Demography
https://doi.org/10.1007/s13524-017-0632-9

Three Dimensions of Change in School Segregation: A Grade-Period-Cohort Analysis

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Abstract This study uses the first age-period-cohort (APC) analysis of segregation to examine changes in U.S. public school segregation from 1999–2000 to 2013–2014. APC analyses disentangle distinct sources of change in segregation, and they account for grade effects that could distort temporal trends if grade distributions change over time. Findings indicate that grade effects are substantial, drastically reducing segregation at the transition to middle school and further at the transition to high school. These grade effects do not substantially distort the analysis of recent trends, however, because grade distributions were sufficiently stable. Black-white segregation was stagnant overall, while Hispanic-white segregation declined modestly. In both cases, declines across periods were offset by increases across cohorts. Further analyses reveal variation in these trends across metropolitan and nonmetropolitan areas, regions, and areas with different histories of desegregation policy.

Keywords Segregation · Age-period-cohort analysis · Education · Race/ethnicity

Introduction

Racial segregation is a keystone topic in the social sciences, and segregation research has been fundamental to understanding variation and change in racial and ethnic relations (Farley and Frey 1994; Fischer et al. 2004; Massey and Denton 1993). School segregation is particularly important: it is a necessary condition for racial disparities in school-based experiences and opportunities that appear to exacerbate

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s13524-017-0632-9) contains supplementary material, which is available to authorized users.

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Published online: 21 November 2017

racial educational inequality and steer youth toward segregated adult lives (Braddock and Gonzalez 2010; Vigdor and Ludwig 2008). As the era of direct desegregation policy recedes (Orfield and Lee 2007), understanding patterns and sources of change is as important as ever. This task is not easy, as evidenced by decades of work aiming to tighten the link between segregation's theoretical foundations and its empirical analysis (Duncan and Duncan 1955; Massey and Denton 1988; Reardon et al. 2000). We take another step forward by offering the first age-period-cohort (APC) analysis of school segregation, focusing on public schools nationwide between the late 1990s and mid-2010s. Although conventional analyses have shown modest declines in segregation in this period, these methods conflate various underlying processes and may provide misleading results.

One contribution of our APC analysis is that it disentangles distinct sources of change in segregation: age or grade effects, period effects, and cohort effects. We expect these dimensions of change to arise from distinct social, demographic, and institutional forces; we also expect them to have distinct implications for the persistence of segregation, for efforts to address it, and for its consequences. By isolating these effects, we pave the way for richer studies of the causes and consequences of school segregation. We also take a first step in exploring variation in these dimensions of change by comparing patterns in metropolitan and nonmetropolitan areas, across different regions of the United States, and across areas with different desegregation histories.

Another contribution of our APC analysis concerns accurately assessing segregation trends, which can be muddled by demographic changes. The recent decline in minority students' exposure to white peers in schools, for instance, seems to be due to changes in the racial composition of the student population rather than heightened segregation (Fiel 2013; Logan 2004). Yet, prior research has overlooked another demographic change that may cloud our view of segregation trends: changing cohort sizes and grade distributions. Live births declined in the early 1990s, increased from 1997 to 2007, and have declined since (Hamilton et al. 2016). These fluctuations, along with population changes related to migration and educational changes related to school attendance patterns and grade progressions, have produced fluctuations in the size of cohorts (i.e., groups of students who begin school in the same year) and thus in the distribution of students across grades. Consequently, cross-grade differences in segregation can distort temporal trends.

We examine public school segregation among blacks, Hispanics, and whites within metropolitan areas and nonmetropolitan counties nationwide from the 1999–2000 to 2013–2014 school years. We pair the grade-level racial composition data necessary to measure segregation with plausible assumptions that break APC collinearity, the fundamental identification problem in APC analysis (Mason et al. 1973). These assumptions are based on the typical timing of transitions across levels of school, and they allow us to identify grade (age), period, and cohort effects in constrained regressions. Our findings highlight divergent sources of change in school segregation since the late 1990s, reveal variation across areas of the United States, and provide new puzzles for future research.

Grade, Period, and Cohort Effects

We seek to disentangle recent age- or grade-based, period-based, and cohort-based change in school segregation. Our analyses focus on trends in local racial imbalance, which is most relevant to the social processes that separate racial and ethnic groups across schools (James and Taeuber 1985; Massey and Denton 1988) and to theories that segregation promotes inequality via the unequal distribution of opportunities across schools (Condron and Roscigno 2003; Jackson 2009; Johnson 2011). We begin with a brief introduction to these three dimensions of change.

We focus on *grade level* in school rather than age; except for those who repeat or skip a grade, students advance one grade each year. We use *periods* to refer to school years, distinguished by the year in which the fall semester begins. We use *cohorts* to distinguish groups based on the year they start first grade: students of different cohorts are in different grades at the same time.[1] Accordingly, *grade effects* capture the typical changes in segregation that all cohorts experience as they progress through their schooling careers, *period effects* capture temporal changes that affect students of all grades and cohorts, and *cohort effects* capture differences in segregation across cohorts that persist over grades and years.

Assessing Temporal Change in School Segregation

One contribution of an APC analysis is to improve the measurement of temporal change in school segregation. Before elaborating, we briefly review the evidence on national-level trends. American schools were highly segregated throughout much of the twentieth century, with few white students anywhere attending school with black students (Caliver 1956; Clotfelter 2004). This status persisted until the late 1960s in many places, despite the U.S. Supreme Court decree in *Brown v. Board of Education of Topeka* (1954) that segregated schools were inherently unequal and unconstitutional. Segregation plummeted between the late 1960s and the late 1980s, when courts forced desegregation on school systems in the South and in several other metropolitan areas, and when social and economic incentives induced other areas to voluntarily desegregate (Cascio et al. 2010; Clotfelter 2004; Logan et al. 2008).

Progress slowed around 1990 (Logan et al. 2008; Reardon and Owens 2014) despite continued declines in residential segregation (Iceland and Sharp 2013; Iceland et al. 2014). This halt accompanied the reversal of many desegregation orders and the expansion of choice-based assignment policies (Orfield and Lee 2007; Renzulli and Roscigno 2005), which heightened segregation in some affected school districts (Bifulco and Ladd 2007; Reardon et al. 2012). School segregation appears to have declined slightly again in the 2000s amid continued declines in residential segregation and despite the further retrenchment of desegregation policy (Fiel 2013; Stroub and Richards 2013).

Grade effects could create problems when assessing these trends. Prior work has suggested that grade-level differences are substantial: segregation is highest at the

[1] We ignore kindergarten in this study. Although most students attend kindergarten, states differ in their requirements regarding the provision and nature of kindergarten.

elementary level and much lower at middle and high school levels (Coleman 1975; Sohoni and Saporito 2009). Because grade effects apply to all cohorts and periods, they are relevant to temporal change only if the grade distribution of students changes over time because of changing cohort sizes. In addition to changes in fertility, fluctuations in child immigration (Passel 2011), increasing homeschooling (Isenberg 2007), declining private school attendance (Kena et al. 2016), and declining dropout rates (Murnane 2013) could alter the grade distribution. In our data, public school students became less concentrated in the elementary grades and more concentrated in high school grades since the late 1990s: the share of students in grades 1–5 shrank from 43.8 % in 1999 to 42.2 % in 2013, while the share in grades 10–12 grew from 21.7 % to 23.9 %, respectively.[2]

Given these changes, suppose that we assess trends in segregation using aggregated school-level data. Segregation at lower grades will contribute relatively more in 1999, and segregation at higher grades will contribute relatively more in 2013. The increasing influence of higher, less-segregated grade levels will cause our measure to decline, even without period- or cohort-based change. It seems problematic to infer that segregation is declining when each cohort could experience the same degree of segregation as any other throughout its schooling career. Hence, even the modest declines in segregation suggested by recent work may be overstated, or they may obscure what were actually increases. APC analyses can solve this problem by purging period- and cohort-based change of grade effects.

Implications of Grade, Period, and Cohort Effects

Another contribution of our APC analyses is to disentangle grade, period, and cohort effects, which likely stem from theoretically distinct phenomena. Conventional analyses may obscure offsetting or otherwise distinct effects, and distinguishing them can improve our ability to understand the causes of segregation. Our analyses cannot assess these causes directly, but they will shed light on recent trends in each dimension as well as variation across places. Next, we review some of this place-based variation and relate it to potential causes of segregation.

Variation by Place

The aforementioned declines in school segregation throughout the 1970s and 1980s were most pronounced in the South and West. By 1990, black-white segregation was highest in the Northeast and Midwest (Clotfelter 2004). One obvious explanation is residential segregation, which also declined most in the South and West, partly because of ecological factors conducive to segregation in the older metropolises of the Northeast and Midwest (Farley and Frey 1994; Logan et al. 2004). Another explanation is school desegregation policy, which mainly affected the South, although the majority of black students in all regions except the West were covered by desegregation orders by the 1970s (Logan et al. 2008).

[2] This is based on students in grades 1–12 in our primary analytic sample, which we describe in the Data and Measures section.

Less obvious but also critical are organizational features of school systems that shape the impact of residential segregation and school desegregation policies. Most notably, school systems in the South and West often consist of a few large districts and are generally less fragmented than those in the Northeast and Midwest. This limits opportunities for between-district segregation that undermines district-level desegregation policies (Bischoff 2008; Clotfelter 2004; Fiel 2013). Consequently, the South and West were better situated to reap the benefits of desegregation policies than the Northeast and Midwest.

Desegregation came to a halt in the 1990s in all regions (Logan et al. 2008) and then resumed in the 2000s everywhere but the South (Stroub and Richards 2013). This occurred despite similar declines in residential segregation across regions in the 1990s and 2000s (Iceland and Sharp 2013; Park and Iceland 2011) and may be related to the retrenchment of desegregation policies. As of 1990, almost 500 districts were under desegregation orders, and approximately 80 % were in the South. By 2009, approximately 40 % of these districts were released. Most reversals outside the South occurred in the 1990s; those in the South occurred later in the 2000s (Reardon et al. 2012).[3]

Because most prior work focused on metropolitan areas, evidence on trends in nonmetropolitan school segregation is scant. School segregation is higher in metropolitan than nonmetropolitan areas (Clotfelter 2004), likely because metropolitan areas tend to have more fragmented school systems with multiple urban and suburban districts. Conversely, residential segregation is typically higher in nonmetropolitan than metropolitan areas, although it declined as much or more in nonmetropolitan areas since 1990 (Lichter et al. 2015; Parisi et al. 2015). Residential segregation may be more strongly linked to school segregation in more fragmented metropolitan school systems.

In sum, the evidence suggests that school segregation is driven by the interaction of organizational features of school systems with social forces that shape segregation-related behaviors. With respect to the former, policies explicitly addressing school segregation and the fragmentation of school systems into autonomous districts create an opportunity structure for sorting across schools (Bischoff 2008; Fiel 2015). With respect to the latter, both residential and school segregation are consequences of social processes that shape preferences related to homophily and out-group prejudice as well as socioeconomic disparities that alter groups' abilities to realize their preferences (Clark 1991; Lareau and Goyette 2014; Sampson and Sharkey 2008; Schelling 1978; Swaroop and Krysan 2011).

Next, we relate these potential causes to grade, period, and cohort effects and predict variation in these sources of change across areas. We speculate about the potential consequences in the discussion. It is worth emphasizing at the outset that many of the following assessments and predictions are speculative and will shape our interpretation of results, but most are not assumptions consequential to our analyses. They should be tested more rigorously in future research.

[3] Although school choice policies also expanded throughout this period, this expansion affected all regions. See Table 216.90, 2016 Digest of Education Statistics (https://nces.ed.gov/programs/digest/d16/tables/dt16_216.90.asp).

Grade Effects

We expect grade effects to derive from organizational features of school systems. School systems not only regulate student assignment to schools but also shape the opportunity structure for segregation by virtue of the number of schools they provide and where they locate them. Furthermore, they structure the timing at which sorting occurs by establishing transition points—those that distinguish one level of school from another and entail school changes. The key transition points are those among elementary school, middle or junior high school, and high school. A common arrangement has elementary schools serving grades 1–5, middle schools serving grades 6–8, and high schools serving grades 9–12. Most students attend the same school throughout each level and change schools when transitioning to the next level. Other arrangements exist, and some students will change schools within these levels; our analyses accommodate these complexities. We return to this issue later when we describe how these discontinuities help us solve the APC identification problem.

The opportunity structure in U.S. school systems is most conducive to segregation at lower grade levels. Compared with middle schools, elementary schools are smaller, greater in number, and draw from smaller geographic areas. This arrangement creates more opportunity for sorting across elementary schools and also increases the link between residential and school segregation. The same holds when comparing middle schools with high schools, which are fewer in number and have larger catchment areas. Hence, we expect large declines in segregation at transition points among elementary, middle, and high school.

We also expect grade effects to be moderated by other factors. Most obviously, transition grades may vary across school systems. Additionally, because grade effects operate by reducing sorting opportunities within the same school system, they may be blunted by district fragmentation given that between-district sorting moves segregation to a level at which within-system constraints are less relevant. They may also be blunted by desegregation policies, which constrain sorting at all levels and thus reduce changes across grades.

Cohort Effects

We expect cohort effects to arise from changes in determinants of children's schools that are relatively stable for families, including cross-cohort changes in attitudes and preferences driven by social and economic circumstances relevant to race relations (Bobo and Hutchings 1996; Quillian 1996; Renzulli and Evans 2005). Such changes could alter school and residential segregation by changing patterns of discrimination, inequality, or the degree to which racial composition shapes perceptions of school or neighborhood quality, safety, or status (Billingham and Hunt 2016; Goyette et al. 2012; Holme 2002; Saporito and Lareau 1999).

We expect these changes to emerge as cohort effects rather than period effects because they will operate primarily at school entry and create differences across cohorts that persist over time and throughout their schooling careers. Families are unlikely to change their children's schools on a whim, which would disrupt relationships with peers and teachers and may have detrimental social and academic consequences (Pribesh and Downey 1999). School attendance, particularly at the elementary level, is also strongly related to residence, which is based on expensive long-term commitments. When families sort across neighborhoods with children's schools in mind, they tend to do so when children are young (Long 1972). Current Population Survey (CPS) data indicate that residential mobility rates in 2009 were highest among families with children younger than age 6 (22.6 %) and lowest among those with children between 6 and 17 (10.2 %).[4] In short, we expect that there is inertia to school progressions and residential decisions such that variation in many social processes relevant to racial sorting will emerge across cohorts at school entry and persist throughout their educational careers.

Declining residential segregation over this period suggests negative cohort effects, but residential segregation patterns may differ for families of school-aged children (Owens 2017), and many other cross-cohort social changes could operate independently of residential segregation. In any case, the effects of these social changes should be most pronounced where the opportunity structure is conducive to self-segregation and where school assignment is more closely linked to residence. We expect more-pronounced cohort effects in areas with fragmented school systems and less-pronounced cohort effects in areas with desegregation policies.

Period Effects

We expect other changes to emerge as period effects, which alter segregation for students of all grades and cohorts at a given time. School assignment policies that affect all grades are a likely source. We focus on the reversal of desegregation policies.[5] Other possibilities include the expansion of school choice, which may increase segregation, and changes in immigration, which alter population composition and could affect racial and ethnic relations within cohorts over time (Van Hook and Snyder 2007). Like cohort effects, period effects may depend on organizational features of school systems. We expect period effects to increase where desegregation policies were reversed, but we expect these trends to be less pronounced in fragmented school systems that blunt the effects of desegregation policies.

Predictions

Following our reasoning thus far, we expect to observe negative grade effects at common transition grades. We expect them to be the least pronounced in areas with more fragmented school systems—specifically, metropolitan areas, the Northeast, and the Midwest. We also expect them to be weaker in areas under desegregation orders than in areas released from such orders.

Assuming that cohort effects are driven by social changes related to residential segregation, and given recent declines in residential segregation, we expect negative cohort effects. They should be most pronounced where residential segregation is most consequential to school segregation—namely, metropolitan areas and the Northeast and Midwest because of their more-fragmented school systems and the greater

[4] See Table 21 at http://www.census.gov/library/publications/2011/demo/p20-565.html.

[5] If such policy changes are anticipated by families at school entry or are phased in across cohorts, they may emerge as cohort effects rather than period effects.

opportunities for sorting across districts. We also expect cohort effects to be more negative in areas with recent desegregation policy reversals, which should tighten the link between residential and school segregation.

Assuming that period effects are driven by the reversal of desegregation policy and the spread of school choice, we expect positive trends across periods. They should be the most pronounced where desegregation reversals were most common and where the original policies were most influential because of centralized (less-fragmented) school systems, especially the South. It is unclear how this breaks down across metropolitan and nonmetropolitan areas because reversals were more common in metropolitan areas, but the policies may have been more influential in nonmetropolitan areas.

Methods

Data

Our analyses require grade-level racial composition data for all schools, which we collect from the Common Core of Data (CCD) universe of public schools. These data include traditional public schools as well as charter schools. Grade-level data are available beginning in the 1998–1999 school year, but some states are missing data early in this time frame. Our primary sample balances a desire for greater coverage of the nation's school systems with a longer time span. It includes all school years from 1999–2000 to 2013–2014, and it includes all metropolitan areas and nonmetropolitan counties where at least 80 % of the student population was enrolled in schools reporting grade-specific racial composition data. Samples are also restricted based on the population share of the groups of interest, as described shortly. Our main findings hold in an alternative sample that adds the 1998–1999 school year but retains fewer areas, and a larger sample with almost complete coverage that spans the 2009–2010 to 2013–2014 school years. Unfortunately, the requisite data are not available for private schools; we discuss the potential implications later.

Segregation Measures

Our first step is to calculate segregation separately within each metropolitan and nonmetropolitan area by grade in each school year. These areas comprise our schooling markets, and they are based on 2010 combined statistical area (metropolitan) and county (nonmetropolitan) boundaries. Segregation within these areas includes both between-district and within-district imbalances. We examine racial imbalance between whites and the two largest minority groups: blacks and Hispanics. These categories are mutually exclusive, although some states began reporting multiracial students as a separate category in later years. Our primary analyses exclude these students, but our findings are robust to alternative treatments (e.g., treating them as white or nonwhite). Supplementary analyses examine black-Hispanic segregation.

In addition to the sample restrictions discussed previously, we include only those areas where each of the two focal groups accounts for at least 1 % of the student population throughout the period of analysis. For black-white segregation, this leaves 93 metropolitan areas and 853 nonmetropolitan counties; these areas include 75 % of all public school students and 85 % of black public school students enrolled nationwide throughout this period. For Hispanic-white segregation, our primary sample includes 72 metropolitan areas and 884 nonmetropolitan counties, accounting for approximately 70 % of public school students and 90 % of Hispanic public school students.

We measure racial imbalance within each area using the dissimilarity index (D), shown in Eq. (1), where n_{xs} is the number of students of group x in school s, n_{ys} is the number of students of group y in school s, and T_x and T_y are the total populations of each group in the area. Dissimilarity is interpreted as the proportion of students of either group that would have to switch schools to achieve racial balance. D ranges from 0 to 1. When we discuss changes in the text, we use a 100-point scale—that is, a change of .05 is described as a five-point increase. After calculating D separately for each grade-year within each schooling market, we average these measures across all markets nationwide. Our APC analyses use these unweighted grade-by-year averages as the outcomes. Additional analyses show that our findings are robust to alternative imbalance measures (Theil's information theory index) and weighting schemes (total population, race-specific populations).

$$D = \frac{1}{2}\sum_{s=1}^{S}\left|\frac{n_{xs}}{T_x} - \frac{n_{ys}}{T_y}\right|. \tag{1}$$

Age-Period-Cohort (APC) Analyses

We begin our APC analyses by arraying average segregation by grade and school year. Table 1 does so for black-white dissimilarity. Both grade and year are of one grade-year interval length, and cohorts are tracked across table diagonals from the upper left to the lower right as they progress across grades over time; cohorts are indexed by the year they started first grade. Table 1 suggests that segregation regularly declines across

Table 1 Black-white average dissimilarity by school year and grade

	Grade											
School Year	1	2	3	4	5	6	7	8	9	10	11	12
1999–2000	**0.393**	0.394	0.390	0.387	0.388	0.353	0.328	0.326	0.300	0.303	0.309	0.301
2000–2001	0.393	**0.394**	0.392	0.389	0.382	0.355	0.330	0.326	0.306	0.301	0.301	0.308
2001–2002	0.383	0.393	**0.391**	0.391	0.383	0.348	0.332	0.331	0.305	0.308	0.303	0.307
2002–2003	0.382	0.391	0.387	**0.386**	0.385	0.348	0.327	0.328	0.309	0.307	0.311	0.303
2003–2004	0.385	0.384	0.385	0.383	**0.382**	0.347	0.331	0.324	0.309	0.312	0.307	0.309
2004–2005	0.386	0.392	0.387	0.382	0.378	**0.345**	0.331	0.330	0.301	0.308	0.309	0.307
2005–2006	0.378	0.388	0.387	0.381	0.378	0.342	**0.324**	0.329	0.309	0.306	0.309	0.308
2006–2007	0.381	0.384	0.380	0.382	0.378	0.340	0.324	**0.322**	0.302	0.305	0.302	0.309
2007–2008	0.380	0.387	0.384	0.381	0.378	0.338	0.326	0.324	**0.304**	0.305	0.305	0.302
2008–2009	0.379	0.384	0.383	0.381	0.375	0.339	0.324	0.325	0.299	**0.304**	0.307	0.305
2009–2010	0.388	0.386	0.386	0.384	0.379	0.335	0.326	0.324	0.303	0.299	**0.308**	0.308
2010–2011	0.392	0.396	0.395	0.390	0.387	0.340	0.328	0.328	0.303	0.305	0.304	**0.307**
2011–2012	0.395	0.388	0.393	0.390	0.382	0.343	0.328	0.326	0.302	0.304	0.300	0.305
2012–2013	0.391	0.393	0.389	0.393	0.381	0.342	0.328	0.323	0.300	0.301	0.303	0.304
2013–2014	0.387	0.391	0.394	0.387	0.391	0.342	0.328	0.329	0.302	0.301	0.302	0.304

Notes: Based on primary sample described in text. Diagonals running from the upper left to lower right follow cohorts over time, as illustrated by the bolded cells for the 1999 cohort.

grades, and declines across years for some grades but not others. Closer inspection reveals the difficulty in teasing apart the three effects.

We can see this by examining a few cells in the table. Segregation is one point higher among first graders in 1999–2000 (0.393), the 1999 cohort, than among first graders in 2001–2002 (0.383), the 2001 cohort. This finding could be the result of period-based change across these years or time-invariant differences across cohorts. By sixth grade, segregation declined 4.8 points for the 1999 cohort (0.345), perhaps due to period effects between 1999 and 2004 or to time-invariant grade effects. Disentangling these dimensions of change without further analysis is impossible.

We treat grade, period, and cohort as discrete categorical variables, and we specify the conventional APC multiple-classification model (Mason et al. 1973) shown in Eq. (2). Y_{ij} denotes school segregation from the ijth cell in Table 1; β_i, γ_j, and δ_k are vectors of dummy variables that refer to the ith grade, jth period, and kth cohort effect, respectively, on the dependent variable; μ is the intercept indicating the grand mean of the dependent variable; and ε_{ij} is the random error term. We assume these are the data generating parameters.

$$Y_{ij} = \mu + \beta_i + \gamma_j + \delta_k + \varepsilon_{ij}, \quad (i = 1, \ldots, r; j = 1, \ldots, s; k = 1, \ldots, r + s - 1). \tag{2}$$

Because grade, period, and cohort are linearly dependent (in our case, Period = Grade + Cohort – 1), it is impossible to solve Eq. (2) to obtain unique grade, period, and cohort effect estimates. Put simply, if we know the grade and period for any cell, we also know its cohort. We cannot obtain independent variation in one of the dimensions of change while controlling the others; it is essentially a problem of perfect multicollinearity in a regression framework.

Constraints

Demographers and epidemiologists have addressed this identification problem in several ways (Mason and Fienberg 1985; O'Brien 2014; Yang and Land 2013a). Our primary analyses follow the classic and widely used constrained generalized linear model (CGLM) approach, in which the analyst postulates equality constraints on specific categories within one of the APC dimensions and estimates the multiple classification model under those constraints (Mason et al. 1973; O'Brien 2014). We do so with constrained ordinary least squares (OLS) regressions; we obtain almost identical results using CGLMs with a logit link.

Mason et al. (1973) showed that constraining two categories to be equal within any dimension is sufficient to identify all model parameters. In Eq. (2), an equality constraint on two coefficients allows us to omit one dummy variable, which breaks the collinearity problem and enables identification. Intuitively, referring back to Table 1, suppose that we constrain grades 1 and 2 to have equal coefficients. We could then attribute within-cohort changes across these grades to period effects; from there, we could tease apart all three dimensions of change.

The main problem with this CGLM approach is that estimates may be sensitive to the choice of constraint. These constraints should embody plausible assumptions based on substantive knowledge of the process of interest, which is often lacking. We have little basis for assumptions about period or cohort effects, but we can make credible assumptions about grade effects based on knowledge of the organizational features of school systems.

We separately consider four constraints based on the assumption that certain grade effects are equal; that is, there are no systematic changes in segregation across particular grades (net of period and cohort effects). Our logic is that the within-cohort changes in sorting across schools that alter segregation occur when students choose new schools or when the opportunity structure for segregation changes, which happens primarily at school entry and at the transitions to middle and high school. Elementary school almost always includes first through fourth grades, so our first three constraints assume equal grade effects at first and second grades (constraint 1), at second and third grades (constraint 2), and at third and fourth grades (constraint 3). Seventh and eighth grades are almost always in the same school as well—whether elementary, middle, or junior high—so constraint 4 assumes equal grade effects between these grades.

If our logic is sound, these constraints should not straddle common transition points. We check this in our data by calculating the percentage of students in each grade attending schools in which that grade is the lowest one offered in the school. We would be concerned if the higher grade in one of our constraints is a common transition point. The transition rates relevant to our constraints are low. In 2013, 2.1 % of second graders were in schools where second grade was the lowest grade (constraint 1); the corresponding rates are 5.3 % for third grade (constraint 2), 4.2 % for fourth grade (constraint 3), and 1.6 % for eighth grade (constraint 4). As expected, transition rates are much higher for sixth (60.3 %), seventh (23.7 %), and ninth (87.5 %) grades.

We favor constraints 2 and 3, which assume no change in grade effects between second and third grades and between third and fourth grades, respectively. Constraint 1 may be problematic because grade repetition is most common in first grade (Warren et al. 2014), and this could alter cohort composition between first and second grades. Similarly, dropout may alter cohort composition at higher grades, although it is probably not prevalent enough at seventh and eighth grade to be problematic for constraint 4.

An alternative and recently popularized solution to the APC identification problem is the intrinsic estimator (IE), studied extensively by Yang et al. (2008). IE has efficiency advantages, and it provides a vector of coefficients that is (1) insensitive to the shape of the data matrix and (2) qualifies as an estimable function of the data generating parameters (see Yang and Land 2013a for details). The latter means that its coefficients are an unbiased linear combination of the parameters in Eq. (2), although these coefficients may not accurately reflect the direction and magnitude of the true parameters. Critics note that the constraint used by IE is statistically rather than substantively driven, and it can be described as a weighted composite of all possible constraints (Luo 2013; O'Brien 2014; Smith 2004; Yang and Land 2013b).

Because we find many possible constraints problematic—including those related to period effects, cohort effects, and grade effects at transition points—we prefer our grade-based constraints. Nonetheless, we conduct supplementary IE analyses and use the IE as a diagnostic tool to assess our grade-based constraints. We do so with Yang et al.'s (2008) asymptotic t test, which compares the estimates from a constrained model with the IE estimates to assess whether the solutions to the constrained model are estimable functions of the parameters in Eq. (2). More details are provided in Online Resource 1.

Additional Analyses

To assess our predictions regarding variation across areas with different characteristics, we replicate our analyses separately for metropolitan and nonmetropolitan areas, separately by region (Northeast, Midwest, South, West) and separately across areas with different desegregation policy histories. The latter are based on Reardon et al.'s (2012) data, which tracked court-ordered desegregation policies through 2009. We distinguish four types of areas: (1) those that never had districts under court-ordered desegregation, (2) those where all districts were released from such orders prior to 1998, (3) those where the final orders were reversed between 1998 and 2009, and (4) those where districts remained under order as of 2009. We consider these comparisons descriptive because they cannot isolate the influence of any particular factor from the others. Doing so would require a more complicated multilevel framework that permits and explains variation in APC parameters between places—a substantial methodological undertaking beyond the scope of this study. We see these comparisons as useful extensions of our population-level analysis that pave the way for more detailed analyses in the future.

In Online Resource 1, we also discuss analyses incorporating controls for each focal group's public school enrollment and total public and private school enrollment.[6] These controls account for the real effects of population change on segregation (e.g., white flight in response to growing minority populations) as well as systematic selection into, out of, and across cohorts in our public school data (e.g., grade retention and private school attendance).

Results

We begin by describing basic features of the public school population, summarized for our primary samples in Table 2 (black-white) and Table 3 (Hispanic-white). Between 1999–2000 and 2013–2014, the public school population grew by 8 % to 9 %, accompanied by a 9 % to 11 % increase in the number of schools. Meanwhile, the grade distribution shifted toward higher grade levels: the share of students in first through fifth grades declined 1.6 percentage points, and the share of students in eleventh and twelfth grades increased 2.3 points. The student population also became less black (–2 percentage points), less white (–12 points), and more Hispanic (+10 points).

Tables 2 and 3 also summarize conventional segregation analyses, which use school-level data aggregated across grades 1–12. Average within-market dissimilarity declined 0.3 points (1 %) for black-white segregation and 3.3 points (11 %) for Hispanic-white segregation. If these changes are sensitive to the changing grade distribution, they

[6] Although yearly grade-specific racial composition data are unavailable for private schools, grade-specific total enrollment data are available from the Private School Surveys every two years from 1997 to 2011. We use linear interpolation to impute intervening years.

Table 2 Descriptive statistics, black-white analysis, primary sample

School Year	Segregation (D), All Grades	Students (millions)	Total Schools	% White	% Black	% Hispanic	% Grades 1–5	% Grades 6–9	% Grades 10–12
1999–2000	0.347	34.4	59,082	57.5	19.4	17.7	43.8	34.5	21.7
2000–2001	0.348	34.7	59,896	56.6	19.4	18.5	43.5	34.7	21.8
2001–2002	0.345	35.1	60,490	55.7	19.3	19.3	42.9	35.1	22.0
2002–2003	0.343	35.5	61,351	54.8	19.4	20.0	42.2	35.5	22.3
2003–2004	0.343	35.8	61,950	54.0	19.3	20.8	41.7	35.7	22.6
2004–2005	0.342	35.9	62,638	53.3	19.3	21.5	41.3	35.7	23.0
2005–2006	0.342	36.1	63,104	52.5	19.2	22.1	41.2	35.2	23.6
2006–2007	0.339	35.9	63,413	51.9	19.1	22.8	41.2	34.9	24.0
2007–2008	0.339	36.0	64,160	51.2	19.1	23.4	41.3	34.4	24.3
2008–2009	0.339	36.1	64,283	50.3	18.8	23.7	41.6	34.1	24.3
2009–2010	0.339	36.2	64,583	49.5	18.6	24.4	41.7	34.0	24.3
2010–2011	0.343	36.6	64,622	47.9	17.9	25.4	42.0	33.8	24.1
2011–2012	0.343	36.7	64,461	47.2	17.6	26.0	42.0	33.9	24.1
2012–2013	0.342	36.9	64,578	46.5	17.5	26.6	42.0	34.0	24.0
2013–2014	0.343	37.1	64,556	45.8	17.4	27.2	42.2	33.9	23.9
Change	–0.003	2.7	5,474	–11.6	–2.0	9.5	–1.6	–0.6	2.3
% Change	–1.01	7.86	9.27	–20.24	–10.46	53.56	–3.69	–1.85	10.39

Notes: Based on primary sample described in text; includes 93 metropolitan areas and 853 counties. Dissimilarity is calculated using school-level data aggregated across all grades 1–12.

likely overstate the true declines or obscure increases. We begin with APC results of national-level segregation based on constraint 2, which assumes equal grade effects between second and third grade.

Primary Analyses: National Averages

Figure 1 illustrates the results for average black-white dissimilarity. The first graph shows the temporal trend under the conventional analysis as well as a grade-adjusted trend. Both intercepts are set to 0 to facilitate comparison. The grade-adjusted trend is based on a combination of period and cohort effects after grade effects are adjusted for; it shows predicted values for each school year, averaged across the cohorts in school at that time, with grade level held constant. The subsequent three graphs illustrate the period, cohort, and grade effects. The points plotted for period effects are based on predicted outcome values, with cohort and grade held constant, derived from our constrained regression model. Cohort and grade effects are presented in a similar manner. Model estimates are tabulated in Table 4 in the appendix.

There is no practical difference in the black-white dissimilarity trend based on the conventional analysis and the grade-adjusted trend. Although the conventional analysis overstates the true decline in segregation, as expected, the difference is inconsequential. Despite substantial grade effects, changes in the grade distribution were not sufficient to appreciably bias the trends in the conventional analysis. Overall, black-white school segregation was stable in the average schooling market.

This stability masks offsetting trends across periods and cohorts. With respect to the former, segregation declined 2.2 points between the 1999 and 2013 school years (see coefficient Y13 in Table 4). This was offset by a 4.4-point increase between cohorts

Table 3 Descriptive statistics, Hispanic-white analysis, primary sample

School Year	Segregation (D), All Grades	Students (millions)	Total Schools	% White	% Black	% Hispanic	% Grades 1–5	% Grades 6–9	% Grades 10–12
1999–2000	0.304	31.4	54,974	56.2	16.8	20.9	43.8	34.5	21.7
2000–2001	0.305	31.7	55,848	55.2	16.8	21.7	43.4	34.7	21.9
2001–2002	0.303	32.2	56,522	54.3	16.8	22.6	42.8	35.1	22.1
2002–2003	0.302	32.6	57,417	53.3	16.9	23.3	42.1	35.5	22.4
2003–2004	0.299	32.9	57,996	52.5	16.8	24.2	41.6	35.6	22.7
2004–2005	0.297	33.0	58,635	51.6	16.8	24.9	41.3	35.6	23.1
2005–2006	0.291	33.2	59,210	50.8	16.7	25.6	41.1	35.1	23.7
2006–2007	0.289	33.1	59,573	50.1	16.6	26.4	41.2	34.8	24.1
2007–2008	0.286	33.1	60,196	49.4	16.6	27.0	41.3	34.4	24.4
2008–2009	0.283	33.3	60,428	48.4	16.3	27.4	41.5	34.1	24.4
2009–2010	0.282	33.4	60,760	47.6	16.2	28.1	41.7	33.9	24.4
2010–2011	0.279	33.8	60,810	45.9	15.4	29.1	42.0	33.8	24.3
2011–2012	0.273	33.9	60,721	45.2	15.3	29.8	41.9	33.8	24.2
2012–2013	0.271	34.1	60,888	44.6	15.1	30.4	42.0	33.9	24.1
2013–2014	0.271	34.3	60,900	43.9	15.0	31.0	42.1	33.8	24.1
Change	–0.033	2.9	5,926	–12.3	–1.8	10.1	–1.6	–0.7	2.3
% Change	–10.89	9.32	10.78	–21.91	–10.82	48.48	–3.75	–2.01	10.75

Notes: Based on primary sample described in text; includes 72 metropolitan areas and 884 counties. Dissimilarity is calculated using school-level data aggregated across all grades 1–12.

starting school in 1988 and 2013 (coefficient C13). This result is surprising. We expected recent policy changes to increase segregation across periods, and we expected declining residential segregation to be related to declining school segregation across cohorts. Grade effects follow the expected pattern, with substantial declines in segregation at common transition grades. Segregation drops by 5 points between elementary (grades 1–4) and middle school (grades 7–8) and by another 1–2 points by high school (grades 9–12); it is fairly stable within these levels. By the end of high school, black-white dissimilarity is more than 6 points lower than when students began school.

Figure 2 illustrates the corresponding findings for Hispanic-white dissimilarity, which decreased over time. The steady decline indicated by the grade-adjusted trend (3.5 points) is practically identical to the trend under the conventional analysis. As in the black-white case, changes in the grade distribution were small enough to prevent bias despite large grade effects. The decline is due to a fairly linear 5.1-point decline across periods, which dominated a 2.8-point net increase across cohorts. Unlike the black-white cohort trend, which is fairly linear, the cross-cohort rise in Hispanic-white segregation is concentrated among those starting school between 1988 and 2004, with little change thereafter. Grade effects are comparable with those for black-white segregation, with dissimilarity 5 points lower in the middle school grades than the elementary grades, and an additional 1–2 points lower in the high school grades. Segregation is approximately 6 points lower by the time students finish high school than when they began first grade.

In short, our APC analyses indicate that black-white school segregation has been fairly persistent since 1999, while Hispanic-white segregation has declined. In both cases, declines across periods were offset by increases across cohorts. In the black-white case, these trends cancel out; in the Hispanic-white case, stronger period-based

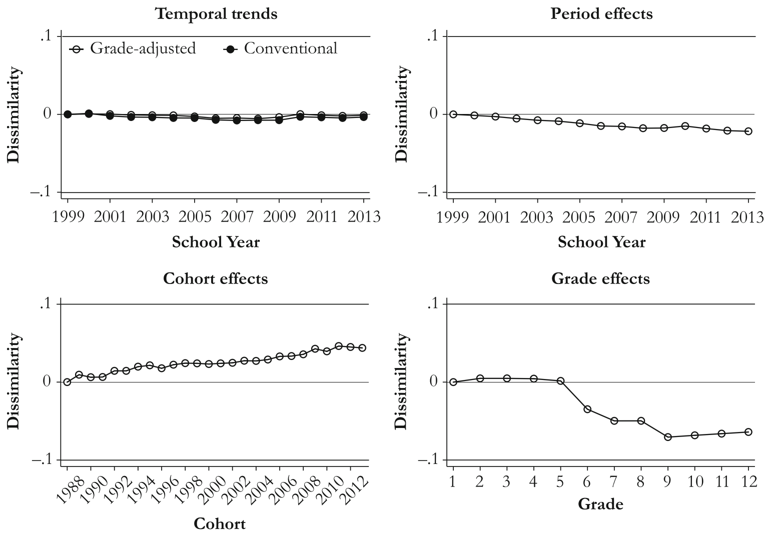

Fig. 1 APC analysis of black-white dissimilarity. Each graph plots national-level average dissimilarity within metropolitan areas/nonmetropolitan counties. The conventional trend uses school-level data (aggregating all grades) to calculate segregation. The grade-adjusted trend plots yearly segregation after controlling for grade effects. Period effects are based on period-specific predictions from the APC model, with cohorts and grades held constant; cohort and grade effects are calculated similarly. All intercepts are set to 0 to facilitate comparison of trends

declines dominated weaker cohort-based increases. For both black-white and Hispanic-white segregation, there are predictable but substantial grade effects reducing segregation at transition grades, although the grade distribution was stable enough to prevent this from biasing temporal trends.

Variation Across Place

We now turn to an exploration of variation in these trends across different types of areas. Again, we cannot make causal attributions using these comparisons and cannot hope to explain them all, but they show the potential of APC analyses for revealing complex sources of change in segregation and pose some interesting questions for future consideration.

We begin by comparing metropolitan and nonmetropolitan trends. After adjusting for grade effects (and thus different grade distributions), both black-white and Hispanic-white segregation in 1999 were more than 20 points higher in metropolitan than nonmetropolitan areas (not shown). Figures 3 and 4 compare the APC findings across these locales for black-white and Hispanic-white segregation, respectively. Grade-adjusted trends reveal stability in black-white segregation and declines in Hispanic-white segregation in both locales. All analyses reveal the familiar trend of declines across periods and increases across cohorts, and grade effects are concentrated at the typical transition points.

It is puzzling that the period and cohort trends are more pronounced in nonmetropolitan areas for black-white segregation but more pronounced in metropolitan areas for Hispanic-white segregation. These differences may be related to increased Hispanic

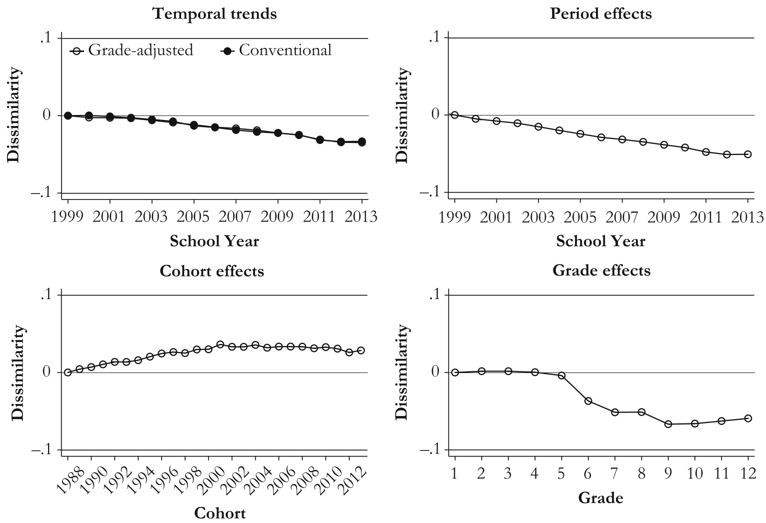

Fig. 2 APC analysis of Hispanic-white dissimilarity

immigration into nonmetropolitan areas and to the distinctive effects of desegregation policy on black-white segregation, but a more specific explanation of these patterns is not obvious. As expected, grade effects are most pronounced in nonmetropolitan areas for both black-white and Hispanic-white segregation. We suspect that between-district sorting in more fragmented metropolitan areas weakens the influence of the organizational constraints underlying grade effects. All else equal, these disparate grade effects expose nonmetropolitan students to less segregation than metropolitan students over their careers.

Next, we turn to regional comparisons. Net of grade effects, both black-white and Hispanic-white school segregation in 1999 were highest in the Northeast, followed by the Midwest, then the West, and lowest in the South (not shown). Figures 5 and 6 compare the APC analyses across regions. Black-white segregation (grade-adjusted) was stable in the South, declined steadily in the Midwest, and declined between 1999 and 2009 before returning to original levels by 2013 in the Northeast and West.[7] Period-based declines are most pronounced in the Midwest, and cohort-based increases are most pronounced in the West. The former may relate to desegregation reversals being less common and less consequential in the Midwest, although the predicted increases across periods in the South in response to desegregation reversals are absent. The muted (less-positive) cohort effects in the Northeast and Midwest are somewhat consistent with our prediction that declining residential segregation would be most impactful in these regions. The migration of blacks out of the Midwest may also play a role (Frey 2004). Grade effects follow similar trends across regions, although they are most pronounced in the West, which makes sense given its relatively large districts.

Hispanic-white segregation declined in all regions but especially in the Midwest and Northeast. Period effects drive these trends, although they are offset somewhat by increases across cohorts in all regions. These offsetting trends are most pronounced in

[7] The West is one instance where the conventional trend is distorted by changing grade distributions; it gives the false appearance of declining black-white segregation (not shown).

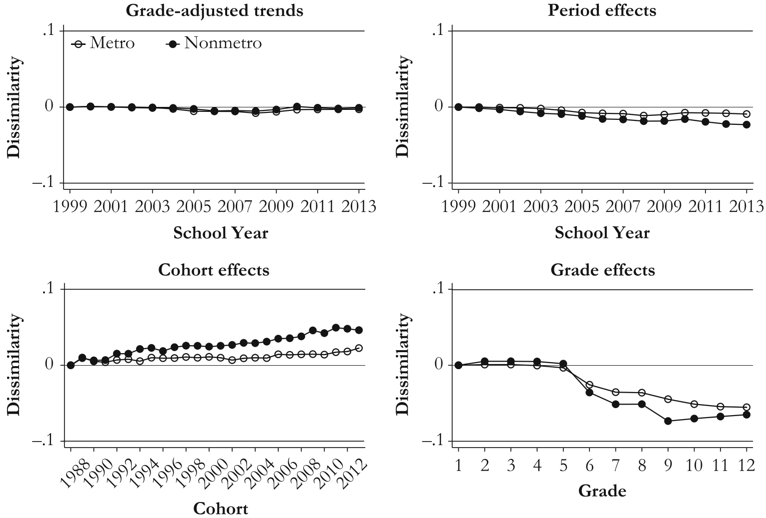

Fig. 3 APC analysis of black-white dissimilarity, by metropolitan status

the Northeast. One possibility is the redistribution of Puerto Ricans—historically the most segregated Hispanic group (Massey and Bitterman 1985)—away from the Northeast, especially to Florida (Duany and Silver 2010). Unfortunately, our data do not disaggregate Hispanics by national origin to explore this sort of heterogeneity. Whatever the reason, the net result is convergence across regions, as declines were most pronounced in regions with the highest segregation levels in 1999. Grade effects follow the familiar pattern but are notably stronger in the West and Midwest. The former is expected given its large, centralized school systems; the latter is more surprising.

Figure 7 directly addresses the issue of mandatory desegregation policy; we focus on black-white segregation, which was almost always the target of such policies. Unsurprisingly, segregation increased slightly across periods in areas where districts were

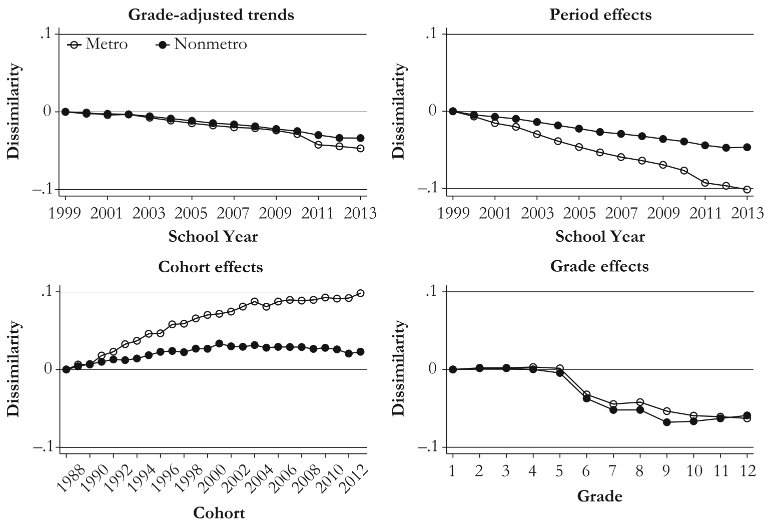

Fig. 4 APC analysis of Hispanic-white dissimilarity, by metropolitan status

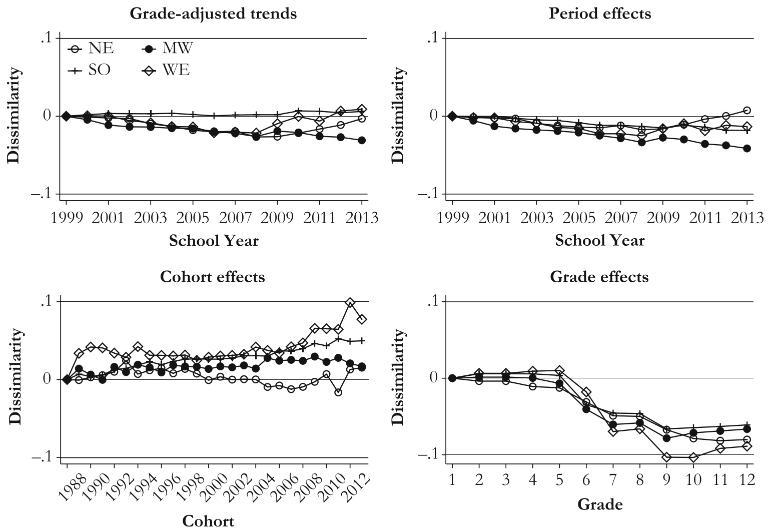

Fig. 5 APC analysis of black-white dissimilarity, by region

released from desegregation orders; it declined in areas where districts were never under order and where they remained under order. It is somewhat surprising that the period trend is positive where districts were released prior to 1998; this finding could be related to delayed implementation of new assignment policies or the subsequent expansion of school choice. Cohort trends are most negative (or least positive) in areas recently released from desegregation policies, which is expected because these reversals should heighten the effects of residence on school attendance, and residential segregation declined throughout this period. For similar reasons, we predicted grade effects to be stronger in areas recently released from desegregation policies, and they are.

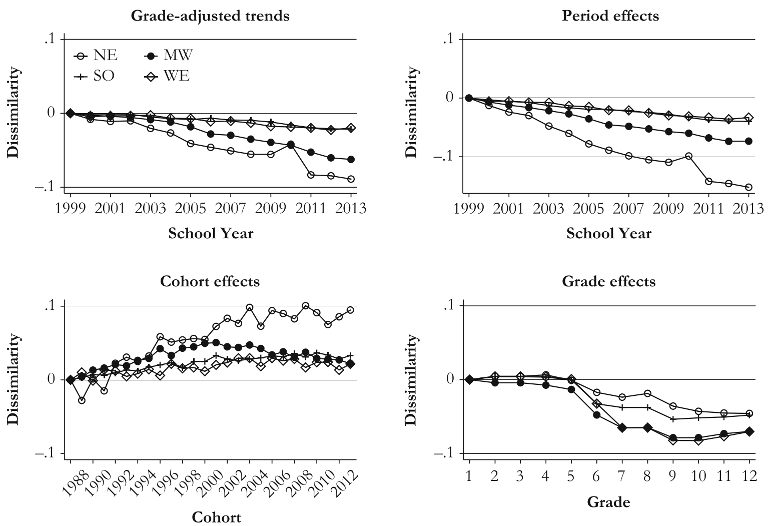

Fig. 6 APC analysis of Hispanic-white dissimilarity, by region

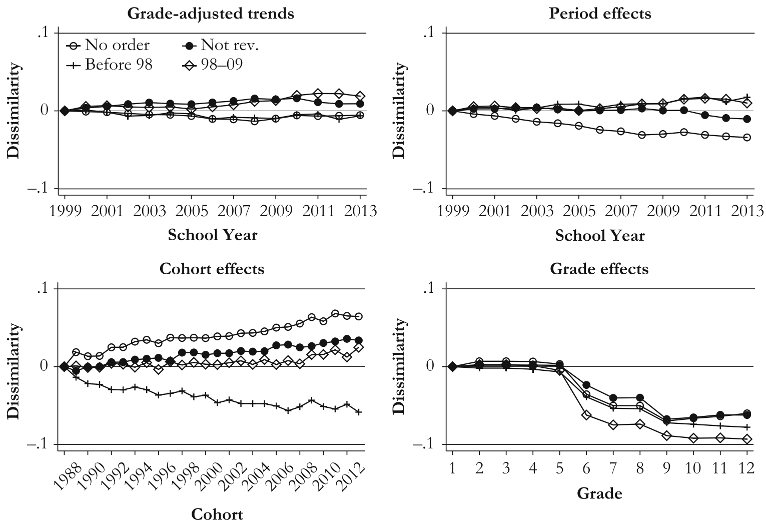

Fig. 7 APC analysis of black-white dissimilarity, by desegregation order status. We distinguish four types of areas: (1) those that never had districts under court-ordered desegregation (No order), (2) those where all districts were released from such orders prior to 1998 (Before 98), (3) those where all districts were released between 1998 and 2009 (98–09), and (4) those where districts remained under order as of 2009 (Not rev.)

In sum, we find variation in period-, cohort-, and grade-based change in school segregation across different areas. Much of this variation makes sense in light of what we know about differences in school systems and desegregation policy across these areas, but much of it remains a puzzle. Although we cannot solve these puzzles here, they highlight the complexity of the forces underlying recent trends in school segregation.

Additional Analyses

We conducted many additional analyses to assess the robustness of our findings to various analytical decisions and to assess additional comparisons. Many of these are discussed in Online Resource 1, and additional details are available on request from the authors. We remark briefly on a few of them here.

First, as with other groups, black-Hispanic segregation declined modestly; this decline was driven by period effects that were offset slightly by increases across cohorts, and grade effects were large and concentrated at typical transition grades. Second, adding regression controls for each group's public school enrollment and for overall public and private school enrollment explains the increase across cohorts for black-white segregation; the findings suggest that this is related to declining white enrollment, which is negatively associated with segregation and is consistent with racial threat and white flight (Renzulli and Evans 2005). These controls exacerbated the increases across cohorts and declines across periods for Hispanic-white and black-Hispanic segregation; this pattern of results appears related to declining private school enrollments, which are negatively associated with public school segregation, consistent with a shift of segregation from the private to the public sector. Grade effects are insensitive to these controls, suggesting that our analyses are not tainted by systematic grade-specific selection related to dropout, retention, or private school enrollment. Third, our findings are robust to most of the aforementioned alternative constraints, including the intrinsic estimator. Although our assessments of the estimability of our constrained solutions do not yield significant results (based on t tests comparing them with the IE solutions), the size of the differences suggests that our preferred constraints perform well, whereas others (including constraint 1) are more problematic.

Discussion

APC analyses have proven useful in efforts to track many social phenomena over time (Mason and Fienberg 1985; O'Brien 2014; Yang and Land 2013a), but they are not found in segregation research. Because people of different ages and cohorts live and work together, it is problematic to measure residential or occupational segregation for different age groups or cohorts at the same time (but see Wagmiller 2013). The graded nature of schooling makes school segregation amenable to such an analysis. Our APC analyses of recent trends in school segregation probe the respective roles of cohort replacement and temporal change, the influence of organizational structures on grade-based change, and the potential problems that changing age or grade distributions pose for conventional analyses.

We find that recent declines in segregation, which are negligible for black-white segregation but more pronounced for Hispanic-white and black-Hispanic segregation, are driven primarily by temporal change rather than cohort replacement. We expected positive period-based change because of policy changes, particularly the reversal of desegregation policies and proliferation of school choice. Accordingly, segregation increased across periods where districts were released from desegregation orders, and it persisted across periods in the South, where the retrenchment of desegregation was most pronounced. However, segregation declined across periods elsewhere, which provides an interesting puzzle. Perhaps some of the social change we expected to reduce segregation across cohorts also affects sorting behaviors within cohorts over time. Or perhaps the recent expansion of choice has not had the widespread segregating effects that many suspect (Butler et al. 2013). It will be important to identify the sources of these period effects in future research, given that they have been decisive in recent trends.

Cohort replacement operated in the opposite direction, helping to increase school segregation. This finding is surprising because we expected cohort effects to capture social changes related to residential segregation, which declined over this period (Iceland et al. 2013; Iceland et al. 2014). Consistent with our predictions, cohort effects were less positive in areas where we expected residential segregation to have a greater impact, particularly those with fragmented school systems and without desegregation orders. Nonetheless, the general increases across cohorts remain a puzzle. We might expect them to be related to changing attitudes relevant to race relations, but explicit racial attitudes became more favorable during this period (Bobo et al. 2012). Perhaps the documented trends in residential segregation obscure cross-cohort increases among families with children. Recent research indicated that residential segregation is higher and declined less in the 2000s among children than among adults; white-Hispanic residential segregation actually increased for children in the 2000s (Owens 2017).

Moreover, white flight from diverse neighborhoods was found to be more pronounced among families with young children than among those without children (Goyette et al. 2014). Alternatively, the policy changes that we expected to drive period effects may have increased segregation across cohorts, or the expansion of school choice may have weakened the link between residential and school segregation. We leave a more thorough examination for future research, but note that the continuation of such a trend may have troubling implications if declines across periods cease.

Predictably, segregation drops sharply at the transitions to middle school and high school, likely because the decreasing number of schools and growing catchment areas across these levels constrain opportunities to segregate. The timing of these transitions, despite being ostensibly unrelated to segregation, can have a large impact on students' exposure to segregated schools. Less obviously, grade effects depend on other factors relevant to the opportunity structure; they are weaker in areas characterized by fragmented school systems and active desegregation plans. Note, however, that within-school segregation likely increases at these transitions as a result of increased tracking, and prior work has suggested that racial disparities in track placement are greater in more diverse schools (Lucas and Berends 2007). Analyses of classroom-level data could assess the extent to which tracking offsets declining between-school segregation.

We also find that fluctuations in the distribution of students across grades do not substantially distort our understanding of change in segregation since the late 1990s. Despite large grade effects, changes in the grade distribution were not sufficient to create bias, which is comforting for those most interested in accurately measuring change in segregation. Nonetheless, because this may not be true in all periods, we recommend examining changes in grade distributions before proceeding with conventional school-level segregation analyses. For similar reasons, it is worth comparing grade distributions of different areas before making inferences about differences in their segregation levels.

Each of these effects likely has distinct consequences, which should also be explored in future research. With respect to grade effects, existing arrangements conducive to elementary school segregation may miss an opportunity to promote positive intergroup relations in a critical period of social development (Killen et al. 2006). With respect to cohort effects, Ryder (1965:854) long ago deemed schools "cohort creators" and cited their importance to socialization and cultural evolution. Cohort-based change in school segregation is likely fundamental to the perpetuation or transformation of race relations (Braddock and Gonzalez 2010; Goldsmith 2010; Stearns 2010). And because period effects represent abrupt changes in cohorts' experiences, they might spur ethnic conflict, which prior work has suggested arises when boundaries such as those embodied by segregation are threatened (Olzak et al. 1994). Moreover, segregation may be related to an uneven distribution of learning opportunities, so changes in segregation across any of these dimensions are likely to have implications for educational inequality.

We addressed concerns that our findings might be sensitive to problematic constraints, sample selection, and other data issues, but there are other limitations that we cannot address here. A particularly important limitation is that we analyzed average segregation at the macro level, but segregation is a local process. Moreover, the variation across types of areas that we explored fails to tease apart the associations among region, urbanicity, desegregation history, and other confounders, and is incapable of testing explanations of differences across these types of areas. A more complex approach would incorporate market-level analyses within a multilevel framework, and we leave this to future research. Also, our data do not disaggregate Hispanics by national origin, which may inform comparisons across regions. It will be worthwhile to incorporate within-group heterogeneity as well as other groups that were ignored here in future analyses. We close by reaffirming the potential of APC analyses to facilitate a greater understanding of segregation and educational inequality and calling for more research exploiting this potential.

Appendix

Table 4 APC estimates of school segregation, constrained OLS regressions

	Black-White Dissimilarity		Hispanic-White Dissimilarity	
	Coef.	SE	Coef.	SE
G1	—	—	—	—
G2	0.005**	(0.001)	0.002	(0.002)
G3	0.005**	(0.001)	0.002	(0.002)
G4	0.004	(0.003)	0.000	(0.003)
G5	0.002	(0.004)	-0.004	(0.004)
G6	–0.035***	(0.004)	–0.037***	(0.005)
G7	–0.050***	(0.005)	–0.051***	(0.006)
G8	–0.050***	(0.006)	–0.051***	(0.007)
G9	–0.071***	(0.007)	–0.067***	(0.008)
G10	–0.068***	(0.008)	–0.066***	(0.009)
G11	–0.066***	(0.009)	–0.063***	(0.010)
G12	–0.064***	(0.009)	–0.059***	(0.011)
Y99	—	—	—	—
Y00	–0.001	(0.001)	–0.005**	(0.002)
Y01	–0.003	(0.002)	–0.008***	(0.002)
Y02	–0.005	(0.003)	–0.011**	(0.003)
Y03	–0.008*	(0.004)	–0.015***	(0.004)
Y04	–0.009*	(0.004)	–0.020***	(0.005)
Y05	–0.011*	(0.005)	–0.024***	(0.006)
Y06	–0.015*	(0.006)	–0.029***	(0.007)
Y07	–0.015*	(0.007)	–0.032***	(0.008)
Y08	–0.018*	(0.008)	–0.035***	(0.009)
Y09	–0.018*	(0.009)	–0.039***	(0.010)
Y10	–0.015	(0.009)	–0.042***	(0.011)
Y11	–0.018	(0.010)	–0.048***	(0.012)
Y12	–0.021	(0.011)	–0.051***	(0.013)
Y13	–0.022	(0.012)	–0.051***	(0.014)
C88	—	—	—	—
C89	0.009**	(0.003)	0.004	(0.004)
C90	0.006	(0.003)	0.007	(0.004)
C91	0.007	(0.004)	0.011*	(0.004)
C92	0.014**	(0.004)	0.014**	(0.005)
C93	0.014**	(0.005)	0.014*	(0.006)
C94	0.020***	(0.006)	0.016*	(0.007)
C95	0.022**	(0.007)	0.020**	(0.008)

Table 4 (continued)

	Black-White Dissimilarity		Hispanic-White Dissimilarity	
	Coef.	SE	Coef.	SE
C96	0.018*	(0.007)	0.025**	(0.009)
C97	0.022**	(0.008)	0.026**	(0.010)
C98	0.024**	(0.009)	0.025*	(0.010)
C99	0.024*	(0.010)	0.030*	(0.011)
C00	0.023*	(0.011)	0.030*	(0.012)
C01	0.024*	(0.011)	0.036**	(0.013)
C02	0.025*	(0.012)	0.033*	(0.014)
C03	0.027*	(0.013)	0.033*	(0.015)
C04	0.027	(0.014)	0.036*	(0.016)
C05	0.029	(0.015)	0.032	(0.017)
C06	0.033*	(0.016)	0.034	(0.018)
C07	0.033*	(0.017)	0.033	(0.019)
C08	0.036*	(0.017)	0.033	(0.020)
C09	0.043*	(0.018)	0.031	(0.021)
C10	0.039*	(0.019)	0.033	(0.022)
C11	0.046*	(0.020)	0.031	(0.023)
C12	0.045*	(0.021)	0.026	(0.024)
C13	0.044*	(0.022)	0.028	(0.025)
Intercept	0.365***	(0.010)	0.326***	(0.011)

Note: Estimates based on constrained OLS regressions with equality constraint G2 = G3.

$^*p < .05$; $^{**}p < .01$; $^{***}p < .001$

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