47	0.323	0.28	0.348	-0.47	0.323	-0.16	0.396
3 years	-0.74 **	0.357	-0.44	0.347	-0.74 **	0.357	-0.55	0.403
4 years	-0.92 ***	0.351	-0.54 *	0.315	-0.92 ***	0.351	-0.56	0.411
5 years	-0.71 ***	0.145	-0.35 *	0.179	-0.71 ***	0.145	-0.25	0.213
	<u>Model 3: Exposure Trajectory</u>							
Latent class membership (<i>Cons. Non-Exposed as ref.</i>)								
Exiters	-0.38	0.278	0.01	0.305	-0.38	0.278	-1.05 **	0.503
Enterers	-1.24 ***	0.440	-0.56	0.352	-1.24 ***	0.440	-0.31	0.197
Consistently Exposed	-0.72 ***	0.136	-0.39 **	0.166	-0.72 ***	0.136	-0.35 ***	0.118

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

NOTE: Coefficients presented are log odds. Adjusted models include the following 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.

Table 5.6

Estimated effects of time-varying exposure to black-segregated schools on college enrollment and completion for black students

	Treatment (>33%)				Treatment (>50%)			
	Enroll		Complete		Enroll		Complete	
	Est	SE	Est	SE	Est	SE	Est	SE
<u>Model 1: Timing Only</u>								
Timing of Exposure								
8th grade	-0.51	0.409	-0.17	0.373	0.34	0.310	0.79 **	0.393
9th grade	0.56	0.598	-0.44	0.499	-0.06	0.391	-0.17	0.444
10th grade	0.67	0.516	0.48	0.622	0.75	0.498	0.73	0.454
11th grade	-0.58	0.631	-0.20	0.782	-0.61	0.609	-2.09 **	0.772
12th grade	-0.38	0.615	0.07	0.714	-0.47	0.495	0.81	0.735
Early (9th and 10th)	0.05	0.469	-0.76	0.699	0.28	0.327	0.62 *	0.338
Late (11th and 12th)	-0.96 **	0.474	-0.29	0.549	-1.08 **	0.476	-1.29 **	0.428
<u>Model 2: Duration Only</u>								
Cumulative Years of Exposure (<i>0 years as ref.</i>)								
1 year	-0.53	0.562	-0.47	0.676	0.68	0.417	1.01 **	0.420
2 years	0.50	0.563	0.68	0.655	0.32	0.424	0.13	0.458
3 years	-0.27	0.525	0.06	0.565	0.06	0.433	-0.09	0.528
4 years	0.65	0.493	0.93 *	0.551	0.33	0.417	0.18	0.494
5 years	-0.26	0.218	-0.30	0.266	-0.04	0.182	0.06	0.228
<u>Model 3: Exposure Trajectory</u>								
Latent class membership (<i>Cons. Non-Exposed as ref.</i>)								
Exiters	0.80	0.492	0.35	0.597	0.25	0.372	0.27	0.387
Enterers	-0.17	0.568	0.94	0.627	-0.54	0.466	-1.14	0.776
Consistently Exposed	-0.13	0.208	-0.18	0.253	-0.09	0.173	-0.11	0.211

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

NOTE: Models adjusted for following time-constant and 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.

Table 5.7

Estimated effects of time-varying exposure to black-segregated schools on college enrollment and completion for non-black students

	Treatment (>33%)				Treatment (>50%)				
	Enroll		Complete		Enroll		Complete		
	Est	SE	Est	SE	Est	SE	Est	SE	
<u>Model 1: Timing Only</u>									
Timing of Exposure									
8th grade	-0.01	0.296	-0.45	0.311	1.13 *	0.588	0.11	0.493	
9th grade	-0.24	0.394	0.11	0.383	-0.88	0.628	0.82	0.600	
10th grade	0.35	0.563	0.37	0.520	-1.13	1.059	-1.10	1.493	
11th grade	0.05	0.662	-0.36	0.643	2.99 **	1.413	2.06	1.745	
12th grade	-0.73	0.516	-0.10	0.486	-2.39 **	1.094	-2.40 **	1.090	
Early (9th and 10th)	-0.25	0.349	-0.34	0.343	0.25	0.580	0.94	0.572	
Late (11th and 12th)	-0.68	0.457	-0.45	0.467	0.60	0.945	-0.34	1.392	
<u>Model 2: Duration Only</u>									
Cumulative Years of Exposure (<i>0 years as ref.</i>)									
1 year	-0.61 *	0.370	-0.34	0.412	-0.88	0.535	-1.36 *	0.695	
2 years	-0.63	0.387	-0.54	0.436	1.51 *	0.846	0.35	0.791	
3 years	0.07	0.402	-0.26	0.437	-0.36	0.785	-0.58	0.886	
4 years	-0.49	0.383	-0.24	0.396	-0.62	0.891	-1.35	0.957	
5 years	-0.61 **	0.215	-0.32	0.243	-0.36	0.443	-0.20	0.491	
<u>Model 3: Exposure Trajectory</u>									
Latent class membership (<i>Cons. Non-Exposed as ref.</i>)									
Exiters	-0.19	0.373	-0.21	0.383	0.22	0.737	0.38	0.670	
Enterers	-0.58	0.362	-0.55	0.446	0.45	0.828	-1.70	1.077	
Consistently Exposed	-0.53 **	0.194	-0.26	0.210	-0.75 *	0.435	-0.38	0.449	

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

NOTE: Models adjusted for following time-constant and 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.

Chapter 6. Exploring Possible Mechanisms

The previous chapter estimated the effect of exposure to black-segregated schools on college enrollment and completion, accounting for time-varying covariates that acted as mediators and confounders of the relationship between exposure and postsecondary educational outcomes. These results demonstrated how segregation exposure influences student outcomes, but did not adjudicate among specific mechanisms through which the concentration of black students might have an affect. The objective of this chapter is to investigate potential mechanisms through which exposure affects postsecondary outcomes. The chapter is purely descriptive and provides suggestive evidence as to *how* black-segregated schools might affect students attending them.

The analyses examine two dynamic pathways simultaneously—one contextual (school segregation exposure) and one developmental (coursetaking, delinquent behavior, or substance use). I focus on these three developmental processes because prior literature has found levels of coursetaking and problem behavior development to vary across schools with different racial compositions and to be predictive of individual educational attainment (Attewell & Domina, 2008; C. Bankston & Caldas, 1996; McLeod & Kaiser, 2004). This approach allows me to describe “profiles” of students following different paths and investigate how the two pathways are related at a given point in time, how each pathway changes over time, and how changes in the two pathways are related over time. Specifically, I look to see whether high levels of exposure to black school segregation are experienced in conjunction with lower levels of coursetaking and higher levels of delinquent behavior and substance use. I also investigate whether segregation exposure in

one year is associated with the onset of problem behaviors or substance use in later years. These relationships will help unpack the effects of black school segregation on college outcomes, but are not meant as a formal test.

Connecting Segregation Exposure Pathways with Developmental Pathways

Chapter 2 discussed the ways segregation exposure could affect student educational outcomes, including school resources, peer effects, and information networks. In this chapter, I examine one aspect of *school resources*—student academic coursetaking. Student enrollment in high-level courses indicates that such courses are available at their school and that they are engaging with a college-preparatory curriculum that prepares them for college. I also examine *peer effects* through two behavioral developments that could result from attending a school with a concentration of students who engage in that type of behavior: delinquent behavior (i.e., running away, lying, cheating, stealing, destroying property, hurting or attacking others, selling drugs, using weapons, involvement with gangs, arrest and conviction record) or substance use (i.e., drinking alcohol, smoking cigarettes, using other drugs).

Academic coursetaking. Prior literature finds that, on average, students at predominantly black schools have less access to high-level curriculum compared to students at predominantly white schools (e.g., Darling-Hammond, 2004). If the causal effect of segregation exposure on college outcomes operates primarily through coursetaking, then students attending predominantly black schools will be disadvantaged because they will not have access to the same rigorous, college-prep classes. Weaker

academic preparation may negatively affect decisions to enroll in postsecondary education, or, once enrolled, may hinder successful completion of a college degree.

I explore whether pathways characterized by consistent segregation exposure are concurrent with lower levels of academic coursetaking, and whether pathways characterized by low (or no) segregation exposure are concurrent with higher levels of coursetaking. If black-segregated schools have lower levels of courses offered overall, then particularly for students exposed to black-segregated schools *later* in high school, we might expect lower levels of the highest coursetaking in the last years of high school, or potentially a “leveling off” of the academic progression. Weaker academic progression could be responsible for the negative effect of black school segregation on lower rates of college enrollment and college completion. Students who remain in non-black-segregated schools may have the opportunity to continue on an upward trajectory of higher-level courses, and finish high school with higher overall coursetaking level.

Delinquent behavior. The effect of segregation exposure could also operate through behavioral pathways. Some prior research notes that delinquency and substance use have not received much attention in their relationship to student outcomes, but that they have a profound and distinct impact on social consequences (McLeod et al., 2012). As the peer effects theory suggests, majority black schools may be less conducive to learning than non-black-segregated schools because majority black schools generally have a higher concentration of poverty—the result of racial segregation (Massey & Denton, 1993)—which can, among other consequences, concentrate students from single-parent families who have higher rates of problem behaviors which can disrupt instruction

in classrooms (ibid.). Prior work has found that students exhibiting delinquency is negatively associated with educational attainment, net of background characteristics (McLeod et al., 2012).

If black-segregated schools concentrate students exhibiting problem behaviors, exposure to such schools may be related to the onset of problem behaviors through peer effects. We might find that pathways of consistent segregation exposure will co-occur with higher levels of delinquent behavior, and that pathways of consistently little or no segregation exposure will co-occur with lower levels of delinquent behavior. I explore relationships between the timing of segregation exposure and delinquent behavior. Exposure early in middle school may start students on a path of risky behavior that has the most negative consequences because it begins during the period adolescents are deciding their personal identities (Crosnoe & Johnson, 2011). Exposure later in high school that results in delinquent behavior may be most detrimental, however, because the behavior is coinciding with a critical period when future academic plans are made.

If the probability of delinquent behavior increases after the probability of segregation exposure increases, this would indicate that moving into a black-segregated school is detrimental for maintaining non-delinquent behavior patterns. And if these pathways are in turn associated with lower levels of college enrollment and completion, we would have suggestive evidence that the effect of segregation exposure on college outcomes operates through delinquent behavior.

Substance use. The final possible mechanism explored in this chapter is substance use (cigarettes, alcohol, other drugs). The effect of black-segregated schools

could negatively impact college outcomes through the onset of substance use. Prior research has shown that substance use—particularly drug and alcohol use—affects college enrollment and completion even after controlling for student background characteristics and achievement (King, Meehan, Trim, & Chassin, 2006). Students who are heavy users of alcohol or drugs, and particularly students who exhibit *growth* in substance use over time are less likely to complete higher education (ibid.). Baumrind and Moselle (1985) posit that substance use during adolescence is negatively related to college outcomes because it prevents the normal development of self-regulation and coping skills, which are necessary to succeed in higher education.

If attending black-segregated schools is positively related to substance use—either because higher proportions of peers are substance users or because substance use is more socially acceptable (Allison et al., 1999), then we would expect to see segregation exposure co-occurring with high substance use, little or no segregation exposure related to low substance use, and increasing segregation exposure related to the onset of substance use. However, support for this mechanism actually travels in the opposite direction: because substance use rates are *lower* for black and Hispanic students compared to white students (R. A. Johnson & Hoffmann, 2000; Kandel, Kiros, Schaffran, & Hu, 2004; Wallace et al., 2002), the peer effects hypothesis suggests that attending black-segregated schools may lead students to have lower levels of substance use, which may, in turn positively impact the likelihood of college-going.

Data and Methods

The analytic sample and measures for academic coursetaking, delinquent behavior, and substance use are the same as in Chapter 5. Results presented in this chapter are from the first imputed dataset.

Analytic strategy. I designate five periods during adolescence—prior to high school, and a period for each year of high school. For each period, every adolescent is coded as having been exposed to a black-segregated school, having engaged in delinquent behavior, and having engaged in substance use. Additionally, each respondent has a value for the level of mathematics and science coursetaking they had taken up to the date of the interview. Segregation exposure, delinquent behavior, and substance use are all dichotomous variables, and academic coursetaking is a continuous variable.

I examine three pairs of trajectories: exposure—coursetaking, exposure—delinquency; and exposure—substance-use. For each pair, trajectories are based on patterns of exposure to black school segregation and the given developmental domain over five waves of data and are classified using latent class analysis (LCA). For the exposure—coursetaking pair, I use observed indicators for the presence (1) or absence (0) of attending a black-segregated school and a continuous variable for the level of coursetaking achieved for each of the five waves of data. Ten total variables are included in the LCA. For the exposure—delinquency and exposure—substance-use pairs, I use observed indicators that identify the presence (1) or absence (0) of segregation exposure and delinquent behavior (or substance use) across five waves of data for a total of ten indicator variables in each LCA. The observed variables give rise to categorical latent

classes that contain groups of students who have similar observed patterns of responses and identify different patterns of segregation exposure and the behavioral development during middle and high school.

Figure 6.1 illustrates the LCA model. The Y s in the figure represent time-ordered dichotomous measures for exposure to highly black-segregated schools that equal 1 if the student attended a school at time t ($t=1, 2, 3, 4, 5$) that was 50–100 percent black and 0 otherwise. For the exposure—delinquency and exposure—substance-use LCAs, the L s in the figure represent the time-ordered measures for the behavioral domains that equal 1 if the student engaged in the behavior at time t and 0 otherwise. For the exposure—coursetaking LCA, the L s represent the level of coursetaking at time t . The C represents a latent categorical variable with c trajectory classes ($C= 1, \dots, c$) that are estimated by the model, where $c_{ci}=1$ for individual i who is most likely to fall into the c^{th} latent class.

Model building proceeded by first estimating the number of distinct trajectory classes, determining the optimal number of latent classes by step-wise increasing the number of classes estimated under a given measurement model. I began with one latent class and added an additional latent class in each successive model run, comparing the same four indices of relative model fit across model runs that were described in Chapter 4 (Muthén & Muthén, 2000).

The emergent classes in each of the LCAs accomplish three major objectives. First, they describe developmental processes *within* each domain. For each latent class, I assess the prevalence of membership and examine the form of change over time. Second, each of the LCAs reveals the dynamic relationship *between* the developmental trajectory

in question and segregation exposure. I describe whether changes in the probability of segregation exposure are related to changes in the probability of substance use, delinquent behavior, or academic coursetaking and in what direction. Third, I assess the relationship between latent class membership and postsecondary educational outcomes. The inclusion of a distal outcome is an extension of the LCA modeling framework (Collins & Lanza, 2013). I utilize the 3-step modeling approach as first introduced by Vermunt (2010) and included in the Mplus v.7.1 software (Asparouhov & Muthen, 2013).

Briefly, the 3-step modeling approach allows one to first estimate latent class membership (step 1), then classify individuals into their most likely latent class (step 2), and finally relate latent class membership to an auxiliary distal outcome (step 3) (Asparouhov & Muthen, 2013). Three-step approaches are often considered advantageous when one does not want the distal outcome to affect the formation of latent classes, which can occur when all modeling is completed in one step. In the current situation, I want to *first* understand how segregation exposure pathways are related to different developmental domain trajectories and *then* understand how membership in different exposure—development groups is related to college outcomes. Letting college outcomes affect the construction of trajectory membership confuses the temporal ordering. Traditional 3-step methods do not account for the uncertainty in latent class membership and pose problems for obtaining unbiased estimates (Schuler, 2013). The approach used here addresses this uncertainty and makes corrections to standard errors.

Results

Results for three separate longitudinal latent class analyses of two pathways are presented. For each combination (segregation—coursetaking, segregation—delinquency, and segregation—substance-use), I first present the classes identified through the longitudinal LCA. I next discuss how the two domains are related to one another, focusing on how the pathways converge and diverge over time. Finally, I discuss how classes are associated with postsecondary college outcomes.

Segregation exposure and academic coursetaking. A four-class model fit the data the best for these two concurrent trajectories of segregation exposure and academic coursetaking (Table 6.1). Although the BIC for the 4-class model was not the minimum BIC achieved, it was the largest number of classes that maintained class separation (i.e. entropy value above 0.90) and had substantively distinct latent classes. This analysis finds two latent classes characterized by consistently extremely low probability of segregation exposure and two latent classes that are characterized by high, but changing, probabilities of segregation exposure.

The first of the two classes with consistently extremely low probability of segregation exposure accounts for nearly half (49 percent) of the sample and is characterized by a strong academic progression, equal to approximately one course each in mathematics and science per year (Table 6.2 and Figure 6.2). This group of students had a mean value of 5.9 by 12th grade, which is approximately equivalent to pre-calculus and physics. This class is labeled *No Exposure – Strong Academic Progression*. The second of the two classes with consistently low probability of segregation exposure has

much slower academic progression, ending with a mean academic coursetaking level of 4.1 – the lowest of all classes and equivalent to algebra II and biology. The class accounts for 29 percent of the sample and is labeled *No Exposure – Slow Academic Progression*. The third and fourth classes both have high segregation exposure probabilities, but differ in that one class has slightly increasing probabilities over time (0.83 to 0.95) and one class that has slightly decreasing probabilities over time (0.88 to 0.79). The class with increasing exposure probabilities is the third largest class (14 percent of the sample), and is labeled *Consistent Exposure – Strong Academic Progression* to reflect the strong academic coursetaking that is nearly identical to the *No Exposure – Strong Academic Progression* class. The final class, just 9 percent of the sample is *Consistent Exposure – Slow Academic Progression*. Students in this class finish 12th grade with mean level of coursetaking equivalent to geometry and chemistry.

There does not appear to be a strong relationship between segregation exposure and academic coursetaking pathways. In fact, when we consider all students belonging to the two *No Exposure* classes and separately consider all students belonging to the two *Consistent Exposure* classes, we find very similar proportions of students split into the *Strong Academic Progression* and *Slow Academic Progression* classes. Among students in the two *No Exposure* classes, about 63 percent ($48.5/(48.5+28.5)=63$) were in the *Strong Academic Progression* class. Among students in the two *Consistent Exposure* classes, about 59 percent ($13.5/(13.5+9.2)=59$) were in the *Strong Academic Progression* class.

How are the different classes associated with college-going behavior? The results indicate that among students with slow academic progress, attending black-segregated schools is not associated with college outcomes (Table 6.3). Specifically, students in the *Consistent Exposure – Slow Academic Progression* and students in the *No Exposure – Slow Academic Progression* had mean probabilities of 0.48 and 0.46, respectively, of enrolling in a 2- or 4-year college and probabilities of 0.12 each of completing a 2- or 4-year degree. Where I do find differences is among students with strong academic progression: students in the *Consistent Exposure – Strong Academic Progression* class were less likely to enroll in college or complete college than their *No Exposure – Strong Academic Progression* peers (0.59 vs. 0.78 for college enrollment, and 0.24 vs. 0.47 for college completion). A strong academic record is advantageous regardless of segregation exposure, but students *without* exposure are the most advantaged.

Segregation exposure and delinquent behavior. The LCA for segregation exposure and delinquent behavior pathways identified six classes as the optimal number. The six-class model minimized the BIC, had strong separation between classes, fit the data significantly better than the five-class model, and had substantively distinct and meaningful classes (Table 6.1).

Similar to the exposure typologies identified in Chapter 3, the exposure and delinquency typologies identify four basic patterns of segregation exposure—two stable classes (consistently exposed and consistently non-exposed) and two dynamic classes (entering and exiting). When these four basic patterns are analyzed concurrently with delinquent behavior, I find two patterns of delinquency among those with consistently

high probabilities of segregation exposure and two patterns of delinquency among those with consistently near-zero probabilities of exposure. Just over half of the sample (51 percent) belong to the class *No Exposure – Low Delinquency*, characterized by near-zero probability of segregation exposure and the lowest probability of delinquent behavior across all time points (Table 6.2 and Figure 6.3). The second largest class, *No Exposure – High Delinquency* (25 percent of the sample) consists of students with similarly low probabilities of exposure but much higher probabilities of delinquent behavior (0.73 to 0.49). The third largest class, *Consistent Exposure – Low Delinquency*, represents 15 percent of the sample. These students have consistently high probability of exposure to black-segregated schools, and stable low probabilities of any delinquent behavior. The fourth largest class is 4 percent of the sample and consists of students with consistently high probabilities of segregation exposure and high but decreasing probabilities of delinquent behavior. This class (*Consistent Exposure – High-Decreasing Delinquency*) has the highest difference in the probability of delinquent behavior between 12th grade and 8th grade ($0.82 - 0.49 = 0.33$). The two smallest classes are the dynamic exposure classes. The *Entering Exposure – Mid-Decreasing Delinquency* class (2 percent of the sample) begins with low probabilities of segregation exposure, but by 11th and 12th grade has very high probabilities of exposure. Meanwhile, students in this class have the largest decline in probability of delinquent behavior (0.49 to 0.11). Notably, the biggest drop occurs from 10th to 11th grade, the same period that the probability of segregation exposure increases to 0.98. The final class, *Exiting Segregation – Moderate Delinquency*, contains 4 percent of the sample and is characterized by extremely high initial exposure

probabilities that decline precipitously over time. This class begins with probabilities of 0.48 for delinquent behavior, and this probability declines slightly to 0.21 by the end of high school.

Examining the relationship between segregation exposure and delinquent behavior suggests that, like substance use, delinquent behavior is not the mechanism through which segregation affects outcomes. First, I find that relatively *more* unexposed students have delinquent behavior than do exposed students. Among students who are not exposed to black-segregated schools, the proportion belonging to the high-delinquency class is about 0.33. The corresponding proportion among students who are exposed to black-segregated schools is just 0.21, demonstrating a higher likelihood of delinquent behavior among the non-exposed classes. Second, I find that students in the *Consistent Exposure – High-Decreasing Delinquency* and students in the *Entering Exposure – Mid-Decreasing Delinquency* class have the largest declines in the probability of delinquent behavior across all classes (see Figure 6.3). Finally, I look to students in the *Exiting* and *Entering* classes to see whether large changes in the probability of exposure to black-segregated schools is associated with changes in the probability of delinquent behavior. Here I find a very weak relationship but, if anything, the decreasing exposure probability in the *Exiting* class is associated with a higher probability of delinquent behavior. All classes have declining probabilities of delinquent behavior over time, but members of the *Exiting* class have smaller declines than their peers in the *Entering* class.

How are these typologies related to college outcomes? Students in the *No Exposure – Low Delinquency* class (students with no contextual or behavioral

disadvantage) have the highest mean enrollment rate (0.77) and the highest mean completion rate (0.44) (Table 6.3). Students who have *no* behavioral disadvantage but are consistently exposed to segregated schools (*Consistent Exposure – Low Delinquency*) are not statistically different in their mean enrollment or completion from their peers in *No Exposure – High Delinquency* class. This finding suggests the mechanism at work is not primarily delinquent behavior, given the wide range of delinquent behavior with similar postsecondary outcomes.

Segregation exposure and substance use. The latent class analysis for segregation exposure and substance use (alcohol, cigarettes, or other drugs) resulted in a seven-class model. The seven-class model minimized the BIC, maintained high classification (entropy=0.86), and fit the data significantly better than the six-class model (Table 6.1). Additionally, all classes identified in this seven-class model were substantively distinct.

With respect to segregation exposure, I find four basic groups of students: those with consistent exposure, those with no exposure, and those entering or exiting black-segregated schools during secondary school (Table 6.2 and Figure 6.4). Three latent classes were characterized by consistent very low probability of segregation exposure, but differed by substance-use patterns. Students in the *No Exposure – Low Use* class represented almost 24 percent of the sample. Between 8th and 12th grade, students in this class had a probability of between 0.06 and 0.29 of engaging in any substance use. The modal class was *No Exposure – High Use* and constituted 39 percent of students in the sample. Students in this class had consistently high probability (ranging from 0.76 to

0.90) of substance use. Students in the *No Exposure – Fast-Increasing Use* class had very low probabilities of substance use in 8th and 9th grade, but by the end of high school had very high probabilities of use. The change in probability is 0.70—the largest change among all of the classes. Notably, this change in substance use does not appear to be related to changes in segregation exposure, as exposure probabilities remained stable throughout.

The second set of latent classes is characterized by consistent segregation exposure but differing substance use patterns. The *Consistent Exposure – Low Use* class accounts for 11 percent of the sample. These students had a very low probability of substance use, beginning and finishing secondary school with nearly identical probabilities of substance use as the *No Exposure – Low Use* class. The second class, *Consistent Exposure – High-Increasing Use* represents 9 percent of the sample. These students begin 8th grade with a probability of substance use of over 0.6 that increase to 0.9 by 12th grade.

The final two latent classes have dynamic exposure to black segregation over time. The *Entering Exposure – Mid-Increasing Use* class is just 2 percent of the sample. These students have rapidly increasing probability of segregation exposure *and* increasing probability of substance use (0.42 to 0.71 over time). The *Exiting Exposure – Mid-Increasing Use* class accounts for 3 percent of the sample. These students have decreasing probabilities of segregation exposure and look very similar to students in the *Entering* class with respect to the probabilities of substance use aside from a modest divergence of probabilities in 12th grade.

How are segregation exposure and substance use related? The resulting latent classes do not provide evidence for a relationship between segregation exposure and high rates of substance use. In fact, we find that there exist high *and* low rates of substance use among students with consistent segregation exposure and among students who are consistently *not* exposed to such schools. Among the students who enter and exit black-segregated schools, there exists weak evidence that the school context may play a role in substance use at the end of high school. Within the *Entering* class, the probability of substance use increases through 12th grade; within the *Exiting* class, the probability of substance use increases through 11th grade, but then decreases in 12th grade. We also find that the largest increases in the probability of substance use between 8th and 12th grade—aside from the latent class defined by the shift from non-user to user (i.e., *No Exposure – Fast Increasing Use* class)—occurs for students in the *Entering* class. These patterns are suggestive, but do not constitute compelling evidence for a relationship between segregation exposure and substance use.

How are the segregation-substance use trajectories related to college outcomes? I find evidence against substance use as a mechanism for the segregation effects on college outcomes. First, the most advantaged class in terms of college enrollment and completion is the *No Exposure – Fast Increasing* class (80 percent of class enrolls and 50 percent completes, Table 6.3). Interestingly, this group had the highest probability of college enrollment and college completion and was advantaged even compared to students in the *No Exposure – Low Use* class (60 percent of class enrolls, 30 percent completes). The second most advantaged classes are those with *Low Use*, regardless of segregation

exposure, and those in the *Exiting Segregation – Mid-Increasing Use* class. Students with *High Use* had different outcomes depending on segregation exposure, with students in the *No Exposure – High Use* class much more likely to enroll in college and complete college (65 vs. 44 percent enrolling; 32 vs. 12 percent completing).

Discussion and Conclusions

This chapter provides an exploratory look at possible mechanisms for the effect of segregation exposure on college enrollment and completion outcomes. I modeled segregation exposure between 8th and 12th grade with three developmental domains over the same period (academic coursetaking, delinquent behavior, and substance use) in three separate longitudinal latent class analyses. I first examined the latent classes that emerged for whether the two domains were related within individuals over time. I then investigated how patterns in the two domains were associated with college outcomes.

The first possible mechanism explored in this chapter was academic coursetaking. This is the most plausible potential mechanism because academic preparation is strongly related to college access and success. It has also been established in prior work that minority-segregated schools have less access to rigorous college-preparatory curriculum (Darling-Hammond & Post, 2000).¹⁵ The results from the exposure—coursetaking LCA identified four latent classes. I find two classes with high probability of segregation exposure and two classes with low exposure probability. Within each high and low

¹⁵ It is important to note here that several studies have shown that attending a school that offers rigorous college-prep courses does not guarantee access to them, particularly for minority students (e.g., Tyson, 2011; Attewell & Domina, 2008).

group, one class had weak academic progression and one had strong academic progression. The results do not suggest any relationship between black-segregated schools and weaker academic coursetaking. On the contrary, I find that that among the classes with high exposure probabilities, the class with slightly declining exposure probability (from 0.9 to 0.8 between 8th and 12th grade) had weaker academic progression. In line with previous research, the results *do* indicate that the strength of academic preparation is important for college outcomes. Regardless of segregation exposure, classes with weak academic preparation had similarly poor rates of college enrollment and completion. Differences in outcomes were apparent, though, for students with strong academic progression. The class with stable low exposure probabilities had the strongest enrollment and completion rates. Even with similar mean levels of academic coursetaking, students with high exposure probabilities had enrollment and completion rates that were 20 percentage points lower than their peers in non-segregated schools.

There are several limitations with the coursetaking information used in these analyses. First, coursework information was self-reported and students are not always reliable in their responses to academic courses taken. Second, and more problematic, the survey question asked whether the student ever *enrolled* in a given course, but did not indicate the grade received or even if the student received credit for taking the course (usually given for passing a class). Therefore, the measure is an indication of whether the course was offered at the student's school, but is not an indication that the student is proficient in the course material. Finally, the level of course taken says nothing of the quality of the course, and high school course content and quality is not standardized

across the country or even within districts. It is possible, for instance, that students at black-segregated schools taking pre-calculus are not receiving the same instructional rigor, which may make students less confident in their academic preparation, and therefore less likely to enroll in college, or once attending college, less likely to finish.

The LCA for exposure and delinquent behavior identified six classes: two classes with no segregation exposure and two classes with consistent segregation exposure—each paired with one low delinquent behavior and a second with consistently high delinquent behavior; and two classes with dynamic segregation probabilities—each starting with moderate probability of delinquent behavior. Across classes, the probability of delinquent behavior declined throughout secondary school, but the decline was largest for the *Consistent Exposure – High-Decreasing Delinquency* class and the *Entering Segregation – Mid-Decreasing Delinquency* class. This suggests that the mechanism is *not* operating in the way one might hypothesize (i.e., that attending a black-segregated school would increase delinquent behavior, thereby increasing a student’s probability of involvement with the criminal justice system and decreasing the probability of postsecondary education). In fact, these two classes with the largest declines in delinquency over time have the two lowest rates of college enrollment and college completion. Instead, we find that students with consistently no exposure and low delinquency have a clear advantage in postsecondary outcomes, and that except for the two declining delinquency classes, students have very similar postsecondary outcomes across a range of exposure and delinquent behavior patterns. In summary, exposure to

segregated school does not have a clear positive relationship with delinquent behavior, and delinquent behavior does not have a strong relationship with college outcomes.

The LCA for exposure and substance use identified seven classes: two classes with stable high exposure probabilities, with one class characterized by high substance-use probabilities and the other by low probabilities; two classes with stable low exposure probabilities, one with high substance-use and one with low; a third low-exposure class with late-onset substance use; and two dynamic exposure classes—entering or exiting exposure—with moderate probabilities of substance use.

I did not identify a relationship between substance use and segregation exposure. In terms of outcomes for the exposure—substance-use classes, I find that students with low substance use (or late onset substance use), regardless of segregation exposure patterns, have the highest enrollment and completion rates. However, students with high substance-use who are *not* exposed to segregated schools also have relatively high enrollment and completion rates while their exposed peers have much lower enrollment and completion rates. This finding suggests a marked disparity between how substance use affects students in different school settings. Because I do not control for background factors like parental education and family wealth, it could be that the students with high substance use who are exposed and not-exposed to segregated schools have very different background characteristics that predict their college outcomes. But the results are suggestive of students in segregated schools paying a postsecondary penalty for substance use that their peers in non-segregated schools do not.

These analyses offer some insight into the nature of racial school segregation, but they have several key limitations. First, the results describe concurrent pathways of segregation exposure and developmental domains, and the association between these pathways and college enrollment and completion outcomes. The relationships are not causal and do not address confounding, but instead model the association between latent class membership (i.e., experiencing a given pattern of exposure and development) and the distal college outcomes. Recent work has begun to address confounding in latent class regression primarily through the use of propensity score methods, when latent class is regressed on auxiliary variables such as predictors of latent class or distal outcomes (Butera, Lanza, & Coffman, 2013; Schuler, Leoutsakos, & Stuart, 2014). Because the analysis presented in this chapter was focused on the dynamic relationship between exposure and developmental domains, it does not adjust for baseline differences across the latent classes and may therefore conflate the “true” effect of latent class membership on postsecondary educational outcomes.

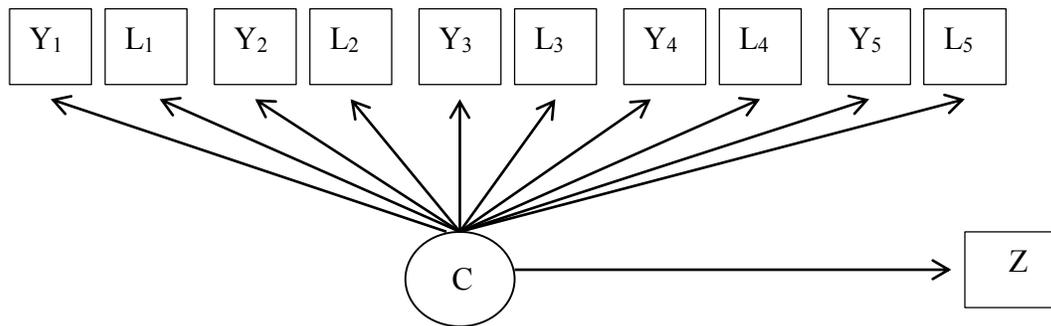
This chapter explored academic coursetaking, delinquent behavior and substance use as possible mechanisms responsible for the effect of school segregation on college outcomes. Although I do not find support for these mechanisms, the results do indicate that students attending segregated schools have worse postsecondary outcomes than their peers at non-segregated school even if they have *similar* levels of academic coursetaking, delinquent behavior, and substance use. For instance, I find that across both behavioral domains, students with high probabilities of substance use or delinquent behavior have diminished college outcomes *only if* they attend black-segregated schools.

Recent research has shown that students from privileged backgrounds who drop out of high school fare just as well or better than students from poor backgrounds who were college graduates in terms of income earnings at age 40 (Reeves & Sawhill, 2014). This chapter’s findings provide similar evidence, but from further “upstream.” Instead of examining how educational attainment affects later adult earnings for students of different socioeconomic backgrounds, these analyses examine how harmful or normative development (with respect to risky behavior and academic coursetaking) affects educational attainment for students with different segregation exposure patterns. Students who have weak academic progression in both segregated and non-segregated schools have equally low rates of college enrollment and college completion outcomes, but students with equally strong academic progression are differentiated in their college outcomes by whether or not they attended black-segregated schools. Students with no segregation exposure had higher mean enrollment and completion than their peers with consistent segregation exposure. Students with little segregation exposure seem to fare just as well or better in terms of college enrollment and completion even if they have high probabilities of risky behavior throughout secondary school. The same is not true for students in black-segregated schools.

In conclusion, results from this chapter do not provide definitive answers for why students in black-segregated schools—particularly in the final years of high school—face worse rates of college enrollment and college completion. Future work must attend to identifying the mechanisms responsible. Additional possibilities include student engagement and attachment to school; student networks, including maintaining

relationships with friends and family who have experience applying for and attending college; and school-level resources other than academic preparation, including school counselors with the time, ability, and experience to assist students in navigating the college application process.

Figure 6.1. LCA model with outcome.



The Ys represent time-ordered dichotomous measures of exposure to black-segregated schools. The Ls represent time-ordered measures of one of three developmental processes—academic coursetaking level, delinquent behavior, or substance use. C represents the categorical latent variable, and Z is the college outcome (enrollment or completion).

Table 6.1
Model fit indices for three longitudinal latent class analyses

Segregation-Coursetaking Pathways					
Number of Classes	Log Likelihood	AIC	BIC	LMR-LRT	Entropy
1	-21073	42176	42261	--	--
2	-17463	34979	35126	p<.001	0.99
3	-16406	32887	33096	p<.001	0.88
4	-15995	32087	32359	p<.001	0.90
5	-15488	31094	31428	p=.001	0.86
6	-15294	30729	31125	p=.001	0.83

Segregation-Delinquency Pathways					
Number of Classes	Log Likelihood	AIC	BIC	LMR-LRT	Entropy
1	-11169	22359	22415	--	--
2	-8071	16183	16302	p<.001	0.99
3	-7614	15293	15474	p<.001	0.84
4	-7470	15026	15269	p<.001	0.87
5	-7379	14866	15172	p<.001	0.86
6	-7319	14767	15136	p<.001	0.88
7	-7289	14730	15160	p<.001	0.81

Segregation-Substance Use Pathways					
Number of Classes	Log Likelihood	AIC	BIC	LMR-LRT	Entropy
1	-12040	24099	24156	--	--
2	-8861	17765	17884	p<.001	0.99
3	-8101	16266	16448	p<.001	0.87
4	-7886	15858	16101	p<.001	0.87
5	-7763	15634	15940	p=.003	0.89
6	-7685	15501	15869	p<.001	0.86
7	-7632	15415	15846	p=.04	0.86
8	-7597	15368	15861	p=.04	0.81

NOTE: AIC is Akaike's Information Criterion. BIC is the Bayesian Information Criterion. LMR-LRT is the Lo-Mendel-Rubin Likelihood Ratio Test. Values displayed are p-values. Bold font indicates the model chosen based on statistical and substantive criteria.

Table 6.2

Class prevalence and item response probabilities for latent class analyses

Class Label	Percent	Time 1	Time 2	Time 3	Time 4	Time 5	Time 1	Time 2	Time 3	Time 4	Time 5
Segregation--Academic Coursetaking											
		<u>Probability of Segregation Exposure</u>					<u>Mean Coursetaking Level</u>				
<i>Consistent Exposure – Slow Academic Progression</i>	9.2	0.88	0.89	0.83	0.82	0.80	1.3	2.7	3.4	4.1	4.5
<i>No Exposure – Slow Academic Progression</i>	28.5	0.02	0.00	0.00	0.00	0.01	1.3	2.7	3.3	3.8	4.1
<i>Consistent Exposure – Strong Academic Progression</i>	13.5	0.83	0.90	0.96	0.97	0.95	1.9	4.0	4.9	5.6	5.9
<i>No Exposure – Strong Academic Progression</i>	48.5	0.05	0.02	0.00	0.00	0.01	1.8	3.8	4.9	5.6	5.9
Segregation--Delinquency											
		<u>Probability of Segregation Exposure</u>					<u>Probability of Delinquent Behavior</u>				
<i>Consistent Exposure – High-Decreasing Delinquency</i>	3.9	0.90	1.00	0.99	1.00	0.96	0.82	0.79	0.76	0.56	0.49
<i>Consistent Exposure – Low Delinquency</i>	14.8	0.91	1.00	0.99	1.00	0.98	0.31	0.15	0.13	0.09	0.09
<i>Entering Exposure – Mid-Decreasing Delinquency</i>	2.3	0.29	0.00	0.70	0.98	1.00	0.46	0.39	0.37	0.15	0.11
<i>No Exposure – High Delinquency</i>	24.8	0.02	0.00	0.00	0.00	0.00	0.73	0.70	0.70	0.62	0.49
<i>No Exposure – Low Delinquency</i>	50.8	0.02	0.00	0.00	0.00	0.01	0.23	0.12	0.08	0.07	0.06
<i>Exiting Exposure – Moderate Delinquency</i>	3.5	0.85	0.78	0.26	0.05	0.05	0.48	0.29	0.37	0.29	0.21
Segregation--Substance Use											
		<u>Probability of Segregation Exposure</u>					<u>Probability of Substance Use</u>				
<i>Consistent Exposure – Low Use</i>	10.5	0.96	0.99	0.98	1.00	0.97	0.17	0.08	0.07	0.15	0.24
<i>No Exposure – Low Use</i>	23.6	0.04	0.00	0.01	0.00	0.01	0.16	0.17	0.13	0.06	0.29
<i>No Exposure – High Use</i>	39.2	0.01	0.00	0.00	0.00	0.01	0.76	0.92	0.91	0.89	0.90
<i>Entering Exposure – Mid-Increasing Use</i>	1.9	0.20	0.00	0.66	0.99	1.00	0.42	0.52	0.49	0.65	0.71
<i>Consistent Exposure – High-Increasing Use</i>	8.5	0.84	0.97	0.99	1.00	0.97	0.63	0.70	0.83	0.79	0.86
<i>No Exposure – Fast-Increasing Use</i>	12.8	0.05	0.00	0.00	0.00	0.00	0.16	0.15	0.54	0.97	0.86
<i>Exiting Exposure – Mid-Increasing Use</i>	3.4	0.87	0.84	0.26	0.05	0.05	0.34	0.44	0.52	0.60	0.57

NOTE: Time 1 corresponds to grade 8, time 2 corresponds to grade 9, and so on.

Table 6.3

Probability of college enrollment and college completion, by latent class membership

Class Label	Mean College Enrollment	SE	Mean College Completion	SE
Segregation--Academic Coursetaking				
<i>Consistent Exposure – Slow Academic Progression</i>	0.480	0.042	0.115	0.023
<i>No Exposure – Slow Academic Progression</i>	0.464	0.024	0.115	0.014
<i>Consistent Exposure – Strong Academic Progression</i>	0.589	0.031	0.237	0.025
<i>No Exposure – Strong Academic Progression</i>	0.775	0.015	0.470	0.017
Segregation--Delinquency				
<i>Consistent Exposure – High-Decreasing Delinquency</i>	0.438	0.074	0.115	0.022
<i>Consistent Exposure – Low Delinquency</i>	0.619	0.060	0.260	0.034
<i>Entering Exposure – Mid-Decreasing Delinquency</i>	0.520	0.073	0.125	0.047
<i>No Exposure – High Delinquency</i>	0.543	0.024	0.224	0.021
<i>No Exposure – Low Delinquency</i>	0.768	0.020	0.443	0.024
<i>Exiting Exposure – Moderate Delinquency</i>	0.625	0.061	0.249	0.051
Segregation--Substance Use				
<i>Consistent Exposure – Low Use</i>	0.601	0.036	0.240	0.029
<i>No Exposure – Low Use</i>	0.647	0.041	0.317	0.064
<i>No Exposure – High Use</i>	0.580	0.019	0.280	0.021
<i>Entering Exposure – Mid-Increasing Use</i>	0.514	0.086	0.146	0.044
<i>Consistent Exposure – High-Increasing Use</i>	0.436	0.057	0.124	0.028
<i>No Exposure – Fast-Increasing Use</i>	0.800	0.023	0.459	0.057
<i>Exiting Exposure – Mid-Increasing Use</i>	0.695	0.054	0.257	0.051

Figure 6.2.
Latent Classes of Segregation Exposure and Academic Coursetaking.

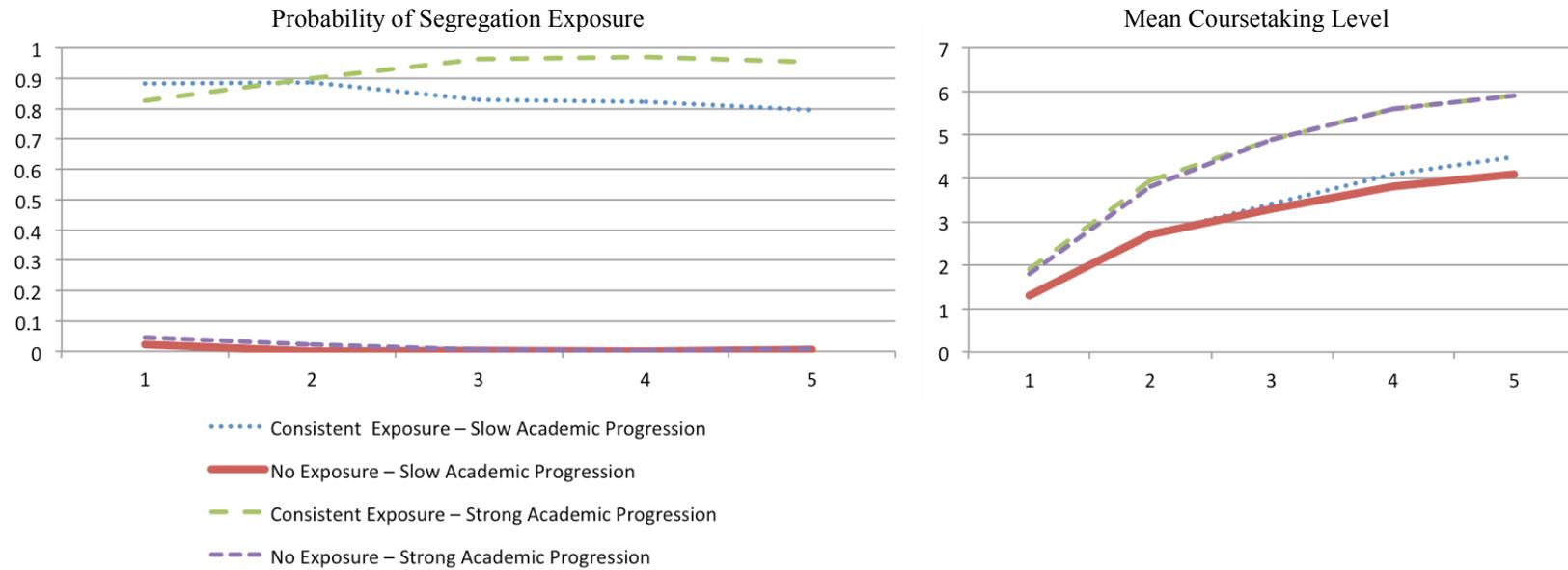


Figure 6.3.
 Latent Classes of Segregation Exposure and Delinquent Behavior.

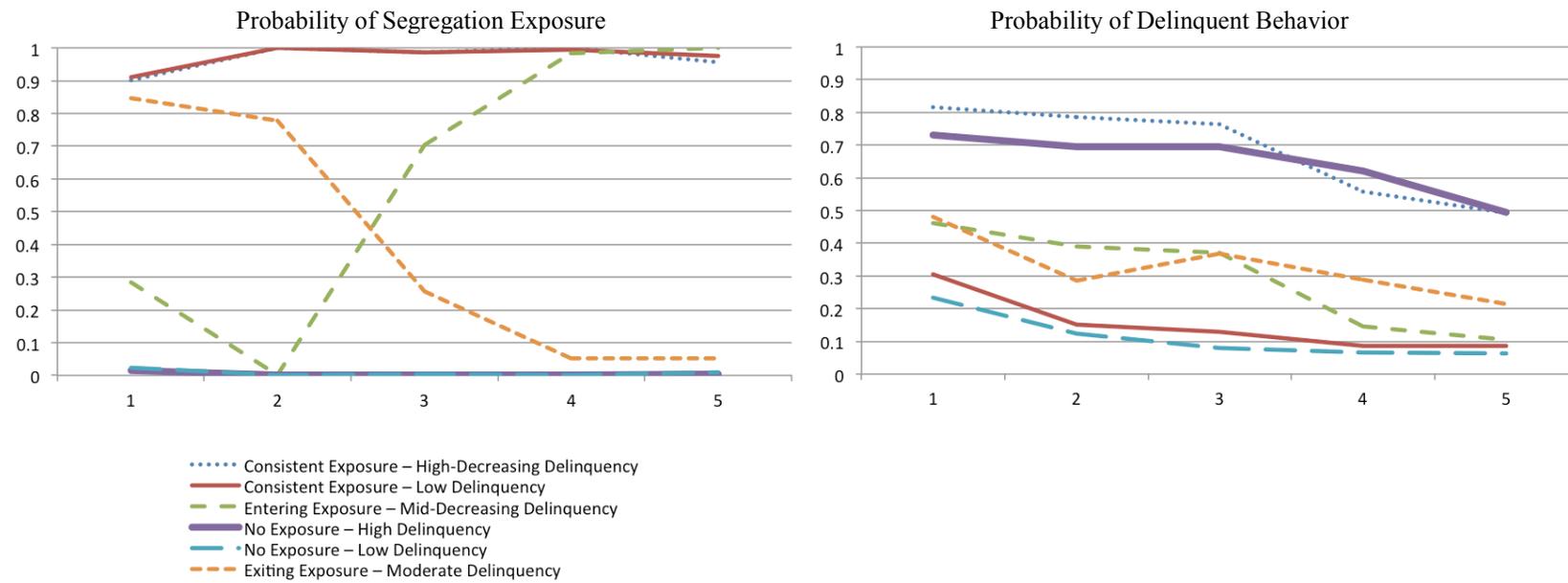
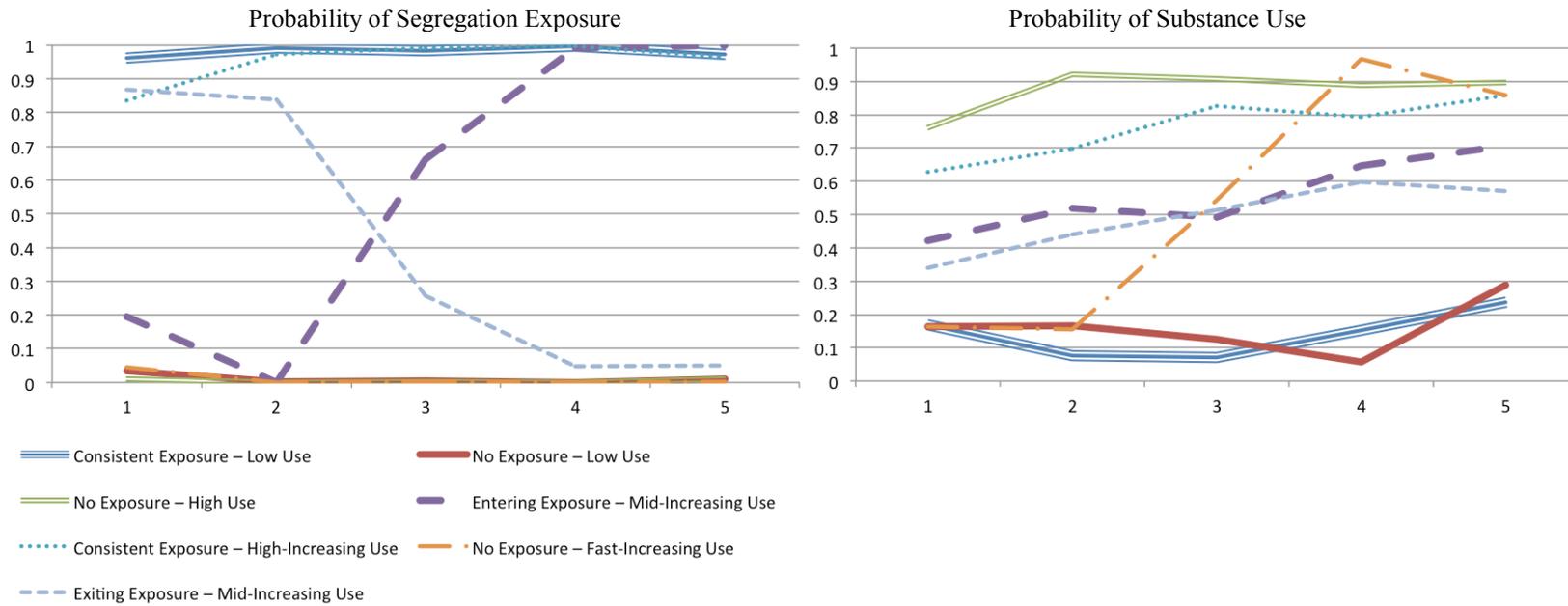


Figure 6.4.
Latent Classes of Segregation Exposure and Substance Use.



Chapter 7: Conclusion

The year 2014 marked the sixtieth anniversary of the Supreme Court's *Brown vs. Board of Education* decision which ruled unconstitutional the separation of children by race into different schools. Although school integration improved in the decades following the ruling, progress later stalled, and students today are as racially isolated as students were in the late 1960s and early 1970s. This fact alone is disturbing enough to demand continued attention to the causes and consequences of racial school segregation. This dissertation goes further and demonstrates the need for both increased and more carefully nuanced attention. Over the past several decades, the United States has experienced large demographic shifts and changing educational policies that impact the racial composition of schools. These factors suggest that the racial compositions of schools are changing—and that the racial composition of schools experienced by individual students over time may not be stable. The dissertation moves the segregation literature forward by using innovative ways of longitudinally examining school segregation from the student perspective. In the following sections, I review the main findings, present the limitations of the study, and discuss the implications for policy and directions for future research.

Main Findings

Trajectories of exposure to black school segregation. Chapter 4 investigates whether members of a national cohort of students in the United States experience distinct trajectories of exposure to black school segregation throughout middle and high school. I

find evidence of four exposure trajectories, indicating that students experience widely divergent patterns of exposure. The vast majority of students have stable exposure—they are either consistently exposed to majority black schools or consistently not exposed to such schools—but there also exist two dynamic trajectories characterized by movement into or out of black-segregated schools between 7th and 12th grade.

The fourth chapter also examines the factors that shape student exposure trajectories and focuses on comparing the relative strength of two primary factors driving changing exposure: racial changes occurring at the school level, and changes due to a student switching schools. I find that the primary driver of trajectory membership is the racial change patterns at the school level. Student mobility also significantly predicts membership in the four exposure patterns, but is far weaker. In addition, student race is a powerful predictor, with black students being far more likely to belong to exposure trajectories that include black-segregated schools compared to non-black students.

One contribution of this chapter is to highlight the temporal dimensions of segregation exposure that get overlooked when relying on point-in-time measures. If researchers do not follow individual students over time, they miss whether students attend black-segregated schools early in middle school or late in high school, the total number of years they attend such schools, and whether their exposure is stable or changing. Yet it is precisely these temporal dimensions—timing, duration, and stability—that may have important implications for student outcomes. A second contribution of this chapter is to show the dominance of macro-level structure over individual-level agency in the types of school environments to which students are exposed.

Consequences of exposure patterns on college outcomes. Building on the findings in Chapter 4, Chapter 5 examines the consequences of experiencing different patterns of segregation exposure on postsecondary educational outcomes. I rely on a method of causal inference that takes into consideration students' exposure at different points in time and accounts for covariates that change over time.

In general, the results indicate that black school segregation is detrimental for college enrollment and college completion. The major contribution of this chapter, however, is to show that experiencing different temporal dimensions of exposure has implications for postsecondary outcomes. In terms of the *timing* of exposure, I find that exposure later in high school negatively affects college enrollment and completion, while exposure early in middle school is mostly not significantly different than not experiencing any exposure. In terms of *duration*, although exposure in most years is negative, the effect is not linear: the size of the effect does not increase as the number of years of exposure increases. Finally, taking the entire trajectory of exposure as a whole, I find that *entering* black-segregated schools reduces students' odds of enrolling in or completing college relative to never attending segregated schools. The results also indicate that the effects of exposure to black school segregation are different for different racial groups. Although the confidence intervals are wide, my results suggest that exposure later in high school reduces the odds of college enrollment and completion more strongly for black students than for non-black students.

Possible mechanisms responsible for effect of segregation. The final analytic chapter (Chapter 6) explores possible mechanisms for the effect of segregation exposure

on college outcomes. I build upon the life-course framework that describes how adolescents experience multiple concurrent developmental processes and social contexts that affect their outcomes. The previous chapter finds that exposure trajectories matter for college outcomes, but it does not provide insight into the mechanisms underlying those effects. This final chapter explores academic coursetaking, delinquent behavior, and substance use as possible mechanisms.

Interestingly, the results do not find support for any of these mechanisms being responsible for the negative effect of segregation on college outcomes. Examining patterns of coursetaking and segregation exposure together does not identify any relationship between black-segregated schools and weaker academic coursetaking, though it does demonstrate that high levels of coursetaking are associated with higher probabilities of college enrollment and completion. Additionally, exposure to segregated schools does not have a clear positive relationship with delinquent behavior, and delinquent behavior does not have a strong relationship with college outcomes. In summary, the analysis does not provide answers to the mechanisms responsible for school segregation effects on college outcomes. I will return to this by discussing future directions for research below.

In summary, this dissertation describes patterns of exposure to black-segregated schools throughout secondary school, identifies factors predicting membership in various exposure trajectories, and estimates the consequences on segregation exposure over time on college enrollment and completion. The results demonstrate that the vast majority of students experience stable black concentration in their schools, and a small minority of

students experience a changing racial context. I find that the segregation exposure that students experience often happens *to* them (i.e., as a result of racial change or stability at the school level), not because of individual decisions to switch schools. The temporal aspects of segregation exposure, particularly the timing and trajectory membership, are important for understanding the consequences of school segregation on individual students. Exposure late in high school and entering black-segregated schools during secondary school is detrimental for college enrollment and completion, suggesting that studies that fail to follow students over time may miss important effects.

Limitations

This dissertation makes several contributions to the racial segregation literature, but it is not without limitations. The first limitation results from defining exposure to school segregation based only on the percentage of black students in each school. I made the decision to focus on black school segregation because of the historical importance and continuing relevance of black segregation in our nation's cities and schools. However, describing schools by their percentage black means that I do not describe the remaining racial composition of the school. A school might be 10 percent black, but the other 90 percent could be predominantly white, predominantly Latino, predominantly Asian, or some other combination. To illustrate the limitation, consider a student who experiences black school segregation one year and not the following year, but who may be experiencing an increasing Latino population. The presence of racial inequalities in socioeconomic status means that a school with a declining proportion of black students

and an increasing proportion of Latino students may continue to be socioeconomically disadvantaged. As a result, although I hypothesize that students who experience less black school segregation over time will have improved college outcomes, this definition of segregation may lead to conservative estimates. I may underestimate the effects of decreasing exposure to black segregation if the student's exposure transitions from predominantly black to predominantly Latino (as opposed to predominantly white). Therefore, my chosen measurement of segregation exposure may attenuate my findings.

Second, my measure of exposure to black segregation only looks at the student's experience within his or her own school as a whole, measured by the percentage black within the school. This compositional measurement ignores the *larger* context of segregation in the district or metropolitan area that could be measured using dissimilarity or heterogeneity indices. A broader look at the uneven distribution of students by race across districts or metropolitan areas could answer questions about whether students in areas with greater segregation have worse outcomes. This would be the case if the mechanism for negative outcomes resulted from the uneven distribution of resources across schools, including teacher quality and other key resources.

My school-wide compositional measure of black segregation also ignores the *smaller* context of segregation that could be measured either by a school-level segregation index or by classroom-level racial composition. This is particularly problematic for those schools that are diverse overall but have students tracked into different classes in racially disproportionate ways. Students' ability to benefit from improved school resources and practices likely depends on whether they are able to enroll

in higher-level courses and be taught by better-qualified teachers. Minority students are often at a disadvantage in accessing these resources even if they attend schools that contain them (Attewell & Domina, 2008; Crosnoe, 2009; Tyson, 2011). Using a school-wide measure of racial composition may lessen the positive effects one might expect to find among minority students who move out of black-segregated schools; it may also temper the negative effects one might expect to find among non-minority students who attend black-segregated schools. Exploring differences in outcomes when using different definitions of segregation is needed in future research.

Finally, the analysis was limited somewhat by the measures available in the NLSY97 data, particularly concerning the mechanisms responsible for the effect of segregation exposure on college outcomes. Although the NLSY97 provided annual data on several possible mechanisms that prior literature suggests is related to college attendance, including coursetaking, problem behavior, and substance use, future research should expand this line of inquiry by investigating additional potential mechanisms. These might include school-related behaviors, including school engagement measures such as school attendance and extracurricular participation, and measures of peer influence such as peer coursetaking and pro-school attitudes (Hallinan & Williams, 1990).

Significance of the Current Research

This dissertation makes several theoretical and methodological advances to the literature on racial school segregation. One theoretical contribution is to engage a life-

course perspective in the analysis of racial school segregation, connecting student pathways of exposure to school contexts throughout adolescence with early adult educational attainment outcomes. This perspective allows me to describe student exposure to different school contexts during their entire educational career in something I call “exposure trajectories.” Focusing on just one point in time paints a misleading picture of student exposure by ignoring the possibility that students might be exposed to disadvantaged school contexts without interruption over long periods of time, that they might experience such contexts during one developmental period but not another, and that they may move in and out of such contexts over time. The results indicate that some students do experience different trajectories of segregation exposure throughout secondary school, thus presenting a picture of the segregation exposure pathways from the student perspective that has been missing from the racial school segregation literature.

Investigating school segregation exposure through the life-course perspective also illuminates the connection between social contexts experienced early in childhood or adolescence with later adult outcomes (Elder, 1998). Studies that focus on the short-term consequences of racial school segregation on academic achievement measured through test scores truncate our understanding of how these educational trajectories affect development, behavior, and later adult outcomes. Some recent work has focused on the trajectories of exposure to poverty throughout childhood—one aspect of social context shown to be influential for child development (Lee, 2014; Wagmiller, Lennon, Kuang, Alberti, & Aber, 2006; Wodtke, 2013; Wodtke, Harding, & Elwert, 2011). This work confirms that the life-course perspective is essential for understanding how social

contexts of childhood affect individuals by finding support for cumulative disadvantage and varied consequences based on the timing of family poverty during childhood. In addition to families and neighborhoods, school contexts have important implications for education and development. This dissertation demonstrates that the temporal dimensions of school segregation—the timing, duration, and stability of exposure—matter for educational success later in adulthood.

Although the rationale for looking over time at students' segregation exposure patterns and connecting these patterns to educational attainment outcomes is clear, the complexities associated with this approach are substantial. One methodological contribution of this dissertation is to acknowledge the endogeneity of exposure to different school contexts by explicitly modeling it. I take exposure to black-segregated schools as an *outcome* and identify its predictors. In doing so, I differentiate between racial changes occurring at the school level and racial changes due to students switching schools and find that school-level changes are the primary driver of student segregation exposure.

A related methodological contribution is to engage analytic techniques that better address the confounding that arises because students can move into and out of segregated schools, and because factors that influence both exposure to segregated schools *and* eventual college outcomes can vary over time. Adolescents experience multiple concurrent developmental and social context pathways throughout the life course (Elder, 1998; Shanahan, 2000). These paths are interdependent and can affect and be affected by one another. The use of marginal structural models allows for these multiple

interdependent processes of adolescence; it likewise addresses the social process of selection into segregated schools in order to capture the direct *and* indirect effects of racial school segregation on postsecondary education outcomes.

A final methodological contribution is to incorporate all temporal dimensions of segregation exposure simultaneously. Prior use of marginal structural models has tended to focus on one temporal dimension at a time, isolating the effects of duration or timing in isolation (e.g., Wodtke, 2013). With one exception (Lee, 2014), research has not looked holistically at *trajectories* of exposure to estimate the effects of timing, duration, and stability concurrently to understand the consequences on later adult outcomes. This dissertation makes an important methodological contribution in this regard.

Policy Implications

My findings indicate that students in the United States experience vastly different social contexts during secondary school and that experiencing different patterns of racial segregation leads to different probabilities of postsecondary educational attainment. What are the implications for policy, given these results? Research finds that individuals who do not attend college earn less, are more likely to be unemployed, and have poorer health than college-goers (Baum, Ma, & Payea, 2013). This affects not only the individuals who personally suffer depressed earnings and poorer health, but also society at large, which pays for social services. It is in the best interest of individuals and the larger society to find ways to give everyone a chance to enroll in and graduate from college. Recent educational policies have started to focus on increasing college attendance and graduation

rates, allocating billions of federal dollars to educational reforms attempting to target it (U.S. Department of Education, 2009). Although theory informs us of the negative long-term impact of long-term racial school segregation, it has not been empirically examined sufficiently. More research is needed on the role that racial school segregation might play in maintaining inequalities in college attendance and graduation.

Results from this dissertation suggest that a focus on school-level policies to alter the concentration of black students, as opposed to student-level mobility policies, would have the most significant impact on student segregation exposure. Yet a focus on remedies to reduce black segregation in schools flies in the face of recent educational policy trends. The past two presidential administrations have had educational platforms that included student mobility initiatives as a way to improve educational opportunity. No Child Left Behind (NCLB), the signature education bill of the Bush administration, offered students a chance to switch schools if their school failed to meet Adequate Yearly Progress (AYP) several years in a row. Race to the Top, Obama's educational initiative, placed a high premium on school choice policies and required that states enact policies to expand charter schools in order to receive federal grant money. Although both initiatives purport to offer students access to improved educational opportunities, neither policy addresses the vast discrepancies in school quality that result from schools that are segregated by race and poverty, and some argue that these platforms actually increase segregation (Orfield, 2009).

My analysis suggests that focusing on student school mobility may be misplaced, particularly if we are interested in achieving desegregated schools for all students. Given

the strength of school-level racial composition patterns in determining student exposure to segregation, efforts would be better spent implementing policies that impact black concentration within schools. These findings are particularly important in light of recent research that points to how districts resegregate in the wake of shifting educational policies and demographic changes (Reardon et al., 2012; Billings, Deming, Rockoff, 2014; Frankenberg & Orfield, 2012). Students who attend schools with dynamic racial compositions tend to have exposure that reflects the school-level changes. Therefore, if educational policy hopes to offer equal educational opportunities to students, it must attend to the racial composition changes at schools.

Policymakers should address school-level changes on several fronts. From the demographic perspective, as minorities move from city to suburb, conscious plans should be put in place to prevent the resegregation of schools from predominantly white to predominantly minority. This will likely require strategies that address changes at the neighborhood level (Ellen, 2000) as well as the school level (Frankenberg & Orfield, 2012). From the educational policy perspective, federal policies should incentivize districts to include diversity plans. While neither of these recommendations to policymakers are new, findings from this analysis highlight that, from the student perspective, changes that happen over time at the school level have a profound effect on whether and how students are exposed to black school segregation over time. They also provide a strong warning that student-level policies that encourage student mobility (i.e., school choice plans, or vouchers) are not sufficient to realize integrated education.

Although results from this study suggest that enacting policies at the school level would affect the most change, such policies are politically challenging to implement. The Supreme Court decision in the 2007 *Parents Involved in Community Schools v. Seattle School District No. 1* case prevented school districts from voluntarily enacting policies to explicitly promote racial diversity in schools. As a result, some districts have adopted socioeconomic-based diversity plans as an alternative. These plans have had mixed results with respect to achieving socioeconomic diversity, but have had limited success in affecting the racial integration of schools (Reardon et al., 2006; Reardon & Owens 2014). Given the results of this dissertation in conjunction prior literature demonstrating the importance of socioeconomic diversity in schools (Coleman et al., 1966; Palardy, 2013; Schwartz, 2010), ideal policies for school diversity would include both racial and socioeconomic factors.

What other policies, in addition to those specifically aimed at school diversity, might expose youth to less segregated schools? Housing mobility policies and inclusionary zoning are both alternative strategies that might reduce individual students' exposure to black-segregated schools. Housing mobility policies, including the Housing Choice Voucher program and mobility programs such as Moving To Opportunity, give low-income families a housing subsidy to use in the private rental market. These policies offer a small proportion of low-income individuals the possibility of accessing higher opportunity neighborhoods and schools, and find mixed results for whether the children of voucher holders attend higher-performing, less-segregated schools (DeLuca & Rosenblatt, 2010; Horn, Ellen, & Schwartz, 2014). Inclusionary zoning policies that

mandate real estate developers set aside a certain percentage of all built housing to be sold at or below market-rate can also offer an opportunity for low-income children to be exposed to less-segregated schools. These types of policies are currently in place throughout the country, including high-income neighborhoods in Montgomery County, MD; Cambridge, MA; Burlington, VT; and Denver, CO among other places (Schwartz, 2010). Although more feasible politically than school desegregation policies, results from prior research suggest that these individual-level approaches may not always improve access to less-segregated schools for children (Horn et al., 2014), and results from this dissertation suggest that they may be less effective in improving exposure for students than policies directed at the school level. As the country continues to face increasing income segregation throughout the country (Reardon & Bischoff, 2011), with implications for racial and socioeconomic segregation in schools, multiple strategies to combat segregation exposure for youth will be necessary.

With respect to the consequences of segregation, the overall negative effects of attending black-segregated schools on the odds of college enrollment or college completion suggests that policymakers cannot continue to ignore the increasing racial isolation of American schools. Orfield (2014) reports that 40 percent of black and Hispanic students attend “intensely segregated” schools, schools that have far higher concentrations of poverty than the average school of white or Asian students. There currently exist large racial gaps in college attendance patterns, and this analysis shows that continued exposure to black-segregated schools is contributing to that gap. Segregation exposure—particularly in the later high school years—is detrimental for the

probability of enrolling in and completing college, even after controlling for many time-constant and time-varying confounders. These findings suggest that current efforts to improve postsecondary outcomes will be ineffective if we do not also address persistent racial school segregation. Given the larger negative effects later in high school relative to earlier in middle school, policy should prioritize ensuring that *high schools* are not black segregated. Additional research is needed to better understand the mechanisms responsible, and should focus on identifying the factors in the final years of high school that are most influential for college enrollment and completion, including school organizational norms and structures that support college application and enrollment, particularly among minority students with college aspirations (Roderick, Coca, & Nagaoka, 2011). Although within-school changes are promising areas of research and intervention, at the same time policy should not continue to ignore the harmful effects of segregated schools.

The second policy implication points to the need to better address differences in educational consequences of racial composition by student race. Results from these analyses are mostly suggestive, but indicate that the consequences of segregation exposure on college outcomes are different for black and non-black students. We must exercise caution in assuming that students of different races will have the same lived experience in non-black-segregated schools and benefit in similar ways. More work is needed to understand the mechanisms responsible for differing outcomes, and policies should promote, whenever possible, equal access to school resources, networks, and information, regardless of student race or ethnicity.

Obtaining a college degree is a necessary (though not always sufficient) condition for entry into the middle class in the United States. A college degree secures higher average wages—as of 2009, college graduates earned twice as much as individuals without a high school diploma and 50 percent more than high school graduates (Aud et al., 2011). Who has the ability to access a college degree and a place in the middle class? A striking percentage of Americans—82 percent as of 2011—believe in the “American Dream” and the possibility to start out poor in this country and end up rich through hard work. But not all individuals with equal effort and merit have an equal chance. The findings from this dissertation suggest that students who attend racially segregated secondary schools are disadvantaged in their probability of enrolling in and graduating from college, which ultimately limits their future labor market outcomes. To give all children the possibility of upward social mobility, the country must enact policies that integrate elementary and secondary schools such that students are truly offered equal educational opportunities.

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Appendix A: Constructing school-level segregation trajectories

The first set of research questions examines the influence of school-level racial change on student exposure to black school segregation. School-level trajectories were created for the universe of public and private schools. For every year, I calculated the percent black of every school. Growth mixture modeling (GMM) was then used to model the trajectory of the school's racial composition over time (Muthen, 2004; Muthen & Shedden, 1999).

Separate models were run for private schools and public schools because they are separate school populations. The models estimated the intercept and slope parameters for each latent class as the mean and variance of the percent black. The current analysis constrains the variance of the slopes to zero to avoid non-convergence. The model relaxes the homogeneity assumption to allow for latent classes of trajectories. I used Mplus v7.1 to run successive models each with one additional class than the previous and find that for private schools, a four latent-class model fits the school-level data best. (See Table A.1 for estimates of growth factors and latent class membership for public schools and Table A.2 for private schools.) For public schools, a 5-class model fits the data best. For both private and public schools, the first class (*moderate-high decreasing*) was characterized by an initial moderately high black concentration with a negative slope. The second class, *stable high*, was characterized by an initially very high black concentration with an essentially flat slope. The third class, *stable low*, had an initially very low concentration of black students and a flat slope; and the fourth class, *moderate-low increasing*, had an initial level of black concentration that was just above the national

average and a strongly positive slope. For public schools, there were two classes that had initially moderate levels of black concentrations and positive slopes, but neither slope was much steeper than the other. For the purposes of merging each school's racial change trajectory back to the respondents in NLSY97, I combined these last two latent classes.

Each public school belongs to a most-likely latent class based on its observed segregation levels over time. Therefore, every respondent's 7th grade school belonged to one of the four latent classes that characterize the school's segregation trajectory. The latent class of each 7th-grade school was merged to the NLSY97 student-level data using the school identification number. The dynamic process of school segregation—one that changes from year to year over almost a decade—is now captured as a single variable that can be included as an independent explanatory variable for the child-level analysis.

Table A.1.

Estimated growth factors from five-class LCA model for public school percent black trajectories: 1990–2007

	Latent Class Label				
	Moderate-high decreasing	Stable high	Stable low	Moderate-low increasing (1)	Moderate-low increasing (2)
Percent black					
Intercept	51.5	85.7	5.0	25.6	30.6
Slope	-1.4	0.0	0.0	2.8	1.1
Proportion of population	0.046	0.062	0.778	0.028	0.085

NOTE: Results presented for unconditional model with no covariates.

Table A.2.

Estimated growth factors from four-class LCA model for private school percent black trajectories: 1993–2007

	Latent Class Labels			
	Moderate-high decreasing	Stable high	Stable low	Moderate-low increasing
Percent black				
Intercept	56.8	90.1	3.7	18.5
Slope	-2.7	0.1	0.1	3.1
Proportion of population	0.024	0.06	0.861	0.055

NOTE: Results presented for unconditional model with no covariates.

Appendix B: Checking MSM Assumptions

There are three key assumptions that must be met in order to claim unbiased causal estimates using marginal structural models. The first is that there must be no unmeasured confounding (i.e., all relevant variables are observed and included in the model). The second is that there must be no model misspecification and the third is the assumption of positivity, which says that there is no combination of confounders for which it is either always the case or never the case that an individual will receive treatment (Cole & Hernán, 2008).

The assumption of no unmeasured confounding cannot be explicitly tested with observational data. I tried to hedge against problems of unmeasured confounding by identifying and including many potentially confounding variables. However, there is a tradeoff: including variables that are not confounders can introduce bias in the form of collider stratification (see Cole & Hernán (2008) for a review). Also, too many non-confounding variables can introduce bias by violating the positivity assumption.

With respect to positivity, one can check whether there are individuals who receive exposure to treatment for all values of important confounders. I took several steps to avoid violating the positivity assumption. I recoded the delinquency and suspension variables from continuous to binary, and recoded the coursetaking variable from continuous to an 8-category variable. The variables for total number of residences and household size were also top-coded. All of these changes were made to address what Cole & Hernán (2008) refer as “a tradeoff between reducing confounding bias and increasing bias and variance due to nonpositivity” [2008:658].

Beyond checking the assumptions required for marginal structural models, I also assessed the suitability of marginal structural modeling as an analytic strategy for this data. Marginal structural models are useful in situations where there exist problems of time-varying confounding. That is, there should exist time-varying covariates that are affected by exposure to treatment and that also affect the outcome of interest. I checked for three conditions following the strategy outlined by Cerda and colleagues (Cerda, Diez-Roux, Tchetgen, Gordon-Larsen, & Kiefe, 2010). First, I tested whether key time-varying covariates were longitudinally associated with later exposure to black-segregated schools. I ran logistic regression models with exposure to black-segregated schools at a given wave as the outcome and key time-varying covariates for the previous wave as the predictors. I checked for significant effects and found that delinquent behavior, suspension, and living in a single-parent family all positively predicted segregation exposure in the next wave, while substance use negatively predicted exposure. Interestingly, in the last two waves, higher levels of coursetaking positively predicted attending a black-segregated school.

Second, I tested whether exposure to black-segregated schools predicted key time-varying covariates in order to demonstrate whether time-varying covariates served as mediators of exposure to segregated schools and postsecondary outcomes. Results were somewhat mixed: attending a black-segregated school in a given year negatively predicted substance use in that year, but positively predicted suspension. Results were mostly null for delinquency. Attending a black-segregated school positively predicted 2,

3, and 4 residential moves relative to 1, and positively predicted living in a single parent family or “other” family type.

Third, I checked whether the time-varying covariates were related to the postsecondary outcome of interest, independent of the segregation exposure – postsecondary-outcome relationship. I ran logistic regression equations separately for having ever enrolled in and ever completed college and include segregation exposure and time-varying covariates for a given year. I found that even controlling for segregation exposure in a given year, delinquency and suspensions negatively predicted enrollment and completion, and higher levels of coursework positively predicted both enrollment and completion.

Finally, I verified that there was variation across individuals over time with respect to treatment exposure and time-varying covariates. Using correlation matrices, I found a modest amount of variation. The correlations for exposure to black-segregated schools were consistently over .90 indicating very high levels consistent exposure. Time-varying covariate correlations were lower and with wider ranges. Year-to-year correlations ranged from 0.30 to 0.51 for suspensions, 0.41 to 0.74 for substance use, and 0.33 to 0.63 for delinquency, and 0.08 to 0.74 for coursetaking levels.

Appendix C: Marginal Structural Models Counterfactual Notation

Marginal structural models (MSM) employ a potential outcomes framework. The following notation, borrowed from Robins and colleagues (2000), outlines the causal effect of segregation exposure on college outcomes. I let A_k be the treatment (attendance at school that is 50–100 percent black) at the k^{th} follow-up ($k=1, 2, 3, 4, 5$ for 5 waves of data). Then $\bar{a} = \bar{a}_k$ represents a student's history of segregation exposure (a_1, a_2, a_3, a_4, a_5). Let Y_E and Y_C be the observed outcomes of interest, either college enrollment or college completion. Let L_0 be time-invariant confounders (race, sex, parental education, mother's age at first birth, poverty level at baseline, and student ASVAB percentile score). These are pre-treatment covariates that are related to both treatment exposure (attendance at black-segregated school) and college outcomes. Let L_1 be observed time-varying confounders (student academic coursetaking, problem behavior, substance use, family structure, cumulative number of residential moves, household size, and suspension). These variables occur after A_1 and may have been influenced by A_1 ; in addition, they affect both A_2 and outcome Y (i.e., they are a common cause of subsequent treatment and outcome). Not controlling for these confounders will lead to biased estimates of the effect of A_2 on Y . However, controlling for these confounders will also bias the estimate of the effect of A_1 on Y by controlling for an intermediate variable between A_1 and Y .

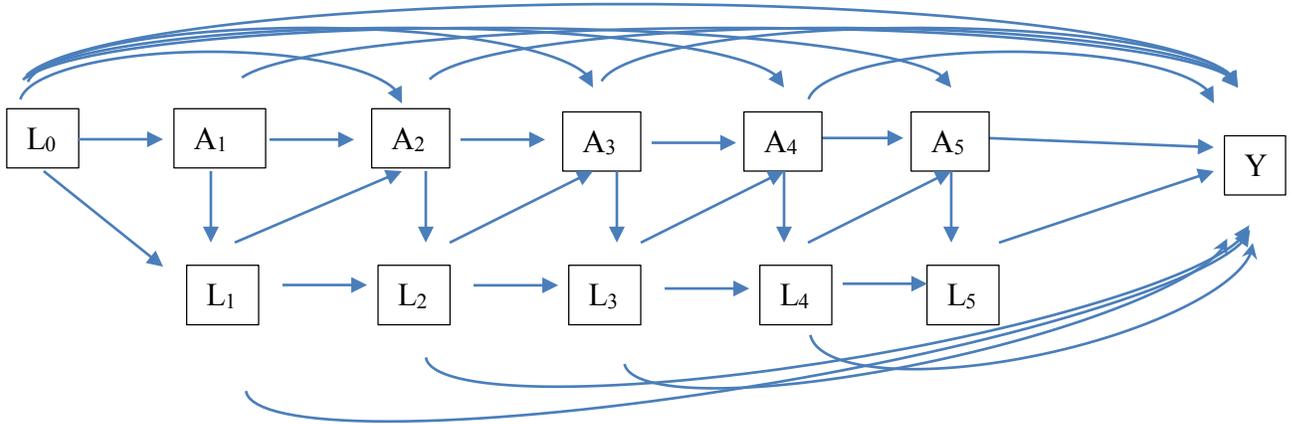
The above relationships can be seen in the causal diagram (Pearl, 1994) shown in Figure C.1a. There are causal arrows from the time-constant covariates (represented by L_0 in the diagram) to exposure to black-segregated schools (shown by A_1, \dots, A_5) as well

as postsecondary outcome Y . There are also arrows from time-varying covariates (L_1, \dots, L_5) to segregation exposure and postsecondary outcomes. Additionally, there are causal arrows from one wave of segregation exposure to the next and from one wave of segregation exposure to concurrent time-varying covariates.

I am interested in estimating $Y_{\bar{a}}$, or the potential outcome indicating whether a student enrolled (or completed) college given experiencing the segregation history \bar{a} . Each student has only one observed $Y_{\bar{a}}$; all others (i.e., $Y_{\bar{a}'}$) are unobserved or counterfactual. The estimate of the average causal effect of one exposure history compared to another exposure history is $E(Y_{\bar{a}} - Y_{\bar{a}'}) = P(Y_{\bar{a}} = 1) - P(Y_{\bar{a}'} = 1)$, where $P(Y_{\bar{a}} = 1)$ is the probability of enrolling in (or completing) college if all students experienced exposure history \bar{a} , and similar for \bar{a}' .

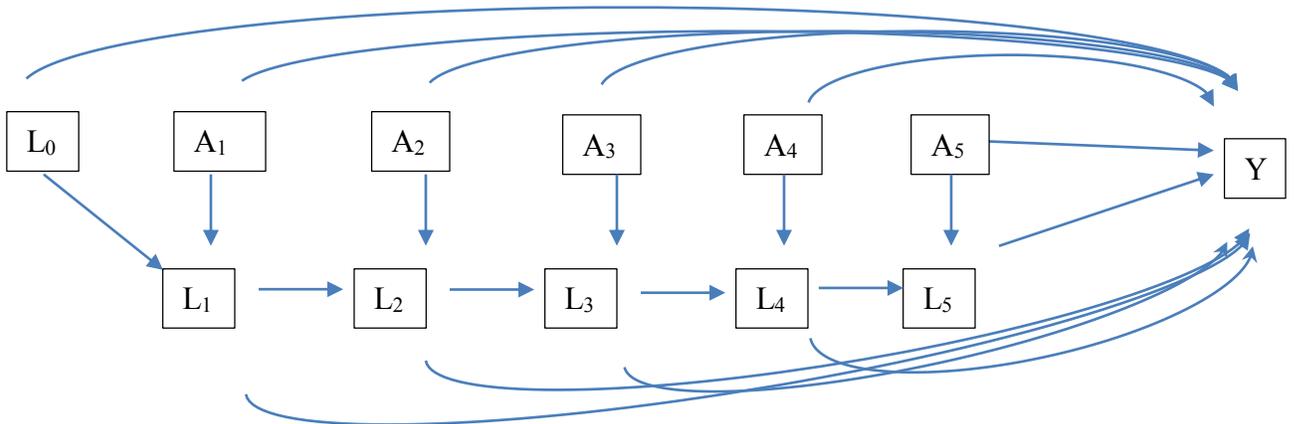
Figure C.1b shows how IPT weighting removes the causal arrows between time-constant covariates and exposure to school segregation as well as the causal arrows for segregation exposure between two time points. This results because the probability of segregation exposure is conditioned on prior exposure and prior covariate history. The causal pathways between exposure to school segregation and the outcome Y (college enrollment and college completion) stay the same.

Figure C.1a. Causal graph for exposure to racial school segregation.



Arrows indicate a causal relationship. Time-constant covariates are represented by L_0 , time-varying covariates are indicated by L_1, \dots, L_5 , exposure to black-segregated schools is shown by A_1, \dots, A_5 , and postsecondary outcome (college enrollment or college completion) is indicated by Y .

Figure C.1b. Causal graph weighted by inverse probability of treatment weights.



The figure demonstrates that IPT weighting removes the causal arrows between time-constant covariates (L_0) and exposure (A_1, \dots, A_5) as well as the causal arrows for exposure between two time points. Causal pathways between exposure (A_1, \dots, A_5) and outcome (Y) stay the same.

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- 2003 B.A., Statistics; B.M., Cello Performance, Northwestern University

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- 2014 American Educational Research Association Dissertation Grant, sponsored by the
National Science Foundation (\$20,000)
- 2009-14 Institute for Education Sciences (IES) Pre-doctoral Training Fellowship, U.S.
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- 2012 Peabody Scholar in Sociology of Education: Awarded for graduate student
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PUBLICATIONS

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Warkentien, Siri; Rhodes, Anna. Unwrapping the Suburban 'Package Deal': Race, Class, and
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Education Research Journal*.)

Warkentien, Siri. "Stable or Changing? The racial/ethnic composition of American public
schools, 1995-2010."

Warkentien, Siri; Condliffe, Barbara; DeLuca, Stefanie. “Identifying Family Structure Changes: Insights from Interview Data.”

Condliffe, Barbara; **Warkentien, Siri;** DeLuca, Stefanie. “Shaken Up? Understanding How Family Instability Can Harm or Help Children.”

Stuart, Elizabeth; **Warkentien, Siri;** Jo, Booil. “Using Propensity Scores to Account for Varying Levels of Program Participation in Randomized Controlled Trials.”

Other Publications

Warkentien, S., and Grady, S. (2009). *Students’ Use of Tutoring Services, by Adequate Yearly Progress Status of School* (2010-023). U.S. Dept of Education. Washington, DC.

Hampden-Thompson, G., **Warkentien, S.,** and Daniel, B. (2009). *Course Credit Accrual and Dropping Out of High School, by Student Characteristics* (NCES 2009-035). U.S. Dept of Education. Washington, DC.

Warkentien, S., Fenster, M., Walston, J., and Hampden-Thompson, G. (2008). *Expectations and Reports of Homework for Public School Students in the First, Third, and Fifth Grades* (NCES 2009-033). U.S. Dept of Education. Washington, DC.

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RESEARCH EXPERIENCE

- 2009-14 **Research Assistant** to Stefanie DeLuca, Sociology, Johns Hopkins University.
- Collaborated with teams of researchers to design qualitative interview guides.
 - Trained undergraduate students in interview techniques; conducted over 40 semi-structured interviews.
 - Analyzed qualitative data across three studies and prepared manuscripts: “Moving Matters: Residential Mobility, Neighborhoods and Family in the Lives of Poor Adolescents.” PI: Stefanie DeLuca (Funded by William T. Grant Foundation); “Low-Income Youth, Neighborhoods, and Housing Mobility in Baltimore.” PIs: Kathryn Edin; Stefanie Deluca & Susan Clampet-Lundquist (Funded by William T. Grant Foundation); “How Parents House Kids.” Cleveland, OH & Dallas, TX PIs: Kathryn Edin; Stefanie DeLuca (Funded by Annie E. Casey Foundation)
- 2009-14 **Research Assistant** to Lingxin Hao, Sociology, Johns Hopkins University.
- Conducted analyses and prepared manuscripts using multilevel, longitudinal, and quasi-experimental methods (propensity scores and difference-in-difference designs) using National Survey of College Graduates (2003, 2010).
- 2010-11 **Research Assistant** to Elizabeth Stuart, Biostatistics, JHU Bloomberg School of Public Health.

- Developed propensity score method to estimate causal effect of continuous compliance in RCTs.
 - Wrote matching code and ran Monte Carlo simulations using R and Mplus.
- 2008-09 **Research Associate**, American Institutes for Research, Education Statistics Services Institute.
- Managed project task of issue brief deliverables for the Data Development Program at National Center for Education Statistics.
 - Supervised development of and reviewed briefs written by sub-contractors; directed monthly client meetings.
- 2006-08 **Senior Research Assistant**, Child Trends, Education Statistics Services Institute, Washington, DC.
- Reviewed over 30 publications for Statistical Standards Program at NCES to ensure accuracy of analyses and adherence to statistical standards.
 - Conducted quantitative analyses and co-authored issue briefs using NCES datasets, including Educational Longitudinal Study (ELS:2002); Schools and Staffing Survey (SASS); Early Childhood Longitudinal Survey, Kindergarten (ECLS-K); National Household Education Survey (NHES); Common Core Data (CCD).

TEACHING EXPERIENCE

- 2013 Instructor, “Integrating Spaces,” Intersession Course, Johns Hopkins University
- 2010-12 Instructor, “Mathematics Mini-Course,” Johns Hopkins University
- 2012 Teaching Assistant, “Segregation and Social Inequality,” Johns Hopkins University

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- 2015 “Unwrapping the Suburban ‘Package Deal’: Race, Class, and School Access.” Roundtable presentation at American Sociological Association. Chicago.*
- 2015 “Stability or Change? Racial/ethnic compositions of American public schools, 1995-2010.” Presented at American Education Research Association (AERA), Chicago.*
- 2014 “Trajectories of Exposure to Racial School Segregation.” Penn State Education and Civil Rights Conference. State College, PA.*
- 2014 “Racial School Segregation and the Transition to College.” Population Association of America (PAA), Boston.*
- 2014 “Trajectories of Exposure to Racial School Segregation.” American Education Research Association (AERA), Philadelphia.*
- 2013 “Measuring Family Complexity Among Low-Income African American Families.” American Sociological Association (ASA), New York City.*
- 2013 "Shaken Up? When and Why Family Instability Can Be A Good Thing For Children." American Sociological Association, New York.

- 2013 “Patterns of Neighborhood Racial and Ethnic Change, 1970-2010.” Population Association of America, New Orleans.
- 2013 “The Knowledge Structure of Individuals and Cohorts in American Knowledge Economy.” Poster at Population Association of America, New Orleans.
- 2013 “Trajectories of Racial Change in U.S. Public Schools: 1995-2008.” Eastern Sociological Society (ESS), Boston.*
- 2012 “Students Changing Schools or Students’ School Changes: Factors that Shape Trajectories of Exposure to School Segregation.” American Sociological Association, Denver, CO.*
- 2011 “Beyond Binary: Using Propensity Scores to Account for Varying Levels of Participation in Randomized Controlled Trials.” Poster presented at Society for Research on Educational Effectiveness (SREE), Washington, DC.*

PROFESSIONAL MEMBERSHIPS

American Sociological Association
Society for Research on Educational Effectiveness
Population Association of America
American Educational Research Association