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Income Segregation between Schools and School Districts

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ABSTRACT

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Abstract

Although trends in the racial segregation of schools are well documented, less is known about trends in *income* segregation. We use multiple data sources to document trends in income segregation between schools and school districts. Between-district income segregation of families with children enrolled in public school increased by over 15% from 1990 to 2010. Within large districts, between-school segregation of students who are eligible and ineligible for free lunch increased by over 40% from 1991 to 2012. Consistent with research on neighborhood segregation, we find that rising income inequality contributed to the rise in income segregation between schools and districts during this period. The rise in income segregation between both schools and districts may have serious implications for inequality in students' access to resources that bear on academic achievement.

Keywords: economic segregation, income segregation, school district segregation, school segregation, social stratification

Introduction

Trends in *racial* segregation of schools and school districts have been well-documented over the past half century, but we know far less about trends in *income* segregation of schools and districts (Reardon & Owens, 2014). We know that residential segregation of census tracts by income has increased sharply since the 1970s (Bischoff & Reardon, 2014; Jargowsky, 1996; Reardon & Bischoff, 2011; Watson, 2009). However, census tract boundaries seldom correspond perfectly with school attendance zones or district boundaries, and even when they do coincide, parents do not always send their children to the nearest public school. Some children attend private schools, charter schools, magnet schools, or open enrollment schools that draw from multiple neighborhoods. All these factors work to decouple residential segregation from school segregation.

On the other hand, even when parents have a wide range of choice about where to send their child, those choosing an elementary school often put a lot of weight on proximity to their residence (Hastings, Kane, & Staiger, 2005). Likewise, when schools of choice are oversubscribed, proximity is often a key factor in determining which applicants will be admitted (Abdulkadiroglu & Sonmez, 2003). In 2007, nearly 75% of public school students attended their neighborhood school (Grady & Bielick, 2010). In addition, parents often make choices about where to live and where to enroll their children in school based on the characteristics of both individual schools and school districts. Income segregation between neighborhoods or schools may be an unreliable guide to income segregation between school districts, because within-district student assignment policies and parental choices may strongly influence within-district enrollment patterns. Therefore, how closely trends in the income segregation of schools and districts match the trends in the income segregation of tracts is an open question.

We address this gap in knowledge by asking how school income segregation has changed in recent decades. We use multiple data sources to document trends in segregation between districts from 1990 to 2010 and between schools from 1991 to 2012. We document 1) within-metropolitan area income segregation between school districts; 2) within-metropolitan area income segregation between schools; and 3) within-district income segregation between schools. We measure income segregation between districts in two ways. One measure relies on family income as measured in the Census, where income is reported in 15 to 25 ordered categories. Data on the full income distribution allows us to explore not only average income segregation but segregation of the poor and of the affluent. Our other measure relies on counts of the number of enrolled students who are and are not free lunch eligible (FLE). We measure segregation between schools using only FLE counts, as more detailed information on family income is not available at the school level. Overall, we find that segregation both between districts and between schools grew since 1990. Our analyses provide the first comprehensive account of recent trends in income segregation between schools and districts.

We then investigate one potential explanation for these changes. Prior research shows that rising income inequality was a key factor contributing to the growth in income segregation between neighborhoods (Reardon & Bischoff, 2011; Watson, 2009). Owens (2016) finds that this relationship is twice as large among families with children as among those without. If families with children make residential choices with school or district options in mind, rising income inequality may also have led to rising income segregation between schools and school districts. In the second part of this article, we test this hypothesis. Our results indicate that rising income inequality is indeed one factor contributing to rising income segregation between districts and schools.

Overall, this article contributes to the growing body of scholarship on rising economic inequality in the U.S. over the past several decades by documenting trends in income segregation between schools and districts and examining the implications of rising income inequality for educational inequalities.

Implications of Income Segregation

Documenting school and district income segregation is an important part of identifying explanations for educational inequalities. Recent research documents a growing achievement gap in the U.S. between children in high- and low-income families, a trend that contrasts with the decline of racial achievement gaps over the past 50 years (Reardon, 2011b). Other research notes a growing income gap in college attendance and completion, while the black-white attainment gaps have remained fairly stable (Bailey & Dynarski, 2011; Duncan, Kalil, & Ziol-Guest, 2013; National Center for Education Statistics, 2015; Ziol-Guest & Lee, 2016). School income segregation may lead children from low- and high-income families to experience disparities in school resources and contexts; these disparities may in turn lead to economic achievement and attainment gaps.

First, between-district income segregation may lead to inequalities in the financial resources available to school districts. A substantial portion of school funding is raised through local tax revenue, often through property taxes. Income segregation thus implies variation in school funding between school districts. In many states, these inequities are partially or wholly offset by state and federal funding, but there are still many states where funding remains correlated with local residents' income and property values (Baker & Corcoran, 2012). Schools that serve low-income populations tend to have fewer instructional resources, less rigorous curriculums, and teachers with fewer formal qualifications (Orfield & Eaton, 1996; Phillips & Chin, 2004). Past research has shown that standardized test scores are more equal in states that rely less on local taxes for school funding, suggesting that unequal spending can influence student achievement (Card & Payne, 2002; Downes & Figlio, 1997). Further, even if funding formulas equalize spending, income segregation between districts may produce high-income districts where residents, particularly parents, vote to spend more on schooling. In addition, poorer districts may need more financial resources than richer districts to provide children with equal opportunities for educational success, such as a safe environment, schools in good physical condition, and high-quality teachers, who may require higher salaries to work in poor districts seen as undesirable (Boyd, Lankford, Loeb, & Wyckoff, 2013; Corcoran, Evans, Godwin, Murray, & Schwab, 2004). Therefore, segregation between districts may lead to inequalities in resources that in turn contribute to unequal academic achievement.

Second, income segregation between both schools and districts affects the socioeconomic composition of the student body. Segregation between districts determines the degree of school integration that can occur—no amount of within-district re-assignment of students can overcome high levels of between-district segregation. Within districts, segregation between schools determines who students' classmates will be. Student body composition may affect student achievement because it can influence teacher quality, school environment, parent involvement, student-teacher interactions, and peer interactions (Kahlenberg, 2002; Rumberger & Palardy, 2005; Schwartz, 2012). Some correlational studies have suggested that mean student socioeconomic status (SES) impacts student achievement (Gamoran, 1996; Mayer, 1991; Reardon, 2016; Rumberger & Palardy, 2005), although others have not found much relationship between the two (Carbonaro & Gamoran, 2002; Jencks & Mayer, 1990; Lauen & Gaddis, 2013). These correlational studies also face methodological challenges in assessing causal impacts of student body composition on student achievement. Schwartz (2012) provides stronger causal evidence from random student assignment in Montgomery County, comparing the performance of students living in public housing who attended the district's most versus least advantaged schools. She finds that students from public housing in low-poverty elementary schools had significantly higher scores in math and reading than equally poor students assigned to higher-poverty schools, and these positive impacts accumulated over time. Overall, past evidence indicates that income segregation between schools and districts may contribute to economic inequalities in educational outcomes, motivating our investigation of the trends and causes of school income segregation.

Trends in Segregation between Schools and Districts

We know relatively little about income segregation between schools and school districts. Rusk (2002) uses data on the enrollments of students in all public elementary schools from 1989 to 1999 to explore trends in income segregation between schools. Using dissimilarity indices that compare how FLE and non-FLE students are distributed among all elementary schools, Rusk finds that average income segregation between these two groups increased among the 65,000 elementary schools nationwide from 1989 to 1999. Among elementary schools in the 100 largest metropolitan areas, income segregation rose in 53 metros, was stable in 15, declined in 13, and could not be calculated in 19. The mean change in the dissimilarity index for the 100 largest metropolitan areas during the 1990s was 2.2 points (on a 0 to 100 scale). Although Rusk's results are a useful starting place, his analysis ends with data from 1999 and does not examine segregation among schools within the same district. In addition, many schools (including those in several of the largest school districts in the U.S.) are missing FLE counts for the early 1990s, making the overall trend somewhat uncertain. Furthermore, his measure of income segregation is based only on segregation between FLE and non-FLE students, rather than on the full income distribution. Other evidence on income segregation comes from Corcoran and Evans (2010), who examine income inequality within and between school districts within metropolitan areas from 1970 to 2000 and find that the share of income inequality attributable to between-district inequality (which is one measure of income segregation) grew by 40% from 1970 to 2000 (we discuss the role of income inequality in contributing to income segregation below).

We know more about school segregation by race than by income because a large body of social science research has documented trends in racial segregation between schools and districts since *Brown v. Board of Education* in 1954 (see Reardon & Owens, 2014 for a review). Overall, school racial segregation declined through 1980, with most of the change occurring in the late 1960s and early 1970s. Since the mid-1980s, minority students' exposure to other minority students has risen (Orfield & Lee, 2007; Orfield, 2001), largely because of the decline in total white enrollment and the growth in total Hispanic enrollment. Net of changes in racial composition, the sorting of students between schools by race changed little in the 1990s and declined slightly in the 2000s (Logan, 2004; Stroub & Richards, 2013).

Black-white segregation between *districts* increased from the early 1970s through the 1990s but has declined slightly since 2000 (Coleman, Kelly, & Moore, 1975; Rivkin, 1994; Stroub & Richards, 2013).

Trends in school racial segregation suggest conflicting hypotheses about income segregation. On one hand, sorting between schools and districts by race declined over the past two decades. Given the link between race and income, sorting by income may therefore have followed suit. On the other hand, the residential segregation literature shows that trends in racial and income segregation do not always correspond. Black-white segregation between neighborhoods declined from 1990 to 2010, for example, and white-Asian and white-Hispanic segregation remained stable (Logan & Stults, 2011). During this same time period, income segregation between neighborhoods rose among all families and among whites, blacks, and Hispanics examined separately (Bischoff & Reardon, 2014; Reardon & Bischoff, 2011).

Residential Income Segregation and School Assignment Policies

Income segregation between *neighborhoods* has risen over the past 40 years (Bischoff & Reardon, 2014; Jargowsky, 1996; Reardon & Bischoff, 2011; Swanstrom, Casey, Flack, & Dreier, 2004; Watson, 2009). Reardon & Bischoff (2011) find that much of the increase in income segregation occurred at a large geographic scale—indicating that high- and low-income neighborhoods are clustered in the same parts of cities or metropolitan areas. To the extent that large-scale residential segregation maps onto district or school attendance zones, one might expect that between-district and between-school segregation also increased. Owens (2016) finds that economic residential segregation among census tracts grew only among families with children from 1990 to 2010. Since families with children are the population most relevant to schooling, this increase in residential segregation of children suggests a concurrent rise in school and district income segregation. Past research on residential segregation also finds that the segregation of both the poor and the affluent rose over the past several decades (Bischoff & Reardon, 2014; Owens, 2016; Reardon & Bischoff, 2011). Whether this was also true of segregation trends between schools and districts is unknown.

Because school choice policies, magnet schools, and charter schools have become more common, segregation between schools may not have moved in tandem with residential segregation. Parents may choose a private or other non-local school option for their child. Saporito and Sohoni (2007) studied 21 large U.S. school districts in 2000 and found that school poverty rates were typically *higher* than the poverty rate among all school-age children in a school's catchment area, particularly when the catchment area was predominantly non-white. This suggests that non-poor families in high-poverty catchment areas often choose private, charter, or magnet schools, leaving the most disadvantaged children in local public schools with fewer middle-class peers (Saporito, 2003). This mismatch between neighborhood and school demographic composition increased in the 2000s (Bischoff & Tach, 2016). Segregation between affluent public school students and those with lower incomes may not have changed much if the affluent families most averse to enrolling their children in a mixed-income school left the public system altogether, leaving behind affluent families more open to income integration.

Beginning in the 1990s, some school districts began to shift school assignment policies from focusing on racial diversity to focusing on income diversity. Kahlenberg (2002, 2006a) found that the number of students in districts with attendance policies that consider family SES when assigning students grew from 1999 to 2006, but Reardon and Rhodes (2011) note that such districts enrolled only about 3% of all public school students in the U.S. Reardon and Rhodes (2011) also found no evidence that income segregation levels change after districts adopt SES-based choice plans, a finding they attribute to the voluntary nature and weak design of these plans. With the exception of a few voluntary programs, school assignment policies operate within districts, so they alter segregation between schools within the same district. However, the absence or presence of within-district choice policies could influence parents' decision to live in the district, affecting segregation between districts. Overall, the proliferation of non-local school options indicates that trends in income segregation between schools and districts may not map perfectly onto trends in income segregation between neighborhoods.

The Role of Income Inequality

Despite the ambiguity of how neighborhood, school, and district segregation relate to one another, there may be common explanations for segregation among all of them. Rising income inequality is one key contributor to the growth in income segregation between neighborhoods (Reardon & Bischoff, 2011; Watson, 2009). Income inequality is a particularly strong predictor of the segregation of the affluent because rising income inequality occurred largely because of rising incomes near the top of the income distribution (Reardon & Bischoff, 2011). As affluent families' incomes grow, they can afford housing in neighborhoods that lower-income families cannot afford. Owens (2016) finds that rising income inequality was a much stronger predictor of income segregation among families with children than among childless households from 1990 to 2010, suggesting that parents in particular use additional resources to change contexts.

Rising income inequality may contribute to income segregation between schools and districts if parents see membership in a certain district or school as an investment in their children's well-being. Parents' economic investments in their children have increased over the past several decades (Kornrich & Furstenberg, 2013), and enrollment in a school or district that parents see as advantageous for their children is one way parents make such investments. Quantitative studies find that racial and income segregation between neighborhoods and districts is higher in metropolitan areas that have more school districts, as parents can better match their preferences to schooling characteristics in more fragmented places (Bischoff, 2008; Owens, 2016).

In sum, past research suggests hypotheses but provides little evidence about trends in income segregation between schools and districts. In this article, we document the trends in school and school district income segregation in the 1990s and 2000s. We can document average income segregation as well as segregation of the poor and affluent between districts. We can measure income segregation between schools only by the segregation of students eligible and ineligible for free lunch. After documenting trends over time, we examine whether rising income inequality is associated with higher levels of income segregation between schools and districts.

Data

To investigate trends in school income segregation over time, we would ideally like data on the exact family income of all students in all schools over many years. With such data, we could describe any changes in between-school and between-district segregation in detail. However, such data are not available. Instead we use multiple data sources to report trends in school income segregation measured in several ways. Each of these data sources provides counts of families or children in income or poverty categories at the school or district level. We then calculate between-district and between-school segregation within metropolitan areas or districts (in the case of between-school segregation) as described below.

Census Data

We start by considering income segregation between school districts among families with children enrolled in public schools. From 1990 onward, the School District Demographics System (SDDS), produced by the National Center for Education Statistics (NCES), provides estimates of the number of families living within each school district's boundaries in multiple income categories (25 categories in 1990, 16 in 2000, and 10 in 2010).[1] The SDDS data come from the School District Special Tabulation Census files from the 1990 and 2000 Census and the 2008-12 American Community Survey (ACS) estimates (for parsimony, we refer to the 2008-12 ACS as describing 2010). From the SDDS, we obtain income tabulations for families living within district boundaries who report that one or more of their school-age children attends public school. We calculate between-district segregation within metropolitan areas for families with children enrolled in public schools in U.S. elementary or unified school districts in 1990, 2000, and 2010. (See Appendix A for a list of missing counties in 1990.) As described below, student income data is limited to free lunch eligibility, so the SDDS data are critical in providing a measure of income segregation between districts across the full income distribution for families with students enrolled in public school.[2]

To provide a sense of segregation over a longer time period, we also examine data from 1970 and 1980. The School District Geographic Reference File, 1969-1970 (U.S. Department of Commerce, 1970), distributed by ICPSR, provides a link between 1969-1970 school district boundaries and 1970 census tract and enumeration district data (Adams, 2007).[3] Family income from the 1970 Census is available in 15 categories. For 1980, the Census of Population and Housing, 1980: Summary Tape File 3F, School Districts (U.S. Department of Commerce, 1983) provides family income in 17 categories for all families within each school district. The available 1970 and 1980 data provide income counts for all families living in a district, but not for just those with children enrolled in public schools. While our interest is in segregation of public school families or students, we estimate segregation from the 1970 and 1980 data for historical reference. Income counts for all families are also available in the 1990, 2000, and 2008-12 SDDS, so we can track trends in between-district segregation for all families within metropolitan areas from 1970 to 2010.

Common Core of Data

We estimate between-school segregation of students within metropolitan areas and within districts using the Common Core of Data (CCD), a publicly available dataset compiled annually since 1987-88 by the NCES. The CCD contains school-level data for all public schools in the U.S., including enrollment counts by grade, race and ethnicity, and free and reduced-price lunch eligibility. Families with incomes less than 130% of the poverty line are eligible for free meals while families with incomes between 130% and 185% of the poverty line are eligible for reduced-price meals. Prior to 1998, the CCD includes school-level counts only for FLE students. From 1998 onward, the CCD includes separate counts for free and reduced-price lunch students. For consistency, we calculate segregation between FLE students and all others in all years.

Not all states reported FLE counts by school for each year of the CCD, particularly in the earlier years of the survey. We exclude FLE counts from 1987 to 1990 from our analysis because the proportion of missing data was very high in many states. We impute missing data after 1990 using a multiple imputation model that uses information on school enrollments (total, by race, and by FLE status) in each year from 1987 to 2012. In other words, each school's non-missing FLE counts are used to inform the imputations for missing years. Although we do not use 1987 to 1990 in our analyses due to high levels of missing data, we do use these years of data in the imputation models, since the non-missing data informs the imputation model. We report the proportion of missing data in the Appendix. Data are missing for 30-40% of students prior to 1995; by the mid-2000s, data are missing for only 4-12% of students. All estimates in this article include imputed data, and the imputed model provides good estimates of missing FLE rates by drawing on schools' non-missing FLE rates.

Reported FLE rates vary with children's age, partly because of differences in family income at different ages (older children tend to have older parents, who typically earn more than younger parents), and partly because of age differences in the fraction of eligible students who sign up for free lunch. Because schools enroll students in different age ranges, age-related variation in reported FLE status may spuriously inflate segregation measures. To avoid this, we first estimate grade-level segregation within each metropolitan area or district and then average segregation across all grades served in that metropolitan area or district. This requires enrollment counts by FLE status for each grade level. The CCD reports enrollment counts by grade and enrollment counts of FLE students, but it does not report grade-specific counts of FLE students. Therefore, after imputation we estimate the FLE counts in each grade by multiplying the enrollment count for the grade by the school-wide proportion of FLE students. We use these estimates to compute grade-specific segregation indices.

The CCD data have two important limitations. First, they do not include information on the full income distribution within a given school. As a result, the CCD measures of income segregation are only sensitive to income segregation between FLE and non-FLE students. This corresponds roughly to segregation of the bottom 20% of the income distribution from the top 80%. If segregation is changing elsewhere in the income distribution (if, for example, children from affluent families are becoming increasingly segregated from middle-income families), our CCD-based segregation measures will not capture the change. (Our SDDS-based measures capture this, but only for between-district segregation.)

A second limitation of the CCD data is that reported FLE counts are an imperfect proxy for true student eligibility counts (Harwell & LeBeau, 2010). Some eligible students do not enroll in the free lunch program, and some ineligible students do enroll. As a result, FLE counts do not always capture the true eligibility rates within schools accurately. Appendix B presents some evidence of the mismatch between CCD FLE counts and true eligibility rates. Comparisons with other national surveys indicate that the CCD overestimates FLE rates. Importantly, the CCD appears to inflate counts of FLE students more in districts where there are more “true” FLE students. Moreover, inspection of the data indicated strange patterns in a few districts, with FLE rates declining by improbable amounts over a few years and then rising sharply again. We use the CCD data to calculate between-school segregation because it provides the only school-level data on students’ income over time. In a set of sensitivity checks (not shown; available on request), our results are fairly consistent across different subsets of the data (e.g., comparing districts by enrollment or number of schools, omitting data from districts where implausible time trends are evident), but these results should still be interpreted with some caution.

Measuring Segregation

Income segregation—the extent to which high- and low-income students attend separate schools or live in separate districts—can be measured in many ways (Reardon & Firebaugh, 2002; Reardon, 2009, 2011a). We use the rank-order information theory index to measure segregation across the full income distribution using SDDS data. We use the binary information theory index to measure segregation between FLE and non-FLE students using the CCD data. Both indices are denoted as *H*. In both cases, *H* compares the variation in family incomes within school districts (or schools) to the variation in family incomes within their metropolitan area (or school district, in the case of between-school segregation). The binary *H* measures segregation between children from families below and above a single income threshold (FLE), while the rank-order *H* is a weighted average of the binary *H* computed at every threshold between multiple income categories (Reardon, 2011a). *H* does not measure exposure. Rather, it measures non-random sorting of families by income across units like school districts or schools.[4]

Because the rank-order *H* index relies only on information about families' ranks in the income distribution rather than their actual income, it is less sensitive to inflation and to changes in the shape of the income distribution than other segregation indices. As a result, *H* does not confound changes in income inequality with changes in income segregation (Reardon & Bischoff, 2011; Reardon, 2011a). Reardon (2011a) also shows *H* is insensitive to the number or location of thresholds used to define income categories so long as there are more than a modest number of categories that capture the underlying distribution well. This feature makes *H* particularly useful for comparing income segregation across time.

In theory, *H* can range from 0 (no segregation) to 1 (total segregation). In a hypothetical metropolitan area where all school districts had identical family income distributions (and were therefore identical to the overall metropolitan area distribution), the index would equal 0, indicating no segregation by income. In contrast, in a metropolitan area where all families in a school district always had the same income, H would equal 1. Although the magnitude of H does not have a particularly intuitive meaning, it is analogous to Jargowsky's (1996) Neighborhood Sorting Index (NSI) in that it can be interpreted as measuring the proportion of variation in income that lies between, rather than within, units like schools or school districts. One main difference is that H is based on income *ranks*, while the NSI is based on actual income (in dollars). As a result, the NSI is sensitive to changes in the shape of the income distribution, while H is not. A second difference is that H measures income variation using a form of the entropy index, while the NSI uses the standard deviation of income.

We present trends in H for the 100 largest metropolitan areas and for the 100 largest districts. Because the increase in residential segregation has been greatest in large metropolitan areas (Bischoff & Reardon, 2014), we examine changes in H within the 100 largest metropolitan areas based on OMB 2003 metropolitan statistical area (MSA) definitions and 2009 populations. (Five of the 100 largest metropolitan areas include only one school district, so the analysis sample for between-district segregation includes only 95 metropolitan areas). We also present between-school segregation results from the 100 largest districts, which had less missing data and thus a smaller proportion of imputed data than smaller districts. Throughout the results, we describe the magnitude of the change in H in terms of percent changes, standard deviation changes, and in comparison to racial segregation.

Income Inequality and Income Segregation

After documenting trends in income segregation between schools and school districts, we examine the association between segregation and income inequality. We measure income inequality with the Gini index, a common measure ranging from 0 to 1 that indicates how much the income distribution deviates from a distribution in which everyone has an equal share (when Gini is 0). We estimated the Gini index from categorical SDDS income data within districts and within metropolitan areas using a robust Pareto midpoint estimation procedure described in von Hippel, Scarpino, & Holas (2015). We measure income inequality only among public school families to predict the segregation of public school families or students.

We use longitudinal regression models to predict income segregation between districts in the 95 largest MSAs with multiple districts and between schools in the 100 largest districts in 1990, 2000, and 2010. First, we estimate an unconditional model predicting income segregation as a function of time, formalizing the time trends we note in the descriptive results. Second, we estimate a model adding the Gini coefficient for public school families in each year. Finally, we include time-varying control variables at the MSA or district level to account for characteristics that may confound our identification of the relationship between income inequality and income segregation. Drawing on past research, we control for the racial mix of public school students (proportion non-Hispanic white, black, and Hispanic), educational attainment of public school children's parents (proportion with a BA or more, proportion without a high school degree), poverty rate, unemployment rate and share employed in manufacturing among public school children's parents, proportion of public school families headed by a single female, proportion of all housing units built in the past decade, and the proportion of children enrolled in private school. Characteristics of public school children's families and all housing units are drawn from the SDDS; characteristics of public school students are drawn from the CCD. Our models include MSA or district fixed effects to account for time-invariant characteristics. While we control for many confounding variables, our models are subject to potential omitted variable bias, and the assumptions required to draw causal conclusions may not be fully met.

Results

Trends in Between-District Income Segregation

First, we estimated between-district income segregation among families with children enrolled in public schools within each of the 95 largest metropolitan areas with multiple districts from 1990 to 2010.

Figure 1 and Table 1 present the average levels of segregation in each year.

[Figure 1 about here]

[Table 1 about here]

Figure 1 (dashed line) and Table 1 (row 1) show that average between-district segregation based on the full income distribution increased from 0.076 in 1990 to 0.089 in 2010, an increase of about 17% of the 1990 level and 28% of the 1990 standard deviation (Table 2).

[Table 2]

For interpretation of the magnitude of *H,* it is useful to compare the level of income segregation to levels of racial segregation. First, however, note that measurement error accounts for roughly 10-30% of the variance in self-reported annual income, implying that a more accurate estimate of income segregation in 2010 would be roughly 0.11.[5] In a separate analysis (not shown) we computed *racial* segregation of public school families between districts in 2010 using binary *H*. Black-white segregation among non-Hispanics was 0.26, and Hispanic-non-Hispanic white segregation was 0.16. Thus, between-district income segregation appears to be roughly 40-70% as large as between-district racial segregation.

Next, we examine how the segregation of poverty and affluence between districts has changed. We can estimate *H* at any point in the income distribution by fitting a polynomial through the estimates of *H* at each income category threshold (see (Reardon, 2011a) for details). Figure 2 presents income segregation in the 100 largest metropolitan areas from 1990 to 2010, showing estimates of average segregation at each percentile in the income distribution (based on a 4^{th}-order polynomial). The x-axis indexes percentiles of the income distribution *p* while the y-axis presents average between-district segregation *H*. The value of the line at each percentile *p* in each year indicates the average segregation level across the 100 largest metropolitan areas of families with incomes below the *p*th percentile from those with incomes above the *p*th percentile*.* Distances between the lines indicates how segregation at that value of *p* changed over time.

[Figure 2 about here]

Figure 2 shows that between-district segregation of public school families declined in the bottom quintile of the income distribution from 1990 to 2010. This contrasts with the trends in residential neighborhood segregation described by Bischoff and Reardon (2014), who found that families in the bottom 10 percent of the income distribution became more segregated from higher-income residents between neighborhoods from 1990 to 2010. This suggests that residential segregation of poor families has increased since 1990 within, rather than between, school districts. In contrast, between-district segregation has increased since 1990 among public school families with incomes above approximately the 30th percentile. The largest increases were among families with incomes in the 50th to 80th percentiles, suggesting that segregation between middle- and upper-middle class families increased. The segregation of very affluent students (those in the top 10% of the income distribution) from all others across school districts changed little in the 1990s but increased sharply in the 2000s, suggesting that affluent families are increasingly isolating themselves not only in terms of neighborhood residence, as Bischoff and Reardon (2014) find, but also in terms of the school districts in which they live.

A measure of poverty particularly relevant to schools is FLE. Figure 2 includes black dots at the national income percentiles corresponding roughly to the FLE cutoff in each year.[6] FLE-non-FLE segregation rose slightly from 1990 to 2010 (Table 1, row 3). We also used CCD data to estimate between-district segregation of FLE from non-FLE public school students according to district FLE counts. Table 1 (row 4) shows that between-district FLE-non-FLE segregation based on CCD data is about twice as large as the SDDS estimate based on estimating *H* at the percentile corresponding to the FLE cutoff. Further, segregation increased in the 1990s and declined slightly in the 2000s among students in the CCD data, in contrast to the trends among families in the SDDS data.

Several factors may explain these differences. First, as described above, the CCD FLE counts may inflate the number of students truly eligible for the free lunch program, particularly in high-poverty schools; this would inflate CCD-based FLE segregation estimates. Second, the SDDS results describe segregation among families, while the CCD results describe segregation among students.[7] Third, the FLE classification in the SDDS data is an approximation based on the national proportion of families with incomes below 130% of the poverty line, which over- or undercounts families in particular MSAs. Although the magnitudes of the segregation estimates and their trends differ, both datasets indicate that between-district segregation of FLE and non-FLE students was higher in 2010 and 2012—by about 14% of the 1991 level and 24% of the 1991 standard deviation in the CCD data and by about 4% of the 1990 level and 6% of the 1990 standard deviation in the SDDS data (Table 2).

For historical perspective we also estimated segregation between all families, rather than just families with children in public school. This allows us to compare levels of segregation going back to 1970. Using these data, average between-district segregation in the 100 largest metropolitan areas among all families rose from 0.032 in 1970 to 0.054 in 2010, a 70% increase over four decades (Table 1, row 2). The 0.022 change from 1970 to 2010 represents a 1.2 standard deviation increase. The largest increases in income segregation between districts occurred during the 1970s and 1980s, consistent with trends in residential segregation between neighborhoods, which also increased most during this period (Reardon & Bischoff, 2011; Watson, 2009). After 1990, between-district segregation among all families increased by 0.004, an increase of 8% of the 1990 level and 14% of the 1990 standard deviation (Table 2). A comparison of the solid and dashed lines in Figure 1 shows that average between-district segregation of families with public school children was greater than between-district segregation for all families in each year. Families with public school children sort themselves more by income than other families (childless families and those who enroll their children in private schools), for whom schools are presumably less important.

To summarize, we find that among families with children enrolled in public school, income segregation between school districts grew from 1990 to 2010 by about 17% (28% of a standard deviation). Although FLE segregation between districts rose somewhat, the main driver of rising segregation of public school families between districts was not increasing segregation of the poorest families from all others. Rising income segregation occurred mainly due to middle and upper-middle class families and, in the 2000s, affluent families becoming more segregated from other families. While families with incomes in the bottom 20% of the income distribution have become less segregated from families with incomes above that threshold, the increase in segregation of the middle and upper classes suggests that the decline in segregation of the poor was mainly due to increasing contact with the working class rather than with higher income families. Looking back to 1970, segregation among all families between districts increased sharply in the 1970s and 1980s and has increased more modestly since then, and at a slower rate than segregation among families with children in public school.

Trends in Between-School Segregation by Income

We turn next to income segregation of students between schools in the same metropolitan area. The CCD data allow us to estimate how segregated poor students are from non-poor students between public schools, relying on FLE as our indicator of poverty. These estimates tell us how segregated students from families with incomes below 130% of the poverty line are from all other students. Figure 3 displays the change in average *H* for segregation between schools in the 100 largest metropolitan areas from 1991 through 2012. We show a break in the trend line in 1998 because of a change in the way the CCD reported FLE status in 1998, although the change does not appear to have had a significant effect on computed segregation.[8]

[Figure 3 about here]

Segregation between the poor or near poor and more affluent students increased by about 13% of its 1991 level and 35% of the 1991 standard deviation during the 1990s, but it was basically unchanged in the 2000s (Table 1, row 5). The 1991 to 2000 change in *H* was about 0.027 for schools on a 0 to 1 scale.

Rusk (2002) documents a 2 point increase in the dissimilarity index during the 1990s, so the change in *H* is slightly larger but of the same order of magnitude. As in the comparison of between-district income and racial segregation, between-school segregation of FLE from non-FLE students in the 100 largest metropolitan areas is about one-third smaller than black-white segregation and about equal to Hispanic-white segregation between schools in the CCD data.

In most metropolitan areas, segregation between schools occurs because of segregation both between and within school districts. Our segregation measure *H* can be decomposed into between- and within-district components by comparing the magnitude of between-district segregation and between-school segregation within the 100 largest metropolitan areas (Theil, 1972; Reardon & Firebaugh, 2002). As Table 1 (row 4) shows, average between-district segregation of FLE from non-FLE students was roughly 0.14-0.16 from 1991-2012, while average between-school segregation was roughly 0.21-0.23. Between-district segregation thus accounts for approximately two-thirds of total between-school segregation by FLE status in these metropolitan areas. Segregation between districts also accounts for about two-thirds of total racial segregation between schools (Stroub & Richards, 2013).

We also examined segregation trends between schools from 1991 to 2010 within districts rather than metropolitan areas. Figure 4 shows these results for the 100 largest districts, which have less imputed data. Here we find an increase in income segregation between schools during both the 1990s and 2000s, with a sharp rise in segregation from 2008 to 2012. The post-2008 rise may be partly due to the economic recession, perhaps because middle-class children whose family incomes fell attended schools that enrolled more poor students, or perhaps because more children eligible for free lunch enrolled in the program during the recession. The trend is slightly steeper in grades K-5 (not shown). The cumulative change in the *H* index during the 1990s and 2000s is nearly 5 points (a roughly 40%, or two-thirds standard deviation, increase), a far larger increase than that of school segregation within metropolitan areas. Strikingly, about half the 40% increase is due to the increase in segregation since

2008.

[Figure 4 about here]

The bottom 4 rows of Table 1 present estimates of segregation in districts with 3 to 5, 6 to 10, 11 to 20, and more than 20 schools. Segregation was initially higher and increased more in districts with more schools. This is consistent with research showing higher segregation in MSAs with more districts (Bischoff, 2008; Owens, 2016). When there are more school options, more affluent parents can match their housing and enrollment preferences more closely, leading to more segregation. Segregation increased by 40% in districts with over 20 elementary schools while changing little in districts with fewer than 10 elementary schools.

Taken at face value, these results suggest that FLE students became more segregated from non-FLE students between schools from 1991 to 2012, and that this was particularly true in large school districts. Given the data issues we noted above, however, we urge some caution in interpreting these findings.

Income Inequality and School Income Segregation

Our analyses show that income segregation of public school families and students increased between districts and appear to have increased between schools from 1990 to 2010. One potential explanation for this increase is rising income inequality. Past research indicates that as income inequality rose among families with children, neighborhoods became more segregated by family income (Owens, 2016). Given that schooling options affect many parents' residential decision-making, we hypothesize that rising income inequality may also contribute to rising income segregation between school districts and between schools.

[Table 3 about here]

Table 3 presents results from panel regression models predicting between-district income segregation from 1990 to 2010 among families with children enrolled in public schools within the same metropolitan area. The models include MSA fixed effects. Model 1 shows the average within-MSA time trend. The coefficients for year are significant and positive, confirming our descriptive results showing a rise in income segregation between districts among public school families. Model 2 includes income inequality among public school families, measured by the Gini coefficient. The coefficient for income inequality is significant and positive, showing that increases in income segregation were correlated with increases in income inequality. Finally, Model 3 includes control variables that might account for the relationship between income inequality and income segregation. (Descriptive statistics for income inequality and control variables are presented in Appendix Table1). Income inequality remains a significant positive predictor of income segregation between districts, with a larger coefficient than in the model without controls. A one-point increase in the Gini coefficient predicts an increase in income segregation of about a third of a point. This is comparable in magnitude to the association linking income inequality to residential segregation in Reardon and Bischoff (2011) and Owens (2016).

As Figure 2 indicated, income segregation between districts increased due to rising segregation among families in the top two-thirds of the income distribution. We therefore investigated how well income inequality predicted income segregation at various points in the income distribution. Appendix Table 2 shows the coefficient on income inequality predicting income segregation at each decile of the income distribution from separate models that include the same variables as Model 3 in Table 3. Income inequality is not associated with income segregation in the bottom third of the income distribution. It does significantly and positively predict income segregation between districts among families in the top 60% of the income distribution, especially segregation of the most affluent. This is consistent with Reardon and Bischoff's (2011) finding that rising income inequality most strongly predicts the residential segregation of affluent families. A one-point increase in the Gini coefficient is associated with a half-point increase in segregation between districts of those with incomes above and below the 90th percentile of the income distribution.

[Table 4 about here]

Table 4 presents results from models predicting income segregation between schools within the 100 largest districts from 1990 to 2010, with district fixed effects. Here, the measure of segregation only captures segregation between FLE and non-FLE students. Model 1 confirms that income segregation of students between schools within districts increased from 1991 to 2010. Model 2 shows that income inequality among public school children's families is a significant and positive predictor of income segregation of public school children. Model 3 adds control variables, and the positive relationship between income inequality and income segregation remains significant. The magnitude of the coefficient is larger than in Table 3, model 3 (though the standard error is also larger), perhaps because between-school segregation in the 100 largest districts is higher and increased more than between-district segregation in the 100 largest metropolitan areas (41% versus 17%).

The relationship between income inequality and FLE segregation is somewhat unexpected, given that income inequality rose primarily due to increases in income at the top of the income distribution and FLE segregation captures sorting between those with incomes above and below about the 20th percentile of the income distribution. However, the FLE composition of a school is publicly available information that high-income parents may consider when making residential and enrollment choices, so rising income inequality may have consequences for FLE segregation between schools. The more robust relationship between income inequality and FLE segregation within districts suggests there may be a stronger link between income and school enrollment within than between districts. High-income families may be more concerned about the economic mix of their children's schools than about the mix of the entire district. There may also be a cyclical loop here: high-income families may only enroll their children in public schools if they can do so in a low-poverty school. As segregation increases, there are more low-poverty schools that attract high-income families. If more high-income families stay in the public school system, this will increase income inequality in such districts, leading to more segregation and continuing the cycle.

Discussion

Income segregation between schools and school districts increased from 1990 to 2010. First, between-district segregation of public school families increased by over 15% of the 1990 level and 25% of the 1990 standard deviation. Earlier data indicates that segregation of all families between districts has been growing since 1970. The increase between 1990 and 2010 was driven not by increasing segregation of the poorest families from all others but by the lower-middle class becoming more segregated from the upper-middle class and the affluent. That said, between-district segregation of FLE and non-FLE students did increase from 1990 to 2010.

Second, segregation of FLE and non-FLE public school students between schools in the same metropolitan area increased during the 1990s but not during the 2000s. In the 100 largest districts, segregation between schools increased in both the 1990s and 2000s, particularly after 2008, and segregation in 2012 is about 40% higher than in 1990. About two-thirds of income segregation between schools in metropolitan areas occurs due to segregation between districts. Although we have some concerns about the CCD data quality, we conclude that FLE students have become more concentrated in certain districts and in certain schools within districts over the past 20 years, which may lead to increased resource disparities between schools and districts.

The trends we document here are not extreme in magnitude, but they are fairly consistent at different levels of aggregation (between schools in the same district and between districts in the same metropolitan area) and over time, with evidence of rising income segregation back to 1970. Increased sorting by income between schools and districts is part of a larger story of growing economic inequality in U.S. society over the past several decades (Piketty & Saez, 2013; Putnam, 2015; Reardon, 2011b). One driver of the growth in income segregation between districts and schools is rising income inequality. The association between rising income inequality and rising income segregation between schools and school districts is consistent with past research showing the link between income inequality and residential income segregation (Owens, 2016; Reardon & Bischoff, 2011; Watson, 2009). In particular, our results are consistent with Owens's (2016) argument that concerns about schooling coupled with income inequality contribute to income segregation. Parents have become increasingly concerned about ensuring their children's success in a more competitive labor market, and as district and school information has become more readily available, parents can more easily make fine-grained distinctions to identify their preferred schools. Rising income inequality provides high-income families with the resources to realize this preference, resulting in increased sorting by income across districts, schools, and neighborhoods.

Our findings suggest that rising income inequality plays a role in economic school segregation, but other factors are also important. In particular, changes in education policies over time likely contribute to growing income segregation. First, while some school assignment policies now focus on parental income and education rather than race, such policies have been fairly weak and have produced little change in economic segregation patterns (Reardon & Rhodes, 2011). Stronger SES integration policies might have tempered the rise in income segregation documented here. Second, magnet and charter schools have proliferated over the past several decades, and while these schools often strive to provide integrated school environments, they can also provide a way for high-income parents to avoid their neighborhood school, especially as more information about schools' composition and test scores becomes available online and in local media. More research is required on how school choice policies affect segregation. Most school choice and assignment policies are at the district level, so changing these policies may only alter income segregation between schools rather than between districts. However, the existence of district-level policies may influence parents' residential and enrollment choices, so district-level policies may affect segregation between districts as well. Future research should continue to investigate factors accounting for the rise in income segregation between schools and districts, including the role of educational and housing policy.

Our research is limited by available data on students' family income, particularly at the school level. Currently, the only publicly available indicator of student SES is FLE status, and these data are not necessarily reliable indicators of student poverty. FLE counts may soon become a worse measure of school poverty rates: the Healthy, Hunger-Free Kids Act of 2010 introduced a community eligibility provision to the National School Lunch Program, allowing school districts and schools with high percentages of FLE students to enroll all students in the program, including students not individually eligible. Beginning in the 2014-15 school year, all schools in which 40% of students are identified as FLE via their participation in other social welfare programs (i.e., Supplemental Nutrition Assistance Program (SNAP) or Temporary Assistance for Needy Families (TANF)) can implement community eligibility (U.S. Department of Education, 2015). While this is an important step towards eradicating child hunger and will ease administrative burden, it will render counts of FLE students reported to CCD meaningless if 100% of students are considered FLE in some schools and districts. For researchers and policymakers to continue to document and understand economic inequalities in schools and districts, more reliable data collection is necessary, including more fine-grained measures of family income and other socioeconomic indicators (e.g., parental education).

Documenting economic inequalities is important, given recent evidence showing that the income achievement gap has grown. Income segregation may be an important cause of such educational disparities. Although the mechanisms linking segregation to student outcomes remain unclear (Reardon & Owens, 2014), past research suggests several hypotheses. First, districts comprised of more affluent students and parents usually have more social and economic resources than lower-income districts, potentially increasing the richer districts' relative achievement. Second, growing segregation between districts limits how diverse schools can be, as the student population in the district becomes more economically homogenous. School income segregation is about two-thirds as large as black-white segregation and approximately as large as Hispanic-white segregation, suggesting that income is an important (and growing) source of stratification for public school students. Third, high levels of income segregation may affect political support for public education. High-income families generally have more political influence than low-income families, and high-income families in highly segregated metropolitan areas have little incentive to advocate for increases in metropolitan- or state-wide school funding if their own high-income district has substantial resources. Future research should directly test whether the growth in income segregation documented here accounts for the growing income achievement gap. Overall, this article provides the first comprehensive evidence on patterns of income segregation between schools and school districts and tests one plausible potential cause. These analyses have important implications for both policymakers and for understanding the sources of economic inequality.

Endnotes

1. The SDDS collapses income data from the 2008-12 ACS from 16 income categories to 10. We also estimated segregation from 2006-10 SDDS data, where 16 categories were retained and where 3 of the 5 years of data are identical to 2008-12, and estimates are nearly identical.
2. Note that the SDDS data are at the family level, as child-level data are not available after 2000.
3. The 1970 School District Geographic Reference File provides the percent of the tract or enumeration district (ED) population within district boundaries. Seventy-six percent of tracts or EDs exist entirely within one district. For the remaining 24%, we multiply the income counts for the tract/ED by the proportion population in the district to aggregate to the district level. Maryland is omitted from 1970 data, so we are missing data from the Baltimore and Bethesda MSAs.
4. We describe the technical details of calculating the information theory income segregation index in Appendix A.
5. To see this, note that measures of segregation like H can be thought of as measures of the proportion of variation in income that lies between districts. However, because income is measured noisily, measures like H will be attenuated. The attenuation will be proportional to the reliability of the income measure. Estimates of the reliability of self-reported annual income as a measure of true annual income range from 0.7 to 0.9; estimates of its reliability as a measure of permanent income are roughly 0.5 (Marquis, Marquis, & Polich, 1986; Mazumder, 2001). If we take a value of 0.8 as the reliability of income, then we can get a corrected estimate of income segregation in 2010 as $H \approx 0.089/0.8 \approx 0.11$ (a reliability of 0.5 would imply $H \approx 0.089/0.5 \approx 0.18$). Using a different method, Dickens (2003) found that estimates of income segregation should be inflated by 15-30% to adjust for measurement error, which implies a reliability of 0.75-0.85.

6. We estimated the proportion of families with children with incomes below 130% of the family-size specific poverty threshold using March Current Population Survey data in 1990, 2000, and 2010 (King et al., 2010). About 20% of families were FLE in each year.
7. The SDDS does provide student-level data in 1990 and 2000, and these estimates of FLE-non-FLE segregation are slightly higher than the SDDS estimates of FLE family segregation, but still lower than CCD estimates of FLE student segregation.
8. Prior to 1998, CCD only asked school to report counts of free lunch eligible students; beginning in 1998, schools were asked to also (separately) report counts of reduced-price lunch eligible students. We consider the pre- and post-1998 data separately in case schools erroneously reported both free and reduced-price lunch eligible students prior to 1998 or conflated free versus reduced-price lunch eligible students after 1998.

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Fig. 1 Average Between-District Income Segregation of Families with Children Enrolled in Public School and All Families within the 95 Largest Metropolitan Areas with Multiple Districts

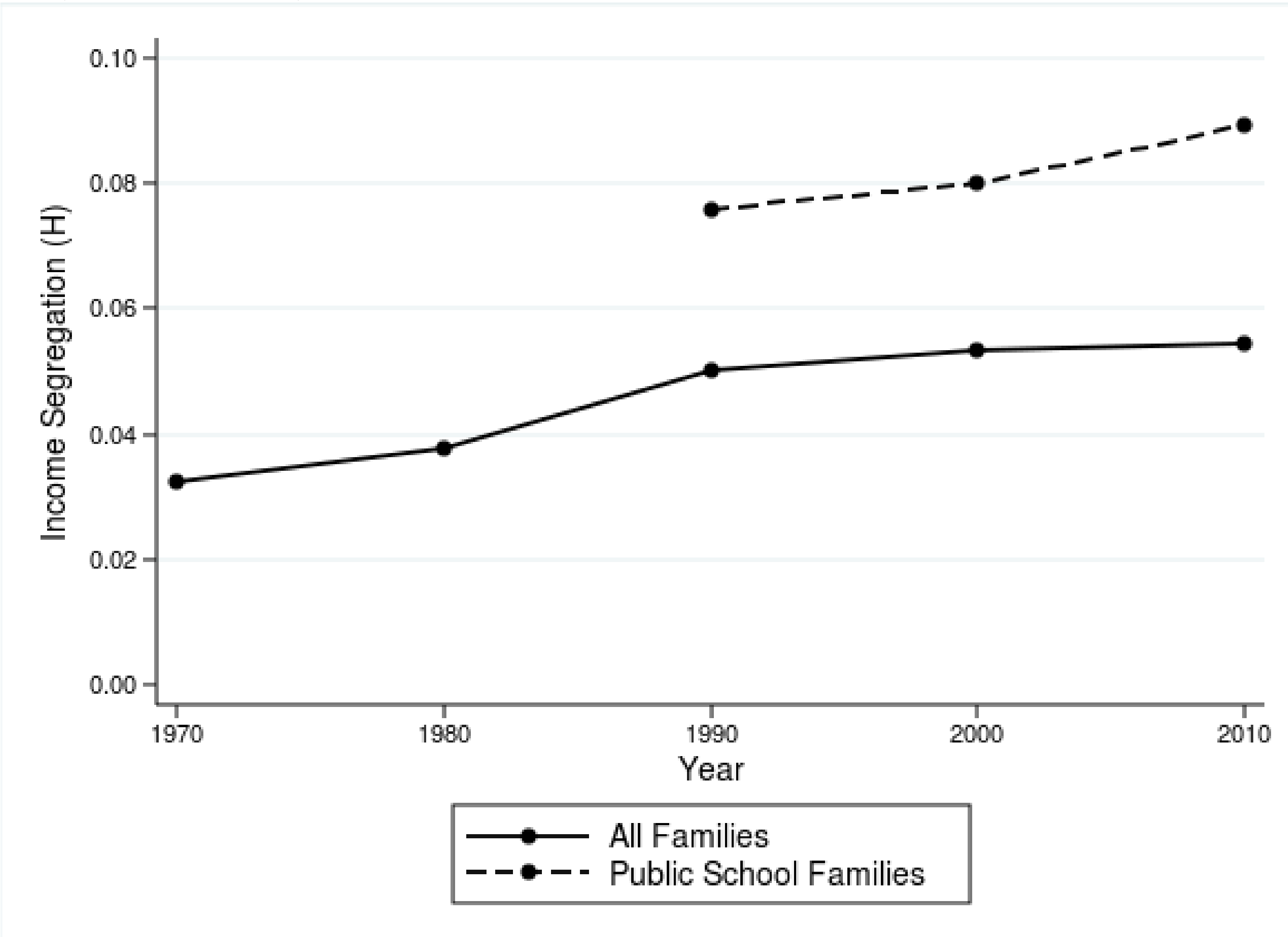


Fig. 2 Between-District Income Segregation of Families with Children Enrolled in Public Schools by Income Percentile within the 95 Largest Metropolitan Areas with Multiple Districts, 1990 to 2010

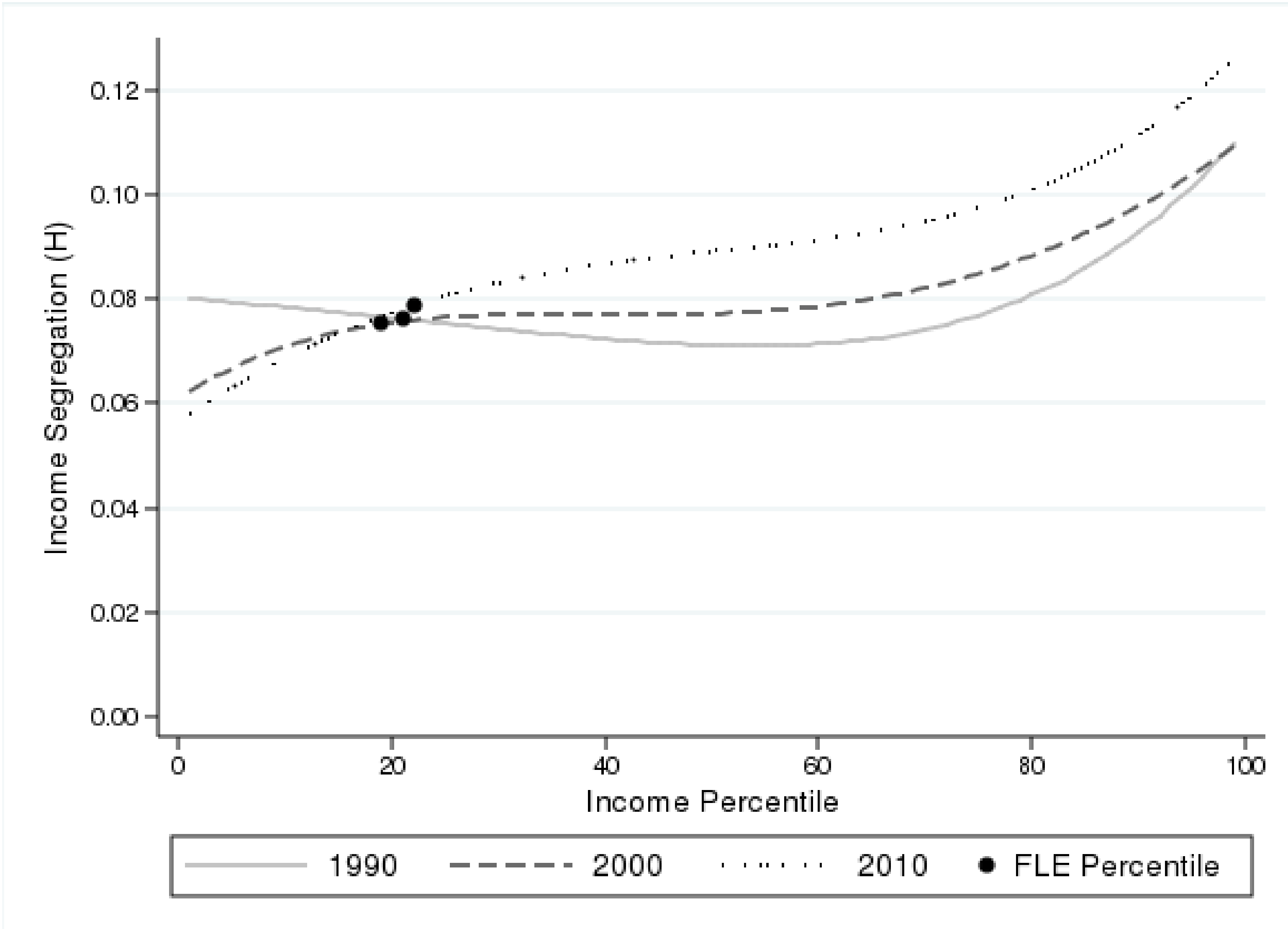


Fig. 3 Average Between-School Segregation (Free-Lunch Eligible to non-Eligible) within the 100 Largest Metropolitan Areas, 1991 to 2012

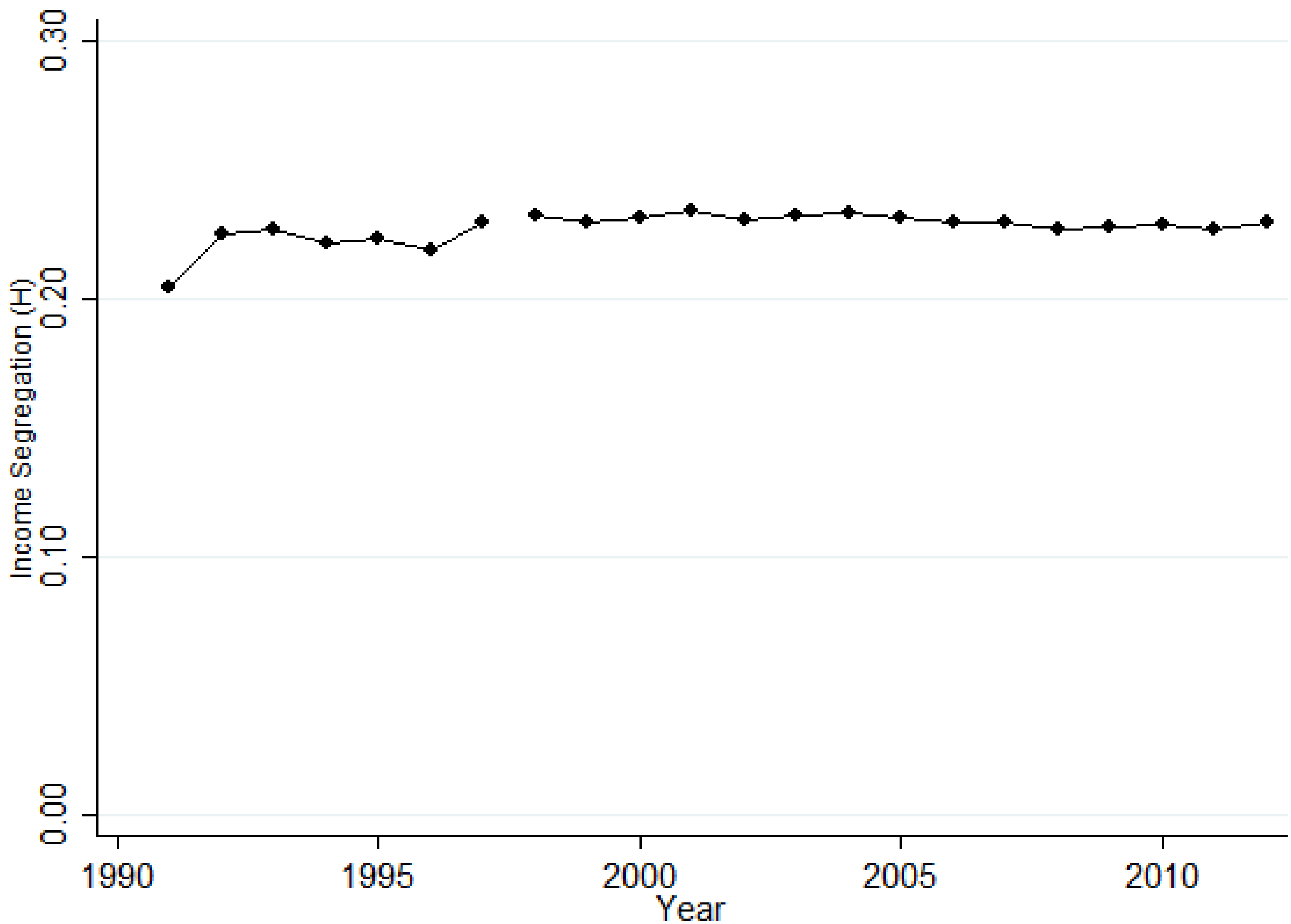


Fig. 4 Average Between-School Segregation (Free-Lunch Eligible to non-Eligible) within the 100 Largest School Districts, 1991 to 2012

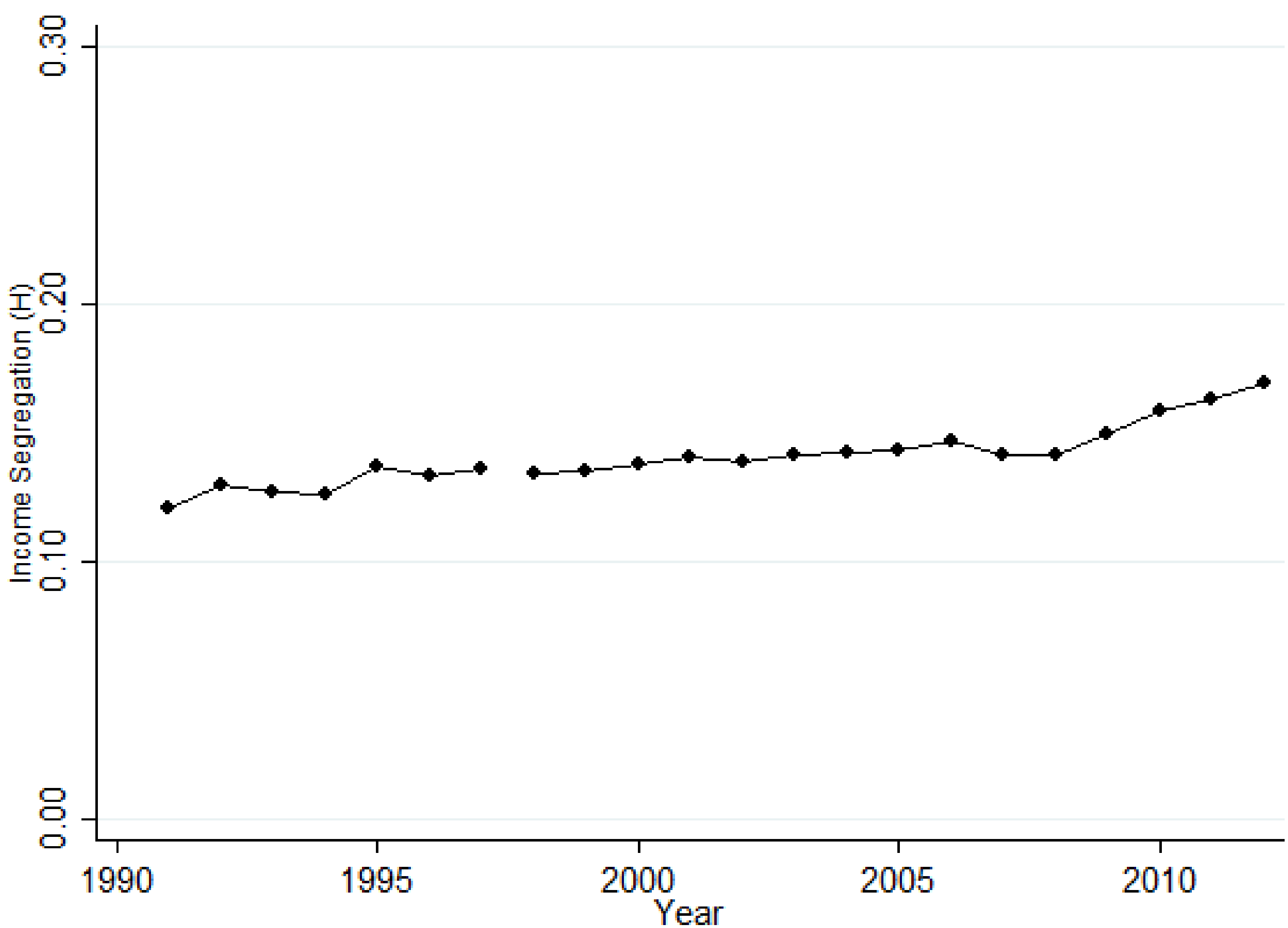


Table 1. Mean and Standard Deviation of Between-District and Between-School Income Segregation within 100 Largest Metropolitan Areas or School Districts

	1970	1980	1990	2000	2010
Between-District Segregation					
Full Income Segregation					
Families with Children in Public School	--	--	0.076	0.080	0.089
			(0.046)	(0.046)	(0.050)
All Families	0.032	0.038	0.050	0.053	0.054
	(0.019)	(0.022)	(0.029)	(0.029)	(0.031)
FLE-non FLE Segregation					
Families with Children in Public School (SDDS)	--	--	0.076	0.075	0.079
			(0.051)	(0.048)	(0.048)
			1991	2000	2012
Public School Students (CCD)			0.137	0.163	0.157
			(0.082)	(0.099)	(0.089)
Between-School Segregation					
FLE-non FLE Segregation					
Within 100 Largest Metropolitan Areas			0.205	0.232	0.230
			(0.078)	(0.088)	(0.079)
Within 100 Largest Districts			0.121	0.138	0.170
			(0.074)	(0.077)	(0.100)
Within Districts with 3-5 Schools			0.027	0.026	0.023
			(0.042)	(0.047)	(0.043)
Within Districts with 6-10 Schools			0.045	0.046	0.046
			(0.054)	(0.060)	(0.069)
Within Districts with 11-20 Schools			0.075	0.081	0.088
			(0.062)	(0.067)	(0.082)
Within Districts with 21+ Schools			0.111	0.125	0.155
			(0.072)	(0.077)	(0.109)

Notes:

1. Cells present mean segregation (*H*) with standard deviations in parentheses.
2. For SDDS analyses, 2010 estimates come from the pooled 2008-12 ACS.
3. Between-district segregation is estimated within the 95 largest MSAs with more than one district.

Table 2. Percent Change in Income Segregation in the 100 Largest Metropolitan Areas or School Districts, 1990/1991 to 2010/2012

Level of Segregation	Population	Full Income Distribution		FLE-non FLE	
		Percent Change	SD Change	Percent Change	SD Change
Between-District	Families with Children in Public School (SDDS)	17.1%	0.283	3.9%	0.059
	Public School Students (CCD)	--	--	14.4%	0.240
	All Families (SDDS)	8%	0.138	--	--
Between-School	Public School Students, 100 Largest Metros (CCD)	--	--	12.2%	0.320
	Public School Students, 100 Largest Districts (CCD)	--	--	40.7%	0.663

Notes:

1. Data sources identified in parentheses. SDDS=School District Demographic System; CCD = Common Core of Data
2. Trends in SDDS data compare 1990 to 2008-12; trends in CCD data compare 1991 to 2012.
3. Cells present the percent change or the SD change in terms of 1990 (1991) SD in segregation (*H*) for each level of segregation, population, and income classification
4. Between-district segregation is estimated within the 95 largest MSAs with more than one district.
5. The level of segregation in 2010/2012 is statistically significantly higher than in 1990/1991 for all levels and populations.

Table 3. Panel Regression Model Predicting Income Segregation among Public School Families between Districts in the 95 Largest Metropolitan Areas with Multiple Districts, 1990 to 2010

	Model 1	Model 2	Model 3
Year = 2000	0.004**	0.0003	-0.006
	(0.001)	(0.002)	(0.005)
Year = 2010	0.013***	0.006*	0.016^
	(0.001)	(0.003)	(0.009)
Income Inequality, Public School Families		0.212**	0.297**
		(0.074)	(0.114)
Proportion non-Hispanic White			-0.016^
			(0.009)
Proportion non-Hispanic Black			-0.004
			(0.016)
Proportion Hispanic			-0.077*
			(0.031)
Proportion with at least a BA			-0.009
			(0.055)
Proportion with less than HS Degree			0.036
			(0.043)
Unemployment Rate			-0.423***
			(0.100)
Proportion employed in Manufacturing			-0.096^
			(0.055)
Proportion housing units build in past decade			-0.062**
			(0.020)
Proportion Female-headed Households			-0.065
			(0.065)
Proportion of students in private school			0.019
			(0.045)
Poverty Rate			0.108
			(0.087)
Intercept	0.076	-0.006	0.024

Notes: ^p≤.10; *p≤.05; **p≤.01; ***p≤.001. All significance tests are two-tailed.

N=295 (95 MSAs with multiple districts x 3 years (1990, 2000, 2010)). All control variables measure characteristics of public school children or parents/households of public school children except housing units built in last decade (which includes all housing units). Racial composition comes from CCD. All other controls come from SDDS in 1990, 2000, and 2006-10 or 2008-12 (parents' education, employment, and industry are only available in 2006-10). All models include MSA fixed effects. Cells present coefficients with standard errors beneath in parentheses.

Table 4. Panel Regression Model Predicting Income Segregation among Public School Students between Schools in the 100 Largest Districts, 1991 to 2010

	Model 1	Model 2	Model 3
Year = 2000	0.017**	0.006	0.001
	(0.006)	(0.007)	(0.014)
Year = 2010	0.038***	0.017^	-0.001
	(0.006)	(0.009)	(0.026)
Income Inequality, Public School Families		0.579**	0.617*
		(0.200)	(0.290)
Proportion non-Hispanic White			-0.007
			(0.025)
Proportion non-Hispanic Black			0.022
			(0.036)
Proportion Hispanic			0.058
			(0.099)
Proportion with at least a BA			0.110
			(0.152)
Proportion Less than HS Degree			-0.027
			(0.132)
Unemployment Rate			-0.128
			(0.348)
Proportion employed in Manufacturing			-0.183
			(0.182)
Proportion housing units build in past decade			0.077
			(0.060)
Proportion Female-headed Households			-0.202
			(0.181)
Proportion of students in private school			0.059
			(0.195)
Poverty Rate			0.013
			(0.186)
Intercept	0.121	-0.100	-0.093

Notes: ^p≤.10; *p≤.05; **p≤.01; ***p≤.001. All significance tests are two-tailed.

N=293 (N=100 in 2000 and 2010; 93 in 1991 due to missing SDDS data). All control variables estimate characteristics of public school children or parents/households of public school children except housing units built in last decade (which includes all housing units). Racial composition comes from CCD. All other controls come from SDDS in 1990, 2000, and 2006-10 or 2008-12 (parents' education, employment, and industry are only available in 2006-10). All models include district fixed effects. Cells present coefficients with standard errors beneath in parentheses.

Appendix A: Data and Measurement

School District Demographic System

Data on family income at the school district level in 1970 were assembled by linking the School District Geographic Reference File, 1969-1970, to Census data. The School District Geographic Reference File (U.S. Department of Commerce, 1970) identifies tracts and Enumeration Districts (EDs) within district boundaries for every district in the U.S. (except in Maryland) with enrollments of 300 or more students (about 12,000 districts); districts with enrollments of 300 or less in the Elementary & Secondary Education General Information Survey (ELSEGIS) sample; and all school districts in IL, KS, and NY. The data include a variable indicating the percent of the tract or ED within district boundaries. We obtained family income counts in 15 categories for census tracts from the 1970 Census (through the Neighborhood Change Database produced by Geolytics). We obtained family income counts in 15 categories for EDs (in areas that were untracted) through ICPSR Study 0964 (Adams, 2007). To obtain district-level counts of families in income categories, we multiplied the counts by the percent of the tract or ED in the district and then summed the counts to the district level. School district data in 1980 come from the Census of Population and Housing, 1980: Summary Tape File 3F, School Districts. This file includes family income data in 17 categories already aggregated to the district level, so untracted areas are accounted for. Data are missing for the metropolitan area of Fairbanks, AK.

In 1990, several counties in CA did not participate in the Census Mapping Project which provides school district boundaries CA estimates for 1990 do not include Tehama, Madera, Humboldt, El Dorado, San Francisco, San Benito, Napa, Monterey, and Del Norte counties. Estimates excluding CA altogether in all years are nearly identical to estimates reported here, so the rest of CA was retained in analyses.

Measuring Segregation with the Rank-Order Information Theory Index

To measure income segregation, we use the *rank-order information theory index* (Reardon, 2011a), which measures the ratio of within-unit (school or school district) income rank variation to overall (district or metropolitan area) income rank variation. For any given value of p, we can dichotomize the income distribution at p and compute the pairwise segregation between those with income ranks less than p and those with income ranks greater than or equal to p. Let $H(p)$ denote the value of the traditional information theory index of segregation computed between the two groups so defined (Theil & Finezza, 1971; Theil, 1972; Zoloth, 1976). Likewise, let $E(p)$ denote the entropy of the population when divided into these two groups (Theil & Finezza, 1971; Theil, 1972). That is,

$$E(p) = p\log_2 \frac{1}{p} + (1-p)\log_2 \frac{1}{(1-p)}$$

and

$$H(p) = 1 - \sum_j \frac{t_j E_j(p)}{TE(p)},$$

where T is the population of the district or metropolitan area and t_j is the population of school or district j. Then the rank-order information theory index (H^R) can be written as

$$H^R = 2\ln(2)\int_0^1 \mathrm{E}(p)H(p)dp$$

Thus, if we computed the segregation between those families above and below each point in the income distribution and averaged these segregation values, weighting the segregation between families with above-median income and below-median income the most, we get the rank-order information theory index. The rank-order information theory index ranges from a minimum of 0, obtained in the case of no income segregation (when the income distribution in each local environment (e.g. school district) mirrors that of the region as a whole), to a maximum of 1, obtained in the case of complete income segregation (when there is no income variation in any local environment). A more thorough explanation of this technique (and its rationale) is provided elsewhere (Reardon & Bischoff, 2011; Reardon, 2011a).

Appendix B: Estimates of Free-Lunch Eligibility Rates and Enrollment in the National School Lunch Program

In the following figures, we report estimates of FLE rates and counts of students receiving free lunch in schools. The data come from several sources:

Measures from the annual March Current Population Survey (CPS):

- Total number of children ages 6-18
- Total number of children ages 6-18 eligible for free lunch (family income is 130% or less of the poverty line) [includes children in private schools and dropouts]
- Total number of children ages 6-18 eligible for reduced priced lunch (family income is 130-185% of poverty line) [includes children in private schools and dropouts]

Measures from National School Lunch Program Website:

http://www.fns.usda.gov/pd/child-nutrition-tables

- Number of students receiving free lunches (daily average of number of lunches served) [includes children in private schools]

Measures from Common Core of Data:

- Total number of students attending public schools in the U.S.
- Total reported number of students receiving free lunches in public schools in the U.S. (adjusted to account for missing data, by assuming that the rate of FLE among those with missing FLE status is the same as the rate among those for whom FLE is reported)

Of particular interest are the numbers/proportions of students eligible for free lunch (based on CPS), the numbers/proportions of students receiving free lunch (as reported by NSLP), and the numbers/proportions of students receiving free lunch (as reported in the CCD). Figure B1 shows the proportion of children eligible for free and reduced-price lunch and the proportion of children in poverty since 1980. The proportion of children eligible for free price and reduced price lunch tracks fairly closely with the proportion of children in poverty. Note that FLE rates declined from 1984-1990, and again from

1994-2001, and rose in the intervening periods. CPS data indicate rates of eligibility have ranged from 23-30% over the last 30 years.

[Figure B1 about here]

Figure B2 presents the trend in the number of FLE children according to the CPS (solid black line), the number of students receiving free lunch according to the NSLP (solid gray line), and the estimated number of FLE students based on CCD data (dotted grey line).

[Figure B2 about here]

Figure B3 shows the same trends in terms of proportion of children rather than raw number. Note that in Figure B2 and B3, CCD estimates of FLE students are much higher (as much as 30% higher in recent years) than CPS estimates of eligible children. CCD rates are also roughly 10 percentage points higher than the numbers implied by NSLP data, though the trend is similar. Both estimates of the number of children receiving free lunches (from CCD and NSLP) show more increase since 1990 than the increase in eligibility rates implied by CPS data.

[Figure B3 about here]

If the CCD inflates counts of FLE students more in schools where there are more "true" FLE students, segregation estimates will be inflated. We compared district-level counts of FLE students from CCD and from SDDS. Figure B4 presents the percent of FLE students, according to the CCD data, in a school district on the y-axis and the percent of public school students whose family income is below 130% of the poverty line, according to SDDS data, on the x-axis. The black line is a lowess line fitted to the data, suggesting that the proportion of FLE students in the CCD data is increasingly inflated as the proportion of "true" FLE eligible students rises, peaking at about 0.5. This inflation increases over time from 1990 to 2009 (not shown), suggesting that the positive trend in segregation could be an artifact of the data. Unfortunately, we have no other comprehensive national longitudinal data source on students' income at the school or district level.

[Figure B4 about here]

Fig. B1

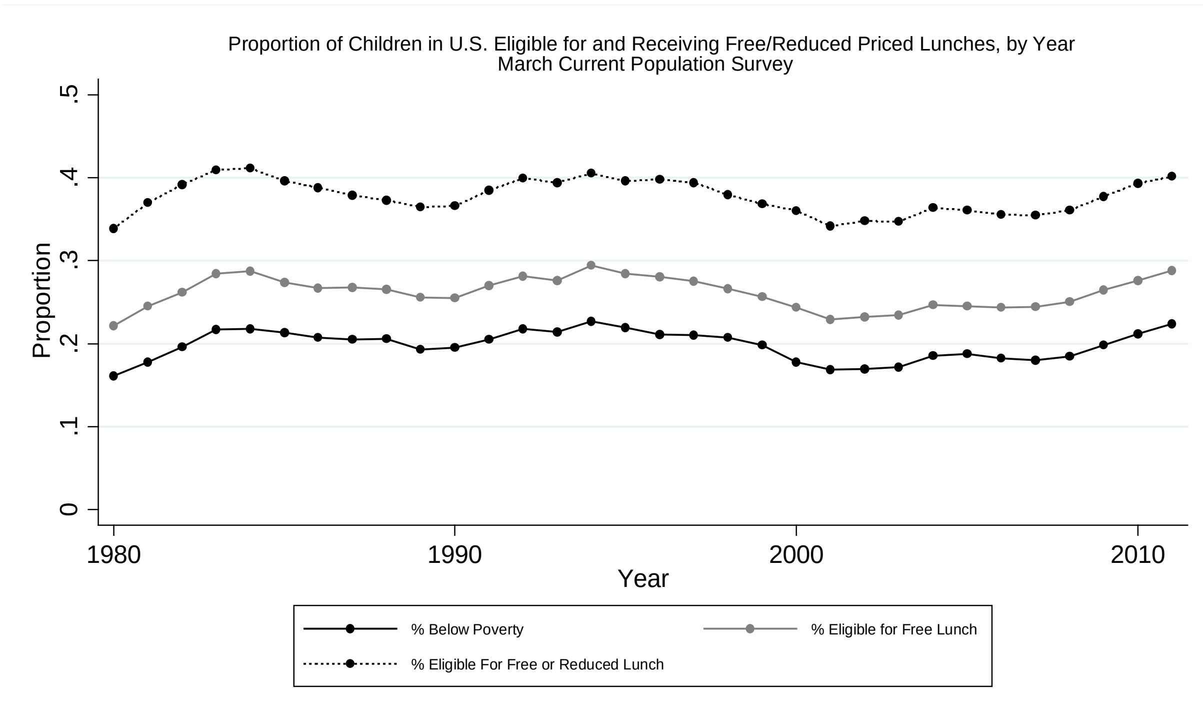
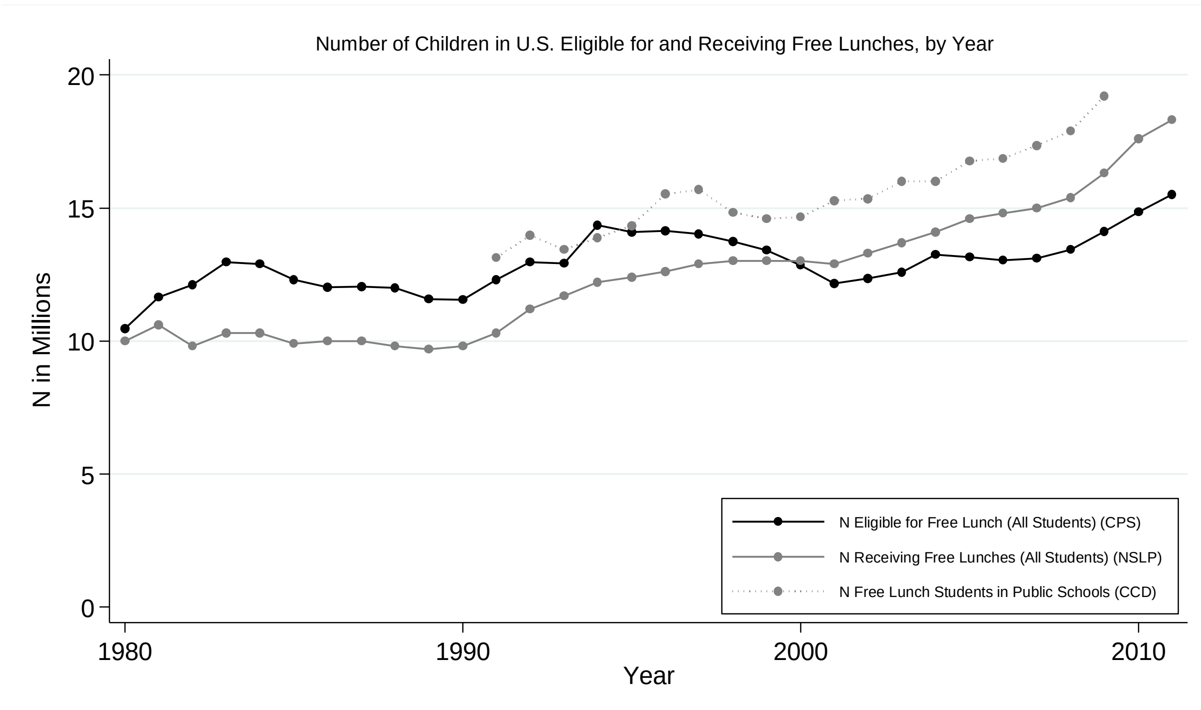


Fig. B2



Number of Children in U.S. Eligible for and Receiving Free Lunches, by Year
N in Millions
20
15
10
5
0
1980
1990
2000
2010
Year
N Eligible for Free Lunch (All Students) (CPS)
N Receiving Free Lunches (All Students) (NSLP)
N Free Lunch Students in Public Schools (CCD)

Fig. B3

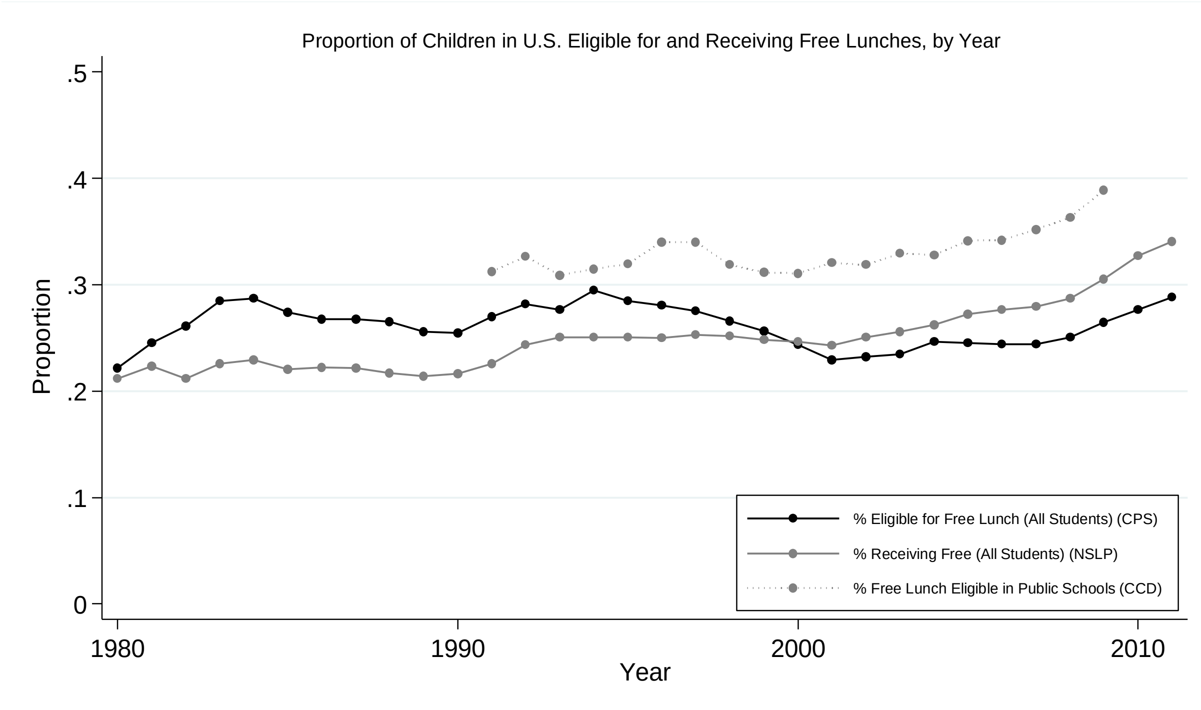
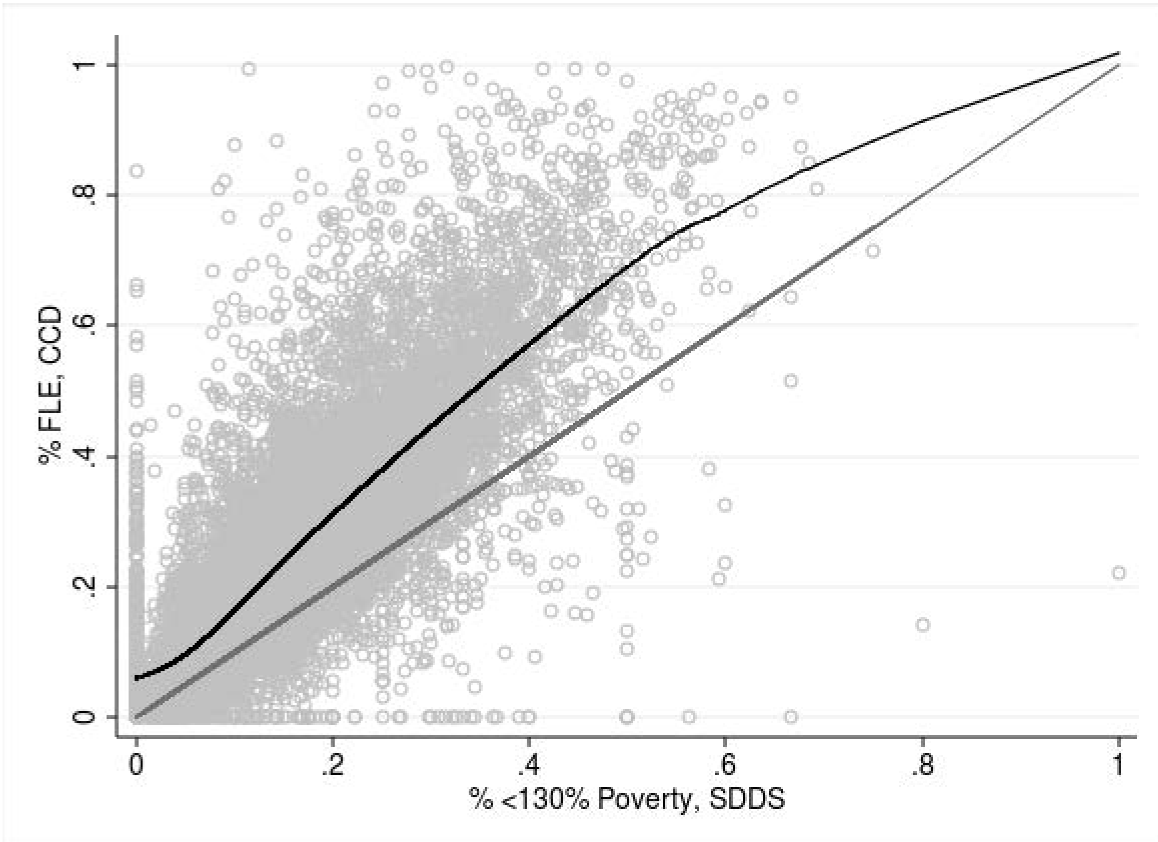

Proportion of Children in U.S. Eligible for and Receiving Free Lunches, by Year
Proportion
.5
.4
.3
.2
.1
0
1980
1990
2000
2010
Year
% Eligible for Free Lunch (All Students) (CPS)
% Receiving Free (All Students) (NSLP)
% Free Lunch Eligible in Public Schools (CCD)

Fig. B4 Relationship between FLE students in SDDS and CCD in All School Districts, 2000



Notes: Each dot represents a school district. The black line is a lowess smoothed line and the gray line is a 45 degree reference line.

Appendix Table 1. Mean Values for Independent Variables in Multivariate Models

	MSA Level			District Level		
	1990	2000	2010	1990	2000	2010
Gini Index	0.386	0.404	0.420	0.381	0.400	0.417
Proportion non-Hispanic White	0.638	0.584	0.523	0.483	0.441	0.342
Proportion non-Hispanic Black	0.160	0.177	0.169	0.196	0.236	0.240
Proportion Hispanic	0.119	0.157	0.219	0.149	0.217	0.310
Proportion with at least a BA	0.214	0.258	0.305	0.218	0.248	0.282
Proportion Less than HS Degree	0.181	0.154	0.126	0.199	0.194	0.169
Unemployment Rate	0.052	0.040	0.062	0.053	0.046	0.069
Proportion employed in Manufacturing	0.170	0.134	0.106	0.134	0.103	0.084
Proportion housing units build in past decade	0.213	0.170	0.280	0.295	0.209	0.332
Proportion Female-headed Households	0.230	0.249	0.284	0.252	0.273	0.314
Proportion of students in private school	0.144	0.137	0.133	0.135	0.140	0.129
Poverty rate	0.144	0.131	0.168	0.153	0.148	0.197

Appendix Table 2. Multilevel Model predicting Between-District Income Segregation at Income Deciles among Public School Families in the 95 Largest MSAs with Multiple Districts, 1990 to 2010

	Income Inequality Coefficient
10th Percentile	-0.088
	(0.145)
20th Percentile	0.061
	(0.141)
30th Percentile	0.184
	(0.137)
40th Percentile	0.280*
	(0.133)
50th Percentile	0.353**
	(0.131)
60th Percentile	0.405**
	(0.130)
70th Percentile	0.439***
	(0.132)
80th Percentile	0.463***
	(0.138)
90th Percentile	0.482**
	(0.156)

Notes: Coefficients come from model identical to Table 3, Model 3.

Appendix Table 3. Rates of Missing CCD Data

	Schools in 100 Largest Metros	Schools in 100 Largest Districts	Schools in 100 Largest Metros, Weighted by Enrollment	Schools in 100 Largest Districts, Weighted by Enrollment
1991	0.45	0.39	0.41	0.37
1992	0.41	0.37	0.38	0.36
1993	0.32	0.30	0.29	0.29
1994	0.32	0.30	0.28	0.28
1995	0.32	0.30	0.28	0.28
1996	0.33	0.20	0.24	0.16
1997	0.28	0.20	0.23	0.16
1998	0.26	0.20	0.21	0.16
1999	0.24	0.18	0.18	0.13
2000	0.23	0.17	0.18	0.13
2001	0.22	0.15	0.16	0.10
2002	0.25	0.23	0.18	0.19
2003	0.26	0.23	0.19	0.18
2004	0.23	0.18	0.16	0.12
2005	0.17	0.18	0.10	0.11
2006	0.16	0.14	0.08	0.08
2007	0.20	0.16	0.12	0.08
2008	0.14	0.12	0.07	0.05
2009	0.16	0.11	0.10	0.04
2010	0.13	0.10	0.06	0.04
2011	0.25	0.22	0.21	0.16
2012	0.13	0.11	0.07	0.05

Notes: The columns weighted by enrollment can be interpreted as the proportion of students for whom we are data on missing FLE status.