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School Segregation, Teacher Sorting, and the Distribution of Teachers

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Abstract

The distribution of teaching effectiveness across schools is fundamental to understanding how schools can address disparities in educational outcomes. Research and policy have recognized the importance of teaching effectiveness for decades. Five stylized facts predict that teachers should be differentially allocated across schools such that poor, Black and Hispanic students are taught by less qualified and less effective teachers. Yet, research is unclear whether these predictions have empirical support. Our purpose is to better understand whether there are meaningful differences in teacher effectiveness among schools. We find that poor, Black and Hispanic students are more likely to be taught by novice teachers when they live in more segregated MSAs. Moreover, the geographic nature of segregation varies across MSAs. Differentiating segregation within urban districts and segregation between urban districts and outlying districts in the same MSAs is essential to understanding poor students' exposure to novice teachers and policies that address these disparities. We find that poor, Black and Hispanic students are 50 percent more likely to be exposed to at least one novice teacher during elementary school compared to their more affluent white peers. These results raise questions regarding the enforcement of ESSA's requirements on the distribution of teacher qualifications and quality.

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School Segregation, Teacher Sorting, and the Distribution of Teachers

Until recently, accounts that poor, nonwhite students received less effective teaching have sparked moments of outrage but little policy response. However, as the importance and variability of teaching quality became better documented, the distribution of teaching quality has received more attention, culminating in state mandates as part of the Every Student Succeeds Act (ESSA) to identify and address uneven distributions of teaching quality and qualifications. Yet, despite this attention, the extent to which poor, nonwhite students are taught by differentially less effective teachers than their more affluent, white peers remains poorly understood.

Beginning in the 1970s, descriptive evidence documented meaningful differences in the qualifications of teachers within and across school districts. These descriptive analyses, as well as a simple teacher labor market model, suggest a maldistribution of teaching quality that disadvantages poor and nonwhite students. Jackson (2009) provides causal evidence linking student race to the distribution of teachers. Yet, recent research finds that, when measured directly, differences in teaching effectiveness between typical poor and nonpoor students, or typical white and nonwhite students, are modest (see, for example, Goldhaber, Quince & Theobald, 2018) or negligible (Isenberg, Max, Gleason & Deutsch, 2022).

To better understand this empirical literature, we summarize five stylized facts[1] related to the distribution of teachers: 1) school districts prefer to hire more effective, and in the absence of effectiveness measures, more qualified teachers; 2) teachers prefer to teach in schools with better leadership, effective peers, higher compensation, more resources and better prepared and engaged students; 3) school attributes are correlated with the economic standing and race of students; 4) schools in U.S. metropolitan areas are economically and racially segregated; and 5) teachers sort to schools with lower concentrations of poor, Black and Hispanic students. On this foundation we explore whether and how school segregation differs across metropolitan statistical areas (MSAs) in ways that may influence teacher sorting, whether teacher sorting conforms to these expectations, and how this influences the distribution of teacher quality and qualifications[2] among schools.

We find that poor, Black and Hispanic students are more likely to be taught by novice teachers when they live in more segregated MSAs. Moreover, the nature of segregation varies geographically across MSAs and can by classified by contrasting levels of segregation between schools in the MSA's urban district and those in the same MSA's outlying districts (versus between schools within the urban district), or whether substantial segregation exists both within the urban district and between the urban and outlying districts within an MSA. Differentiating

[1] Staiger and Rockoff (2010) employ a similar structure to summarize the large literature on teacher effectiveness to explore implications for teacher hiring.

[2] Teacher qualifications are measures of the skills and experiences of teachers which may be inputs to producing greater learning in students. Teacher effectiveness is the teacher's contribution to student learning. Several commonly employed teacher qualifications are only weakly correlated with teacher effectiveness; others, e.g., early-career teaching experience, have been shown to meaningfully improve teacher effectiveness. However, there is substantial controversy over the measurement of teacher effectiveness generally but especially across schools with substantial differences in the racial and economic attributes of students. For a variety of reasons, policies often employ measures of teacher qualifications as signals of teacher quality.

"within" and "between" segregation is essential to understanding the extent to which poor students, Black and Hispanic students are exposed to novice teachers and to develop policies that address these disparities. We find that poor, Black and Hispanic students are 50 percent more likely to be exposed to at least one novice teacher during elementary school compared to their more affluent white peers. These results raise troubling questions for both federal and state policymakers given ESSA requirements for teachers: "Each state plan shall describe how low-income and minority children enrolled in schools assisted under this part [of ESSA] are not served at disproportionate rates by ineffective, out-of-field, or inexperienced teachers, and the measures the State educational agency will use to evaluate and publicly report the progress of the State educational agency with respect to such description…" (ESSA, 1111 (g)(1)(B), 2015).

Five Stylized Facts Relevant for Teacher Sorting

Institutional features of teacher labor markets and empirical regularities, or stylized facts, imply that teachers may be sorted among schools such that schools with concentrations of poor, Black or Hispanic students will receive less effective teaching. We summarize existing research through five generally accepted stylized facts which describe the organization of schools and the allocation of resources, including teachers, to these schools. Like most empirical regularities, there are exceptions, but the preponderance of evidence conforms to the stylized facts.

1. School districts prefer to hire more effective, and in the absence of effectiveness measures, more qualified teachers

School leaders employ the available evidence to identify and hire teachers who they perceive will be successful in improving student outcomes. Teaching quality is a complex and imprecise concept based on individual performance and contributions to school performance. In practice, teaching quality is usually measured by three conceptually different constructs: a) teacher qualifications, e.g., paper credentials, interviews, or prior experience; b) practice-based measures of performance, e.g., standardized classroom observations; and c) measures of teachers' contribution to student outcomes, e.g., teacher value added or, as a proxy, early career teaching experience. The information regarding teacher effectiveness available to school leaders during the hiring process is often limited and as a result hiring is imperfectly related to effectiveness (Rockoff, Jacob, Kane, & Staiger, 2011). Several studies find that employers hire teachers who have stronger academic credentials, have prior teaching experience and score more highly on licensing exams (Boyd et al., 2011b, 2013; Giersch & Dong, 2018; Goldhaber Grout, Huntington-Klein, 2017; Lankford, Loeb, McEachin, Miller & Wyckoff, 2014).[3] With the exception of prior teaching experience, many individual teacher qualifications are only weakly related to teaching effectiveness, but taken as a group they are moderately predictive of teacher value added (Boyd et al., 2008; Jacob, Rockoff, Taylor, Lindy & Rosen, 2017; Staiger & Rockoff, 2010). Prior teaching experience is often valued by employers. Applicants with prior teaching experience are more likely to be hired, with larger differences in teachers' early careers (Giersch & Dong, 2018; Jacob et al., 2017; Simon, Johnson and Reinhorn, 2019).

[3] Employing data from the last 1970s and 1980s, Ballou (1996) finds that prior academic credentials have little bearing on whether an applicant receives an offer to teach.

2. Teachers prefer to teach in schools with better leadership, effective peers, higher compensation, more resources and better prepared and engaged students

A large literature documents teachers' preferences for working conditions.[4] Working conditions encompass a variety of job attributes, including the quality of school leadership, support from peers, the quality of professional development, staff support for students, the physical structure, resources and materials, and the motivation and engagement of students. Evidence from observational studies, exit surveys, conjoint analyses, experiments and meta-analyses finds that teachers value effective and supportive school leaders (Boyd et. al., 2011a; Johnson et al., 2012; Kraft, Marinell & Yee, 2016; Ladd, 2011; Viano et al., 2021), peers (Jackson & Bruegmann, 2009; Johnson et al., 2012; Kraft, Marinell & Yee, 2016; Papay, Taylor, Tyler, and Laski, 2016), student behavior (Viano et al., 2021), school culture (Johnson et al., 2012) and compensation (Biasi, 2021; Borman and Dowling, 2008; Hoxby & Leigh, 2004; Stinebrickner, 2001).

3. School attributes are correlated with the economic standing and race of the students

Several attributes and processes in schools may contribute to differences in the quality and qualifications of teachers employed by schools. Empirically, school attributes valued by teachers are systematically worse in schools with higher concentrations of poor, Black and Hispanic students (Johnson, Kraft & Papay, 2012; Boyd et al., 2011a, 2011b).[5]

In addition, administrative processes that influence the distribution of teachers often work to the disadvantage of schools with concentrations of poor, Black and Hispanic students. For example, late hiring is more likely occur in these schools (Engel, 2012; Levin, 1985; Levin & Quinn, 2003) and late hiring typically results in hiring less effective and qualified teachers (Jacob, 2007; Papay & Kraft, 2016). In addition, in districts where hiring occurs completely or in part at the central level, scholars have argued that schools with greater political influence, e.g., more engaged parents, can receive a favorable allocation of resources and/or teachers (Krei, 1998; Roza, 2008).

In general, compensation for teachers in schools with disproportionate concentrations of Black and Hispanic or poor students is typically no worse and often slightly better than compensation in other schools. However, other working conditions tend to be worse and, in many cases, much worse, with the net effect that slightly better compensation is insufficient to offset the effects of other working conditions (Jacob, 2007; Ingersoll & Perda, 2009, 2010).

Finally, the evidence on teacher preferences over the race and economic status of their students is unclear. Some research finds teacher decisions about where to work are correlated with the concentration of poor and nonwhite students (Allen, Burgess & Mayo, 2018; Borman & Dowling, 2008; Boyd, Lankford, Loeb, & Wyckoff, 2005; Clotfelter, Ladd, & Vigdor, 2005, 2011; Jackson, 2009; Kalogrides, Loeb, & Bèteille, 2013; Sass et al., 2012) but other research suggests it is not these factors per se, but other student attributes correlated with race and economic status, such as perceptions of student behavior or student preparation (Boyd,

[4] For a review of much of this literature see, Boyd et al., 2011b; Hanushek and Rivkin, 2007; Johnston, 2021.
[5] For summary, see, for example, Simon & Johnson (2015) or James & Wyckoff (2020).

Grossman, Ing, Lankford, & Wyckoff, 2011; Johnson, et al., 2012; Loeb, Darling-Hammond, & Luczak, 2005).

Whether these relationships are causal or correlational, they imply that poor, Black and Hispanic students attend schools that make it more likely they will be exposed to less effective and less qualified teachers.

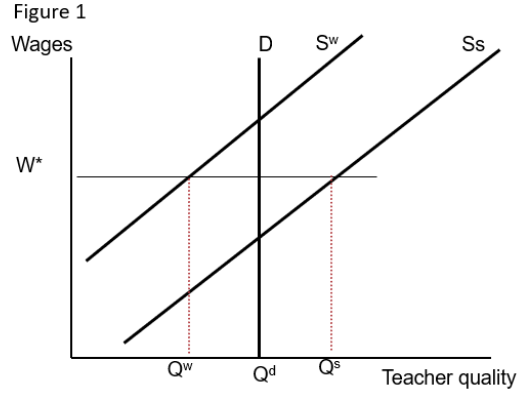
4. Schools in U.S. metropolitan areas are economically and racially and segregated

It is well documented that U.S. public schools remain racially and economically segregated. School segregation results from a variety of de jure and de facto influences, many of which are rooted in policies and practices that link school attendance to residential neighborhood and which preclude or limit the residential location of Black, Hispanic and low-income households (Rothstein, 2019). School segregation has varied over the last 50 years (Boozer, Krueger & Wolkon, 1992; Orfield, 1983; Reardon, Yun, & Eitle, 2000; Reardon, Weathers, Fahle, Jang & Kalogrides, 2021) and across regions (Clotfelter, 1999; Reardon & Owens, 2014), but remains persistent in most areas of the country. Segregation is particularly prevalent in many metropolitan areas (Clotfelter, 1999; Massey & Denton, 1988; Owens, 2020; Reardon et al., 2008). An important component of the school segregation literature describes the racial and economic segregation of schools and its implications for educational opportunity (Bischoff & Owens, 2019; Owens, 2018, 2020; Reardon, 2016). The results of this research have provided valuable insights to levels and trends in school segregation both nationally and regionally (Johnson, 2019; Kahlenberg, Potter & Quick, 2019). This understanding has increased awareness and informed school desegregation policies, such as magnet schools, open enrollment, charter schools (e.g., Ayscue & Siegel-Hawley, 2019) and school reassignment policies (Domina, Carlson, Carter, Lenard, McEachin & Perera, 2021). Nonetheless, these practices concentrate poor, Black and Hispanic students, especially those in metropolitan statistical areas (MSAs), in some schools and not others. Given the prior discussion, such segregation invites a maldistribution of resources, including teachers.

5. Teachers sort to schools with lower concentrations of poor, Black and Hispanic students

Stylized facts 1-4, as well as a simple model of the market for teaching quality (Figure 1) predict that observably more effective or more qualified teachers may sort to schools with lower concentrations of poor, Black and Hispanic students. Figure 1 depicts a district with two groups of schools—those with less desirable or weaker working conditions (w) and those with more desirable or stronger working conditions (s). Given teachers' preferences for better working conditions, and within-district wage rates that do not vary by school-working conditions, the supply of teacher quality will be greater for schools with better working conditions (S^s) than those with weak working conditions (S^w). At any wage rate, fewer high-quality teachers will be supplied to S^w schools. Conditional

Figure 1



on the demand for teacher quality, at many wage rates, S^w schools will experience a shortage of teaching quality as shown at W*.[6] A reduced supply of teacher quality is consistent with a variety of labor market outcomes, including smaller applicant pools, higher exit and transfer rates, and higher rates of novice teachers. The model predicts teacher sorting but rests on the assumptions that differences in working conditions are large enough, that a sufficient number of preferable schools are available, and that employers differentially hire more effective and/or more qualified teachers—all of which are empirical questions.

Seventy years ago, an ethnographic study of 61 Chicago public school teachers documented teacher sorting consistent with this model (Becker, 1952). Since then, several descriptive studies have shown that schools with students who are disproportionately poor or Black or Hispanic systematically have teachers who are less qualified across a variety of measures (Allensworth et al., 2009; Betts, Rueben & Danenberg, 2000; Clotfelter, Ladd & Vigdor, 2003, 2007; Goldhaber, Lavery & Theobald, 2015; Greenberg & McCall, 1974; Hanushek, Kain & Rivkin, 2004; Lankford, Loeb & Wyckoff, 2002; Scafidi, Sjoquist & Steinbrickner, 2007). Differences in teacher quality and/or qualifications between schools disproportionately composed of poor, Black or Hispanic students and their more affluent, white peers may result from differences at the time of hiring, as well as from differential teacher attrition.

Research finds teacher sorting between schools within school districts (Allensworth et al., 2009; Betts et al., 2000; Greenberg & McCall, 1974; Hanushek et al., 2004; Lankford, 1999; Lankford et al., 2002) and between districts within states (Hanushek, Kain and Rivkin, 1999; Lankford et al., 2002). For example, novice elementary teachers in San Diego in 1970 on average were assigned to schools where the percentage of nonwhite students was twice as high as the schools of returning teachers (54% v. 26%) and elementary teachers who transferred to another San Diego school on average moved to schools where the proportion of nonwhite students was 24 percent lower (27.3% v. 35.7%) (Greenberg & McCall, 1974). More recent research demonstrates that novice teachers who transfer between districts within the first five years of their careers are much more qualified (half as likely to fail the certification exam, half as likely to have graduated from the least competitive colleges and 40 percent more likely to have graduated from the most competitive colleges) than teachers who remain in their initial schools (Lankford et al., 2002). Teachers transferring districts move to districts where the percentage of poor and nonwhite students is about half the levels of the districts they left (19 percent v. 38 percent free lunch, 23 percent v. 40 percent Black and Hispanic students; Lankford et al., 2002). Transferring teachers are disproportionately likely to request a transfer to schools with lower concentrations of Black, Hispanic, and poor students and schools which experience fewer crimes (Boyd et al., 2011b).

Jackson (2009) employed the lifting of a 1972 court-ordered busing plan in Charlotte, NC to examine whether teacher preferences over the attributes of students could be decoupled from other mechanisms. The city's controlled-choice plan, implemented following the removal of the court-ordered busing plan in 2002 and 2003, caused many schools to transition from being

[6] The same dynamics are in play between schools in different school districts. If wage differentials are insufficient to compensate for differential working conditions, then we would expect to observe differences in teacher quality or qualifications.

roughly balanced by race to resemble the racial and economic attributes of Charlotte's segregated neighborhoods. Jackson finds that schools expected to encounter larger increases in the share of Black students experienced a reduction in teaching experience and teaching quality primarily driven by the exit of more experienced and more effective teachers. For example, a school where the share of Black students was estimated to increase by 10 percentage points was estimated to have a 2.6 percentage point (or roughly 10 percent) increase in teachers with 1-3 years of experience. Increases in the share of Black students by 30-40 percentage points were not uncommon.

We are unaware of research that documents a specific "tipping point" for teacher sorting; however, descriptive research demonstrates sorting with concentrations of Black or Hispanic students exceeding 40 percentage points and differences between schools of 20 percentage points. When the concentration of poor, Black and Hispanic students is high, (e.g., greater than 40 percentage points), teachers seek out opportunities to work in schools where the concentration of these students is lower (e.g., differences 20 percentage points or more).

Summary. Taken together, these stylized facts predict substantively important differences in teaching quality and—in the absence of observable quality measures—differences in the qualifications of teachers between schools with large differences in the proportion of poor, Black and Hispanic students. This inference is not consistently supported by research attempting to measure the distribution of teaching effectiveness directly.

While approaches and results vary, recent research finds that the distribution of teaching effectiveness may be modestly maldistributed. A few studies find moderate differences in teacher value-added or exposure to novice teachers between poor and nonpoor students or nonwhite and white students. Goldhaber, Lavery and Theobald (2015), employing data for Washington state schools find that fourth grade students eligible for free or reduced-price lunch or underrepresented minority students are 1-6 percentage points more likely to have a novice teacher than free-lunch-ineligible or non-underrepresented minority students, depending on comparison groups. Four percent of white students in the most advantaged quartile of school districts are exposed to novice teachers, while 10 percent of nonwhite students in the most disadvantaged quartile of districts have a novice teacher. Similarly, poor and nonwhite students have teachers whose value added is 3-6 percent of a standard deviation less than students who are not poor or are white. These results also generalize to middle and high school grades. Goldhaber, et al. (2018) extend this analysis, employing schools in North Carolina as well as Washington, to examine teaching quality gaps over time. Depending on the year and the state, they find that poor or nonwhite students are 1-5 percentage points more likely to be exposed to a novice teacher and that these gaps have generally grown over time. They also find that nonwhite and poor students are between 3 and 8 percentage points more likely to be exposed to a teacher in the bottom decile of value added than white or nonpoor students. Of note for our purposes, the authors estimate the strongest predictor of value-added or novice teacher gaps between poor and nonpoor students is the within-district standard deviation of the school-level proportion of poor students—a measure of school segregation. Steele et al. (2015) employing data from one large urban district find differences in teaching effectiveness of 0.04 to 0.06 standard deviations (SD) between schools in the top and bottom quartile of the share of Black students.

Other studies find negligible income or race-based differences in value added. Sass, Hannaway, Xu, Figlio & Feng (2012), employing data for Florida and North Carolina schools, find that teachers in high poverty schools in North Carolina and Florida have value-added scores are 0.001-0.007 SD lower than teachers in other schools and that there is more variability in the quality of teachers in the high poverty schools. They also report greater variability in the least effective (bottom decile) teachers in high-poverty schools, implying students in these school are more likely to have very weak teaching. Isenberg, et al., (2022) employ data from 26 urban school districts and find differences in the value-added between the teachers of high- (non-free- and reduced-lunch-eligible) and low-income (free- and reduced-lunch-eligible) students between 0.004 and 0.005 SD, while the difference between the teachers of the typical white and nonwhite student is 0.01 SD. Moreover, they find no relationship between school poverty and estimated value added. In addition, Isenberg et al. (2022) find that 18 percent of teachers in high poverty schools (> 90 percent low-income students) are novice (3 or fewer years of experience), compared to 9 percent of teachers in low poverty (< 60 low-income students). This is a meaningful difference, but the authors conclude that this difference has only a modest effect, as they estimate that novice teachers are 0.02 SD less effective than veteran teachers, resulting in an estimated difference in teacher effectiveness of 0.001.

We note the inconsistent differences in value-added estimates among studies. Employing value added to measure the effectiveness of individual teachers has been subject to useful debate. Value added in the context of assessing teaching effectiveness across schools, where the racial and economic attributes of students differ substantially, raises additional concerns that have not been addressed in existing research. The challenge is to find variation in student achievement outcomes that is attributable to differences in teacher effectiveness, while controlling for student prior achievement, economic and possibly racial status at the classroom and/or school level, while also recognizing that teachers may sort by effectiveness based on these same attributes. Many of these estimates assume the relationship between school- or classroom-level student income and/or race and teaching effectiveness can be estimated using differences that occur within schools over time. Doing so relies on unstated assumptions about extrapolating small differences in student race and income within schools to the much more substantial differences that exist across schools that may be misleading. Also, this work often only explores differences between schools within an urban district and not the much greater teacher sorting opportunities that exist between urban and suburban schools. A more detailed assessment of the use of value added in this context is beyond the scope of this paper. As a result, and given their wide availability, we employ exposure to novice and uncertified teachers as our measures of differential access to teacher qualifications and quality.

When Does School Segregation Imply Teacher Sorting?

We employ school level data for all U.S. MSAs with the goal of addressing two questions: 1) how does the concentration of poor, Black and Hispanic students differ among schools within the school district of the principal city of a given MSA (core schools) and between these schools and those in the MSA outside of the city district (outlying schools)? And 2) to what extent are within-MSA differences in school-level concentrations of poor, Black and Hispanic students associated with teacher sorting? Said slightly differently, when does school segregation induce teacher sorting?

Measures and Data. We build on existing school segregation research with the specific goal of comparing school-level student economic and racial segregation among schools within MSAs to better understand to what extent and where segregation may induce teacher sorting and affect the distribution of teaching effectiveness. We employ schools and LEAs within MSAs as the unit of analysis and school race/ethnicity and poverty compositions as proxies for a broader range of underlying variables that influence teachers' preferences for working conditions, as described by the five stylized facts. Our interest in differences between schools derives from our interest in understanding teacher sorting to inform a discussion of ESSA, both of which focus on systematic differences in the teachers of poor, Black and Hispanic students.

There is good reason to believe MSAs are an appropriate geography on which to initially focus our analyses (see Clotfelter, 1999). The Office of Management and Budget defines MSAs to be a core area, or principal city, containing a substantial population nucleus (at least 50,000) that with adjacent communities have a high degree of economic and social integration with that core, as measured by commuting ties. As such, MSAs reflect a geography approximating a labor market for teachers, allowing teachers the opportunity to choose to work in schools with a variety working conditions.[7] In addition, MSAs provide a geographic and demographic context that could induce school segregation and make it readily identifiable.[8]

Measures of segregation have been created to address different aspects racial or economic separation. The dissimilarity index and the exposure index are two commonly employed measures of school segregation,[9] each of which captures the overall distributional aspects of the economic (or racial) composition of schools within districts or MSAs. Neither of these measures explicitly differentiates LEAs or MSAs where economic or racial segregation exceeds some threshold associated with teacher sorting, although they will be correlated with such measures.

Measures that would identify the opportunity for teachers to sort would identify:

- Schools with "high" concentrations of free lunch eligible (or Black and Hispanic) students
- Schools nearby (within the MSA) where concentrations are meaningfully "lower"
- MSAs with sufficient numbers of "high" and "low" schools to make teacher sorting a realistic opportunity.

We operationalize these criteria as follows:

- High concentration is defined as a school-level proportion of free lunch students ≥ 0.40
- Low relative concentration reflects a difference in the concentration proportions between high and low schools ≥ 0.30
- Sufficient number is defined across two avenues of sorting:
    - Within city: the difference between the 4th quartile mean of school proportion of free lunch students within the city and the mean of the 2nd quartile in the city (core difference).

[7] Boyd et al. (2006).
[8] Schools in rural areas may also suffer from relatively low levels of teacher quality, although available evidence suggests the patterns likely differ from those in MSAs (Miller, 2012; Nguyen, 2020),
[9] For a review of school segregation measures see Frankel and Volij (2011) or Reardon (2011).

- City to outlying schools in MSA: the difference between the 4th quartile mean in the city and the 2nd quartile mean in schools in the MSA outside the city (core-outlying difference).

In MSAs where the difference between the 4th and 2nd quartile within the city school district (core difference) is at least 0.30, teachers have ample opportunity to choose to work in other schools in the same district with substantially lower concentrations of poor and/or Black or Hispanic students. Similarly, we compare the top quartile within cities to the second quartile of the non-city schools in the MSA (core-outlying difference) to provide signals about the relative potential for sorting between city schools and other schools in the MSA. The choice of any thresholds is arbitrary. Our choice of a 30 percentage point differences in share of free-lunch-eligible (or Black or Hispanic) students is based on our reading of the teacher sorting literature but should be taken as an approximation.[10] We employ the mean of the 2nd and 4th quartiles of the distribution of student racial or poverty concentration to explore schools in the lower and upper portions of the school distribution without focusing on extreme values. We examine the robustness of findings to: employing the 4th and 1st (rather than 2nd) quartiles, the use of differences of 40 (rather than 30) percentage points, and the use of student economic status (rather than race) as segregation measures. The results vary in predictable ways but follow the same patterns.

We examine these relationships employing school-level data from the Stanford Education Data Archive's (SEDA) and the Civil Rights Data Collection (CRDC).[11] Most relevant for our purposes, the SEDA data include measures of the economic and racial composition of students in schools, exposure measures of segregation, school-level estimates of mean student achievement that have been standardized to the national student-level distribution of achievement scores, data on other attributes of families and geographic identifiers for about 85 percent of public schools.[12] The CRDC data are collected every other year and include a variety of measures. Useful for our purposes, the CRDC includes measures of the number of 1st and 2nd year teachers in each school and the number of teachers who are not certified. To reduce potential year-to-year fluctuations and avoid issues that arise from the pandemic, we average data from each data source for academic years (AY) 2015-16 and 2017-18.

Analytic sample. Our primary analytic sample includes all elementary schools within MSAs in the U.S. whose principal city is a large or medium-sized city in 2018 with non-missing data from SEDA and CRDC. Limiting the sample in these ways allows us to retain most public elementary schools, focus on the situations where teacher sorting may be most likely to occur, and for which

[10] It is also consistent with research on 'tipping' based on racial composition studied in areas related to teacher employment decisions, for example, residential location (e.g., Card, Mas & Rothstein, 2008) and school choice (Billingham & Hunt, 2016; Clotfelter, 1976). This research tends to find that whites respond to concentrations of nonwhites of between 5 and 30 percent.

[11] For more details on the SEDA data, see Reardon, S. F., Ho, A. D., Shear, B. R., Fahle, E. M., Kalogrides, D., Jang, H., & Chavez, B. (2021). Stanford Education Data Archive (Version 4.1). Retrieved from http://purl.stanford.edu/db586ns4974. Details on the CRDC data can be found at https://ocrdata.ed.gov/.

[12] The data exclude some schools primarily due to limitations constructing student achievement for schools with insufficient numbers of test takers.

we have good measures of relevant constructs.[13] We limit our primary analysis to MSAs with medium or large principal cities—those with a population of at least 100,000. These MSAs typically have enough elementary schools in the core district and in outlying elementary schools to operationalize our measures. Our analytic sample following these restrictions consists of 156 MSAs,[14] comprising 27,970 schools in 4,389 school districts.[15] The characteristics of students in our analytic sample differs from the population of all schools in predictable ways; there are somewhat greater concentrations of Black, Hispanic, low-income and low-achieving students (Table 1). Our primary analytic sample includes 63 percent of all SEDA elementary schools. Finally, our analyses focus on differences based on the proportion of free lunch eligible students in each school. We replicate each of the relevant tables employing the concentration of Black and Hispanic students with nearly identical results (see Appendix A).[16]

Does school segregation vary across MSAs? Segregation is often conceived as a phenomenon between cities and their suburbs. In many ways it is. In half of the elementary schools in the core city LEAs, more than three quarters of the students are poor (free lunch eligible). Contrast that with elementary schools in outlying LEAs that surround the core city, where half the schools have fewer than a third of their students who are poor. These differences are summarized in Figures 2a, showing the kernel density of poor students in core city school districts and those in MSA schools outside of the core city school district. The density for the proportion of a school's students who are Black and Hispanic is similar (Figure 2b), although notice that differences between core city schools and the outlying schools in the MSA are somewhat smaller and less concentrated for the proportion of students who are free lunch eligibility compared to those who are Black or Hispanic. These overall distributions tell only part of the story about the differences in student segregation between schools within MSAs.

Building on the large body of descriptive and causal evidence that links concentrations of poor, Black and Hispanic students to teacher sorting, we compare differences in the proportion of free lunch students across schools in each of the 156 MSAs with core city populations greater than

[13] School segregation may well influence teacher sorting and teacher effectiveness in schools outside of MSAs or in MSAs whose core city has a population of fewer than 50,000. The median elementary school outside of a MSA has 5 percent of students who are Black or Hispanic and 50 percent who are free lunch eligible. These schools are geographically dispersed and thus reduce the opportunities for teacher sorting given the nature of teacher labor markets. MSAs whose core city is small have relatively few elementary schools and those schools have smaller concentrations of Black or Hispanic students. The median MSA whose principal city has a population between 50,000 and 100,000, has 11 elementary schools with a median proportion of Black or Hispanic students of 0.40 compared to the median medium or large MSA, which has 77 elementary schools and a share of Black or Hispanic students of 0.78. Results for MSAs whose core city is small (< 100,000) are available by request from the authors.

[14] Twelve MSAs meet these criteria but have two or fewer schools in the MSA outside of the core city LEA, thus precluding teacher sorting to "outlying" schools in the MSA, so those MSAs are excluded.

[15] In many of the MSAs the boundaries of the core city and the LEA in which it lies are coincident. In others, primarily those with county-level LEAs, the LEA includes additional urban, suburban and rural areas. We use the LEA in which the core city is located as our focal geographic unit given its importance in teaching hiring, retention, and compensation.

[16] In our analytic sample, the correlation between the proportion of a school's students eligible for free lunch and the proportion of students who are Black or Hispanic is 0.80. The school level correlation of proportion Black or Hispanic and proportion free lunch with average student achievement is -0.73 and -0.82, respectively.

100,000. Figures 3a-h show the diverse patterns of school segregation that exist across four illustrative MSAs.

In the Raleigh, NC MSA, there are large differences among the elementary schools in the Wake County school district, which is the LEA that includes Raleigh (Figure 3a). Schools are evenly dispersed across proportions of free lunch (and Black and Hispanic) students. The blue dashed line at 0.26 is the mean of schools in the 2nd quartile of the Wake County LEA based on their share of free lunch eligible students. The line at 0.63 is the mean of schools in the 4th quartile, a core difference of 37 percentage points. This difference signals the opportunities for teachers to seek out schools within the district where the level of free lunch eligible students is much lower.[17] The core-outlying difference in the proportion of free lunch eligible students (the city LEA's 4th quartile (blue dashed line at 0.63) and the 2nd quartile in schools in the Raleigh MSA outside of the Wake County school district, the red dashed line at 0.46) is relatively small (0.17, see Figure 3b). As a result, based solely on this criterion, we may observe relatively more teacher sorting among schools within the Wake County LEA than sorting between Wake schools and outlying schools in the MSA.

Compare the depiction of school segregation in Raleigh with that for the Savannah MSA (Figures 3c and 3d). Note that within-core differences of the students who are free lunch eligible are similar to those in Raleigh (differences of about 0.40). However, compared to Raleigh, the core-outlying difference is much greater (Raleigh difference = 0.17, Savannah difference = 0.71). In the Savannah MSA, we predict teacher sorting both between schools within the Savannah Chatham LEA and between those schools and schools in outlying parts of the MSA.

In the Rochester MSA (Figures 3e and 3f), the Rochester school district is coincident with the city of Rochester and city elementary schools are relatively homogenous, with very high proportions of free lunch eligible students (core difference = 0.05). Elementary schools outside the core city of Rochester are somewhat more varied, but the vast majority have very low proportions of free lunch students, creating a large core-outlying difference of 0.68). As a result, we predict less sorting within Rochester city schools but more sorting between the city schools and others in the MSA.

In the Fresno MSA (Figures 3g and 3h), most schools have very high proportions of free-lunch-eligible students, creating small within-core and core-outlying differences (core difference = 0.10, core-outlying difference = 0.22). Based on these relatively small differences, we expect to observe little teacher sorting within the Fresno school district or between the Fresno schools and outlying schools in the MSA.

The four MSAs described above are illustrative of MSAs more generally. The relationship between the extent of segregation within core LEAs and between core LEAs and outlying schools in the MSA for all 156 MSAs is shown in Figure 4. The top panel of Figure 4 shows the magnitude of the within-core difference for free-lunch-eligible students (vertical axis) and the core-outlying difference (horizontal axis). The red lines at 0.3 signal a level where differences

[17] Not all teachers will be motivated to act on these differences, and some might respond to larger or smaller differences.

are large enough to prompt teacher sorting and define quadrants that distinguish MSAs. Raleigh is in the northwest quadrant, which we refer to as "Within, not Between" to signal that differences are large (> 0.30) within the core LEA but not large (<0.30) between the core and outlying parts of the MSA; Savannah is in the northeast quadrant ("Within & Between"); Rochester is in the southeast quadrant ("Between, not Within"); and Fresno is in the southwest quadrant (Not Within or Between"). Based on differences in concentration of poor students within core districts and between schools in the core districts and those in outlying districts, we would expect to observe more teacher sorting between schools within core districts in the "Within, not Between" and the "Within and Between" quadrants than in the other two quadrants. Similarly, we expect to see more teacher sorting between schools in the core district and those in outlying districts in the "Within and Between" and "Between, not Within" quadrants than the other two quadrants.

The majority of the MSAs are in the Within & Between (29%) or the Between, Not Within (57%) quadrants, but 15 percent of MSAs are divided between the other two quadrants.[18] The bottom panel of Figure 4 provides a similar depiction of the distribution of MSAs for the proportion of a school's students who are Black or Hispanic.[19] Table 2 quantifies the mean differences in economic, racial and achievement levels within core LEA schools and between core schools and outlying schools across the four quadrants.

The patterns described in Figure 4 and Table 2 are also related to common measures of school segregation. The SEDA data include school-level measures of the difference between an exposure index of Blacks to minority students and the exposure of whites to minorities averaged to the LEA. The distinctions identified in Table 2 generally are identified by the differences in these exposure indices. For example, our core difference for Blacks and Hispanics (Table 2, column 3) is correlated with the difference in exposure indices for these same schools at 0.51 in quadrant 2 and 0.53 in quadrant 3. A similar calculation comparing core-outlying differences results in a correlation of 0.81. So, while related, these measures target different concepts.

Differences in Educational Challenges and Resources. Do these patterns of economic segregation align with other measures of social well-being? Figure 4 and Table 2 distinguish patterns of school segregation among MSAs useful to our understanding of teacher sorting. To what extent do these distinctions align with other differences that could inform teachers' decisions to sort? Three features of economic and racial school segregation bear directly on this issue: 1) the challenges confronting teachers in educating concentrations of children with deep educational needs; 2) the availability of resources to address these needs; and 3) the ready availability of more appealing opportunities.

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[18] Patterns of segregation differ, even within quadrants. Classifying MSAs in quadrant 4 where differences between deciles in the concentration of free-lunch-eligible students are relatively small should not be interpreted as a lack of racial or economic segregation. In some MSAs where differences in concentrations by race or poverty may be relatively low within cities, schools with large concentrations of nonwhite and poor students exist in the suburbs, e.g., Ann Arbor. In these situations, teacher sorting may exist among noncity schools or even from some noncity schools to city schools. Our analysis focuses more directly on the more typical patterns of teacher sorting.

[19] Three quarters of MSA quadrant classifications are the same whether the assignment is made by proportion of students who are free lunch eligible or made by the proportion who are Black or Hispanic.

Challenges associated with concentrations of educational needs. The challenge of educating concentrations of students with meaningful learning needs has been recognized in research and reflected in federal policy through Title I ESEA concentration grants for some time (see, for example, Congressional Research Service, 2017). A variety of other factors beyond measures of income have been associated with student academic performance, including parental education, the presence of two-parent families, parental employment, and parental involvement with the criminal justice system. To understand the extent to which these factors align with the segregation patterns delineated by the four quadrants described in Figure 4 and Table 2, we employ SEDA's socioeconomic status (SES) index. This index is constructed from a set of questions asked of school district residents on the American Community Survey about family income, adult education levels, whether households are headed by a single mother, unemployment status, SNAP receipt, and household poverty.[20] Across a variety of disciplines and methodological approaches, research has shown that the measures included in the SES index get at different aspects of families and communities that contribute to children's educational success (see Putnam & Sharkey, 2016). Meaningful differences in SES may contribute to the teacher sorting described above.

We find that, on average, residents of the core LEA have lower SES than residents of outlying LEAs in the MSA (Table 3). While patterns differ across the quadrants and by race/ethnicity, on average Blacks, and to a lesser extent, Hispanic, families have much lower SES than white families.[21] The SES of Black communities in core LEAs (Table 3, column 5, Total) is more than 2.5 SD lower than that of their white neighbors (Table 3, column 11, Total) and approaches 3 SD lower than white families in outlying districts (Table 3, column 12, Total). These Black-white differences are largest in Quadrants 2 (where there is high segregation within the core LEA and between the core and outlying LEAs) and 3 (where there is high segregation within the core LEA but not between the core and outlying LEAs). The patterns between Hispanics and whites are similar with somewhat smaller differences, averaging between 1.5 and 2 SD. Overall, MSAs in Quadrants 2 and 3 appear qualitatively different than MSAs in Quadrants 1 and 4. SES differences by race/ethnicity and geographic location result from many factors, including racism, and should not be interpreted as causal. Nonetheless, these patterns in socio-economic status imply that Black or Hispanic children on average may confront substantial learning challenges compared to their white peers, and differences in the magnitude of these challenges are greatest between Black and white residents of the MSAs classified in economic segregation Quadrants 2 (Within and Between) and 3 (Between, not Within).

Other attributes of students that relate to educational need differ across the economic segregation quadrants (Table 4). On average about 16 percent of elementary school children in our analytic sample are limited English proficient (LEP). In Quadrant 2, the within-core difference in LEP identification is 15 percentage points (column 1, row 2) and the core-outlying difference is 20

[20] The SEDA SES measure is constructed at the school district level given the mapping of American Community Survey respondents to school districts. As a result, we can distinguish SES between the principal city LEA and the enrollment weighted means of LEAs in the MSA outside the principal city.
[21] The SES measures have been constructed by race/ethnicity. SES measures are not available by poverty status in the SEDA data.

percentage points (column 2 row 2), or roughly double the mean level. Differences in other quadrants are smaller but still large in most cases. Core-outlying differences in student chronic absenteeism are particularly large in Quadrants 2 and 3. Mean chronic absenteeism is 13 percent and the core-outlying *differences* between the city LEA and those in other parts of the MSA are 9 and 15 percentage points (column 6 rows 2 & 3). Notably, differences in the identification of students as disabled for purposes of IDEA are small on average.

Availability of resources to address these needs. There is no consensus about the level or nature of school resources necessary to compensate for additional learning challenges, but research suggests current funding may not compensate for other job-related differences confronted by teachers. The typical core LEA receives about the same revenue per pupil as outlying LEAs in the MSA (Table 5, columns 5 & 6), but these differences vary by quadrant of racial segregation. In Quadrant 2 (where there is high segregation within the core LEA and between the core and outlying LEAs), outlying schools receive slightly more than the core LEAs. In Quadrant 3 (where there is high segregation within the core LEA but not between the core and outlying LEAs) the median core LEA receives 13 percent more revenue. Research suggests even the Quadrant 3 difference is insufficient to compensate for differences in the educational challenges described above (Glazerman, Protik, Teh, Bruch, and Max, 2013).

Availability of more appealing opportunities. Differences in teaching environments may become most stark when institutional structures facilitate segregation. The combination of neighborhood racial and economic segregation with geographically defined school catchment areas and geographically fragmented metropolitan areas contributes to the segregation of students depicted in Table 2. Geographically small school districts facilitate racial and economic segregation between districts (Bischoff, 2008; Clotfelter, 2001). MSA school districts in the mid-Atlantic and South are frequently aligned with county boundaries and thus tend to be geographically larger than those in the Midwest or Northeast. For example, the Charlotte-Mecklenburg school district is coincident with county government and includes not only the city of Charlotte, but six other local cities and towns. The Charlotte MSA includes a total of 15 LEAs. Contrast this with the Rochester school district, which is coincident with the city of Rochester. Monroe county, in which Rochester is located includes 17 other school districts and the Rochester MSA includes 53 LEAs.

Geographic fragmentation creates differential opportunities for households to choose residences in communities both within the core LEA and in outlying LEAs that are systematically related to the racial segregation quadrants. Schools in the core LEAs in Quadrant 3 are more highly concentrated within the principal city than those in the other quadrants (Table 5, column 1). It is also the case that in Quadrant 3 the typical MSA has more LEAs and smaller enrollments. Taken together, Quadrant 3 MSAs afford families who have the means to be mobile more options from which to choose, creating more economically and racially segregated schools. As a result, the economic and racial composition of school districts may be more homogeneous, reducing teacher sorting opportunities within the core and increasing the contrast between within and between schools. Quadrant 3 MSAs are more likely to occur in the Northeast and Midwest (see Figure 5).

School Segregation Summary. We draw three conclusions from the analysis of school segregation. First, schools are segregated by income and by race/ethnicity across most MSAs. This is not a new result and is consistent with a large literature.

Second, there are meaningful differences in patterns of segregation within core LEAs and between core and outlying schools. In some MSAs, core schools consistently have very high levels of low income or Black and Hispanic students while outlying schools are consistently higher income and white (Quadrant 3). In this way Rochester is similar to other cities mostly in the north and east (see Figure 5), where the geography of school districts and the economics of cities promotes these patterns.

Third, these patterns of racial and economic concentration of students correlate with differences in an array of other measures commonly associated with diminished educational opportunities, as well as more general measures of segregation and the geographic fragmentation of school MSAs in ways that align with differences in racial and economic segregation.

Are Some Students Differentially Exposed to Novice Teachers?

The five stylized facts predict an allocation of teacher qualifications and quality that disadvantage poor, Black and Hispanic students. Patterns of economic and racial segregation predict that access to effective teachers will differ across MSAs.

We employ exposure to novice or uncertified teachers as our proxies for teacher effectiveness. Early-career teaching experience is a measure of one component of teacher effectiveness. While estimates vary, most studies indicate that teachers improve, on average, by about 0.05-0.12 student achievement SDs in the first five years of their careers (Table 7). As a result, teacher experience is both a qualification observable by hiring authorities and a predictor of teacher quality. Teacher certification is another common metric of teacher qualifications, and while it is less clearly linked to differences in teacher quality (Boyd et al., 2006; Kane, Rockoff & Staiger, 2008) its distribution provides another opportunity to explore the dynamics of teacher labor markets. The market forces that predict higher concentrations of novice and uncertified teachers in schools with greater concentrations of poor, Black and Hispanic students would also predict lower teacher quality to the extent employers can observe it or its proxies at hiring.

The Distribution of Novice Teachers Within and Between LEAs. We merge data from the Civil Rights Data Collection for AY 2015-16 and AY 2017-18 that summarizes the proportion of teachers who are in their first or second year of teaching (novice teachers) for nearly all public schools with the AY 2015-16 and AY 2017-18 SEDA data. Across all elementary schools in MSAs with large or medium cities the typical student not eligible for free lunch attends a school where 10 percent of the teachers are in their first or second year of teaching, while the typical free-lunch-eligible student attends schools where the average is 13 percent, a difference that is consistent with estimates for North Carolina and Washington found by Goldhaber et al. (2018).

However, exposure to novice teachers differs depending on the extent of school segregation. The within-core difference in the percentage of novice teachers averages 4 percentage points (Table 6, column 1) but is greatest (5.4 percent) in Quadrant 2 MSAs where the core difference in the percentage of free lunch eligible students is likewise greatest (see Table 2).

A similar pattern holds when we compare core-outlying novice exposure differentials (Table 6, column 2). The novice exposure differential is greatest in MSAs where the core-outlying segregation difference is greatest (Quadrants 2 & 3). These MSAs have novice exposure differences that average 8 percentage points (Table 6, column 2, rows 2 and 3). Said differently, students in the highest quartile of free-lunch-eligible schools in Quadrants 2 and 3 are 80 percent (17.6 percentage points v. 9.7 percentage points) more likely to experience a novice teacher than a student in the 2nd quartile of schools outside the core LEA. The other two quadrants have effectively no differences in the proportion of teachers who are novices. If, instead of comparing differences between the 4th (core) and 2nd quartiles (outlying) the comparison was 4th and 1st quartile, the difference in the proportion of novice teachers in Quadrants 2 and 3 would average 10.2 percent points—more than twice as likely to be exposed to a novice teacher. Table 6 shows similar differences for the proportion of only first-year teachers (columns 3 and 4), and for the proportion of teachers who are not certified (columns 5 and 6).

The relationship between differences in economic segregation and differences in novice teachers described in Table 6 is more precisely estimated by the regression for all MSAs shown in Figure 6. Larger differences between schools in the proportion of free-lunch-eligible students predicts increasing differential exposure to novice teachers. For every 10-percentage point increase in the core difference, the exposure to novice teachers increases by 0.7 percentage points on average. The free-lunch-eligible core differences in Quadrant 2 average 40 percentage points (Table 2 column 4, rows 2 and 3), implying an expected differential exposure to novice teachers of 2.8 percentage points.[22] The effect of differences in the proportion of free-lunch-eligible students on differences in novice teachers is about twice as large when estimated between core and outlying schools. A 10-percentage point increase in the core-outlying difference in free-lunch-eligibility predicts a 1.6 percentage point increase in exposure to novice teachers. As a result, mean core-outlying differences in free-lunch-lunch eligibility in Quadrants 2 and 3 imply an 8.8 percentage point difference in exposure to novice teachers. Similar results obtain when we examine differences in the racial composition of schools rather than student free lunch status (see Appendix Figure A2). Regressions explaining the exposure to uncertified teachers produce similar patterns. As economic and racial segregation within MSAs increases, poor, Black and Hispanic students are increasing likely to have an inexperienced or uncertified teacher.

Most children spend five years in elementary school, so the differential annual exposure described in Table 6 and Figure 6 will accumulate to larger differences over time. We assume for simplicity that the annual exposure to novice teachers is uncorrelated over time and estimate five-year exposure using the binomial distribution and the differential annual exposure estimates from Table 6. Students in the 2nd quartile of outlying schools in Quadrants 2 or 3 have a 40 percent chance of encountering at least one novice teacher during their five years in elementary school (Table 8, column 1). The core-outlying differential exposure to at least one novice teacher

[22] The predicted value of 2.8 is less than the actual difference shown in Table 6 of 5.4 Appendix A, Figure 2). When we conduct the regression shown in Figure 6 with employing proportion Black and Hispanic rather than free lunch status, the estimated coefficient is 0.12, which predicts a core difference in novice exposure of 5 percentage points. This suggests that within core districts free lunch status captures only a portion of the variance between schools associated with teacher sorting decisions.

is 0.21 in Quadrant 2 and 0.24 in Quadrant 3 (column 4)—a 50 percent increase. As would be expected given the construction of the quadrants, these differences are much larger in Quadrants 2 and 3 than Quadrants 1 and 4. Core differences are generally smaller but still meaningfully large (column 5) and greatest in Quadrants 1 and 2, based on quadrant definitions.

Finally, given the well-established relationship between teacher experience and improvement in student achievement (Table 7), we approximate how differential exposure to novice teachers may influence student achievement. Employing an average gain to experience between novice and veteran teachers of 0.08 SD, in combination with our estimates of the differences in exposure to one, two, and three or more novice teachers we approximate the resulting reduction in student achievement in Table 9, column 5. In Quadrants 2 and 3 the estimated reduction in student achievement from differential exposure to novice teachers is 0.03-0.035 SD. Larger differences exist for schools where the concentration of free lunch eligible students is greater.

Similar relationships hold examining the exposure to teachers who are not certified (Table 9). On average, about one percent of teachers in the 2nd quartile of Quadrant 2 and 3 outlying schools are uncertified. That rate in the fourth quartile of core schools is more than 3 times higher. Again, a smaller but still meaningful core difference exists.

Summary

Student achievement is influenced by many factors. Owing to a history of neighborhood segregation, schools in most metropolitan areas are segregated by income and race/ethnicity. The resulting concentration of students with multiple educational disadvantages creates many challenges for schools to deliver on the promise of education. Perhaps the greatest challenge is the recruitment and retention of effective teachers. This assessment is not new. Research and policy have long identified the uneven distribution of effective teaching as a potentially important factor in the failure to reduce large differences in educational outcomes across race and income.

This paper makes three contributions toward better understanding the relationship between school segregation, teaching sorting and differences in teacher qualifications and quality. First, employing five stylized facts drawn from previous research, we provide a foundation on which to examine how school economic segregation is associated with the distribution of teacher qualifications and quality. Empirically we find substantial school segregation in most MSAs, but patterns differ. These differing patterns of economic and racial segregation imply testable hypotheses about the relationship between school segregation and the sorting of teachers, their qualifications, and their quality.

Second, these patterns of segregation by race and income are strongly related to differences in several other attributes of students' learning environments that contribute to the educational challenges these students confront, and by implication the classroom environment in which teachers work. These working conditions have been linked in extensive descriptive and more limited causal research documenting the challenges of recruiting and retaining more qualified and more effective teachers.

Third, we find that the distribution of novice and uncertified teachers aligns with patterns of school segregation and teacher sorting predicted by prior research. Schools with high concentrations of free lunch, and/or Black and Hispanic students are more likely to be exposed to inexperienced and uncertified teachers than other schools in the same core LEA or other schools in that MSA outside of the core LEA. These differences are often large—much larger than suggested by prior research. In the two racial segregation quadrants where segregation is most problematic, and which include more than 75 percent of the 156 medium and large MSAs in the U.S., students attending the quartile of schools with the greatest concentration of free-lunch-eligible students are more than 20 percentage points more likely to have a novice teacher (an increase of more than 50 percent) during elementary school than students attending the 2nd quartile of schools in that MSA but outside the city. Teacher experience is both a qualification and a proxy for teacher quality. Similar disparities exist for uncertified teachers.

These results extend and contextualize prior research, yet much remains to be learned. Although the criteria we employ to measure segregation and identify patterns of segregation are informed by prior research, these criteria should be viewed as proxies and approximations. Our use of income as a measure of school segregation to inform teacher sorting is intended as a proxy. Although student income is strongly related to other measures (e.g., race and ethnicity, other attributes of students, and a variety of attributes of families in school districts), many students are misrepresented by such limited measures. In addition, our thresholds characterizing patterns of segregation, while informed by prior research, are arbitrary. We have explored differences in these thresholds and find these patterns and findings robust. Even so, we encourage readers to treat these as approximations and not to make too much of the characterizations of any specific MSA. We obtain similar results when we substitute the proportion of students who are Black or Hispanic for those who are free lunch eligible and when we examine MSAs with smaller core cities, i.e., those with population less than 100,000. However, there are some intriguing differences in those results left unexplained in this paper. We are exploring those elsewhere.

The results presented here inform some prior research. We have found it useful to have our empirical work guided by a simple conceptual model of teacher sorting and by prior descriptive and causal research on teacher sorting. We find that exposure to novice teachers varies by MSA and by schools within MSAs. As a result, research focusing solely on specific differences within districts may be misleading as it does not address the substantial sorting that often occurs between core LEAs and the outlying LEAs in the MSA. Similarly, there are risks to generalizing findings beyond one or two states given the meaningful differences in the patterns of segregation across states shown here. In addition, a focus on mean differences meaningfully understates exposure to novice teachers for a large portion of poor, Black and Hispanic students.

Finally, we are concerned about the use of value-added estimates to explore the distribution of teacher quality. Prior research employing value-added finds meaningly different estimates depending on model specification. Given the dramatic differences in racial and economic segregation across schools and evidence that incremental differences likely don't drive teacher sorting decisions, we question the ability of available observational data to distinguish student learning challenges beyond the teacher's control, for which a teacher should not be penalized (and therefore omitted from a value-added estimates), from the sorting of teachers driven by such differences, which may produce meaningful differences in teacher quality across schools (and which a value added model should account for). Most teachers don't experience the magnitude of differences in the racial and economic attributes of students that characterizes school segregation. There is good reason to believe the modest within-school differences that many teachers do experience should not be linearly extrapolated when making valued added comparisons. We also believe that teachers who do experience dramatic differences in the student composition of their classrooms may differ in important ways from other teachers. Even if one could surmount these modeling challenges, the limited availability of data to estimate value-added risks being misused given the external validity argument made above.

Our results have implications for policy. Beginning with at least the Coleman Report in 1965, research has recognized that some children experience meaningfully different educational opportunities and outcomes. That finding has been reinforced in a multitude of commission reports, research papers, case studies, and popular press accounts. We have experienced periods and pockets of progress, but more than 50 years later the basic problem remains, and in some ways may be worse. Poor and nonwhite children confront tremendous educational challenges, too often resulting in unacceptable outcomes. Schools can't entirely resolve this dilemma, but at the very least schools should not compound it by providing students with less effective teachers.

The Every Student Succeeds Act requires states to publicly report the extent to which minority and poor children experience ineffective, uncertified and inexperienced teachers at disproportionate rates. Only 29 states report on the extent to which schools with large shares of poor children have inexperienced or uncertified teachers. Few of these report differences in teacher effectiveness (Levitan, Holston, & Walsh, 2022). Even in states reporting data, it is unclear if any have developed and acted on plans to address economic and racial differences in students' exposure to teacher qualifications and quality. Title I of ESEA provides more than $20 billion in grants to states and districts to support the education of low-achieving students, especially those in high poverty schools. Title II of ESSA provides more than $2 billion to states and school districts with several purposes, including to provide low-income and minority students greater access to effective teachers, principals, and school leaders (Office of Elementary and Secondary Education, 2022). Why has the federal government not leveraged its substantial investment through Title I and Title II funds to enforce the provisions of ESSA that address differences in teacher quality and qualifications? Why have states not done more to drive resources to easily identifiable schools where these disparities are concentrated?

Ideally, policy would address racial and economic school segregation. Given the patterns of segregation described above, some progress is within the grasp of school districts. For example, in racial segregation Quadrants 1 and 2, there is room for superintendents to explore a variety of policies, such as controlled choice or busing policies to integrate schools. Such policies have met with limited success (Domina et al., 2021). However, given the nature of segregation in many MSAs (Quadrants 2 and 3) being between districts, the Milliken v. Bradley (1974) Supreme Court decision effectively precludes involuntary integration across districts and upending that precedent is unlikely. In these cases, policies to redress a maldistribution of teacher quality are likely to include a combination of substantial additional resources and the thoughtful targeting of those resources to teacher compensation and the work environment. Recent evidence indicates that substantial differences in compensation are likely needed to induce increased supply and retention of higher quality teachers in schools with concentrations of nonwhite, poor and low-performing students (Glazerman, et al., 2013). In addition, substantial evidence indicates that a variety of other factors influence teacher supply, particularly school leadership, peers and school climate. Finally, it has become increasingly clear that while research can provide a menu of potential policies, local labor markets vary. Local policymakers should adapt this research to local context and choose a set of policies accordingly. Regardless of context, tinkering around the margins has not succeeded. Improving teaching quality in our most segregated schools will require a level of investment and focus missing to date.

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Tables and Figures

Table 1. Distribution of School-Level Student Attributes Across Samples, Average 2016 & 2018

			Large & Medium MSA Elementary		
Percentiles of Attributes	All Schools	Elementary	Total	Core City	Outlying
Proportion Free Lunch Eligible					
10th	0.13	0.12	0.10	0.25	0.08
25th	0.27	0.26	0.23	0.49	0.18
50th	0.46	0.48	0.49	0.77	0.39
75th	0.70	0.74	0.76	0.89	0.65
90th	0.89	0.89	0.90	0.95	0.81
N	64,150	42,083	27,970	8,202	19,768
Proportion Black or Hispanic					
10th	0.03	0.05	0.07	0.21	0.06
25th	0.08	0.11	0.16	0.44	0.12
50th	0.27	0.34	0.44	0.78	0.31
75th	0.67	0.75	0.84	0.95	0.69
90th	0.93	0.95	0.97	0.99	0.92
N	64,150	42,083	27,970	8,202	19,768
Average Reading and Math Achievement					
10th	-0.56	-0.58	-0.62	-0.79	-0.49
25th	-0.29	0.30	-0.36	-0.57	-0.23
50th	0.00	0.00	-0.01	-0.28	0.08
75th	0.26	0.30	0.33	0.08	0.39
90th	0.52	0.56	0.61	0.44	0.65
N	62,068	40,730	27,161	8,073	19,088
Proportion 1st or 2nd Year Teachers					
10th	0.00	0.02	0.02	0.03	0.02
25th	0.04	0.05	0.05	0.06	0.05
50th	0.09	0.09	0.10	0.11	0.09
75th	0.16	0.15	0.16	0.18	0.15
90th	0.25	0.23	0.24	0.28	0.22
N	63,447	41,813	27,910	8,183	19,727
Proportion Teachers Uncertified					
10th	0.00	0.00	0.00	0.00	0.00
25th	0.00	0.00	0.00	0.00	0.00
50th	0.00	0.00	0.00	0.00	0.00
75th	0.00	0.01	0.02	0.04	0.00
90th	0.06	0.06	0.06	0.10	0.04
N	63,458	41,817	27,913	8,186	19,727

Notes: Based on SEDA data for schools employing averages for 2015-16 and 2017-18.

Table 2. Differences in School-Level Student Attributes Among Quartiles of School Free Lunch Eligibility by Economic Segregation Quadrants

Economic Segregation Quadrant	Proportion Free Lunch Eligible			Difference Proportion Free Lunch Eligible		Difference Proportion Black or Hispanic		Difference Mean Achievement		Percent of Schools
	Core City 4th	Core City 2nd	Outlying 2nd	Within Core	Core-Outlying	Within Core	Core-Outlying	Within Core	Core-Outlying	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Within, not Between (1)	0.611	0.270	0.420	0.341	0.191	0.378	0.294	-0.499	-0.301	4.5
Within & Between (2)	0.837	0.432	0.313	0.405	0.524	0.362	0.562	-0.538	-0.631	28.9
Between, not Within (3)	0.881	0.743	0.303	0.139	0.578	0.183	0.690	-0.257	-0.846	57.1
Not Within or Between (4)	0.808	0.625	0.687	0.183	0.121	0.159	0.153	-0.262	-0.126	9.6
Total	0.849	0.621	0.348	0.229	0.501	0.241	0.584	-0.350	-0.690	100.1

Note: "Core" refers to schools in the principal city of the MSA; "outlying" refers to schools in that MSA outside of the core. Economic segregation quadrant refers to the quadrants depicted in the top panel of Figure 4; "Within" segregation refers to high levels of segregation within the core LEA, while "Between" refers to high levels of segregation between the core LEA and outlying schools in the MSA. Columns 1-2 show the mean proportion of free-lunch-eligible students for the 4th and 2nd quartiles of core schools' free-lunch eligibility. Column 3 shows the mean for the 2nd quartile of outlying schools in the MSA. Columns 4-9 show the difference in the proportions school quartiles. Achievement is calculated in school-level standard deviations. Estimates based on averages from 2016 and 2018.

Table 3. Standardized Socioeconomic Status of Residents by Race/Ethnicity, Jurisdiction, and Economic Segregation Quadrants

Economic Segregation Quadrant	Standardized Socioeconomic Status											
	All			Black			Hispanic			White		
	MSA	Core	Outlying	MSA	Core	Outlying	MSA	Core	Outlying	MSA	Core	Outlying
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Within, not Between (1)	0.427	0.703	0.171	-1.400	-1.030	-1.435	-0.504	-0.233	-0.566	0.940	1.141	0.672
Within & Between (2)	0.375	0.218	0.466	-1.630	-1.782	-1.139	-0.706	-0.780	-0.333	0.821	0.829	0.701
Between, not Within (3)	0.158	-0.814	0.471	-1.946	-2.507	-1.052	-0.905	-1.332	-0.229	0.807	0.410	0.773
Not Within or Between (4)	-0.580	-0.466	-0.716	-1.460	-1.375	-0.969	-1.124	-1.035	-1.141	0.497	0.530	0.412
Total	0.162	-0.414	0.342	-1.787	-2.135	-1.086	-0.848	-1.091	-0.370	0.787	0.575	0.713

Note: SES includes information from the American Community Survey 5-year pooled samples for 2014-18 which employ data for the total residential population. SES reflects a combination of median income, percent of adults with a bachelor's degree, child poverty rate, SNAP receipt rate, single mother headed household rate, and unemployment rate for adults ages 16-64. The overall SES measure is constructed to have an enrollment weighted mean of 0 and standard deviation of 1. Details of the variable construction can be found in SEDA Documentation 4.1 at http://purl.stanford.edu/db586ns4974. MSA is the MSA-wide measure, "Core" is the measure for the LEA of the principal city, and "Outlying" includes all other LEAs in the MSA. "Within" refers to high segregation within the core, while "Between" refers to high segregation between core and outlying schools.

Table 4. Differences in School-Level Student Attributes by Quartiles of Free Lunch Eligibility and Economic Segregation Quadrants

Economic Segregation Quadrant	Difference Proportion					
	LEP		Special Education		Chronically Absent	
	Within Core	Core-Outlying	Within Core	Core-Outlying	Within Core	Core-Outlying
	(1)	(2)	(3)	(4)	(5)	(6)
Within, not Between (1)	0.091	0.082	0.025	0.025	0.047	0.022
Within & Between (2)	0.149	0.201	0.010	0.011	0.063	0.085
Between, not Within (3)	0.035	0.152	0.005	0.014	0.048	0.149
Not Within or Between (4)	0.131	0.098	-0.002	-0.002	0.025	0.023
Total	0.080	0.158	0.006	0.012	0.050	0.113

Note: "Core" refers to schools in the principal city of the MSA; "outlying" refers to schools in that MSA outside of the principal city. Columns 1-6 show the difference in the proportion of measures of school level student attributes between school deciles by school economic segregation quadrants (see the top panel of Figure 4), where "within" refers to high segregation within the core, while "between" refers to high segregation between core and outlying schools. Estimates based on averages from 2016 and 2018.

Table 5. Geographic Structure and Revenues of School Districts by Economic Segregation Quadrant

Economic Segregation Quadrant	Proportion of City Schools in Core City LEA	Median LEAs per MSA	Median LEA Enrollment		Median Revenue/Pupil	
			Core	Outlying	Core	Outlying
	(1)	(2)	(3)	(4)	(5)	(6)
Within, not Between (1)	0.600	4	16,181	6,197	$10,760	$10,778
Within & Between (2)	0.794	13	18,691	2,284	$11,245	$11,350
Between, not Within (3)	0.919	24	13,687	1,903	$13,887	$12,322
Not Within or Between (4)	0.838	10	15,495	2,245	$11,238	$13,251
Total	0.861	18	15,004	2,079	$12,054	$12,041

Notes: "Core" refers to schools in the principal city of the MSA; "outlying" refers to schools in that MSA outside of the principal city. The proportion of city schools in the core city LEA is calculated as portion of core-city LEA schools which are classified as urban. School district revenues are for 2016 based on data from the NCES Common Core of Data School District Finance Survey (F33). "Within" segregation refers to high levels of segregation within the core city schools, while "Between" refers to high levels of segregation between the core city schools and outlying schools in the MSA. Economic segregation quadrant refers to the quadrants depicted in the top panel of Figure 4. Other data reflect averages for 2016 and 2018.

Table 6. Differences in School-Level Teacher Qualifications Between Free-Lunch-Eligible Student Quartiles by Economic Segregation Quadrant

Economic Segregation Quadrant	Difference Proportion: 1st & 2nd year teachers		1st year teachers		Teachers Not Certified	
	Within Core (1)	Core-Outlying (2)	Within Core (3)	Core-Outlying (4)	Within Core (5)	Core-Outlying (6)
Within, not Between (1)	0.032	-0.047	0.017	-0.037	0.007	0.012
Within & Between (2)	0.054	0.071	0.032	0.037	0.012	0.029
Between, not Within (3)	0.035	0.086	0.023	0.055	0.008	0.029
Not Within or Between (4)	0.028	0.007	0.023	0.006	0.003	-0.005
Total	0.040	0.068	0.026	0.041	0.009	0.025

Note: Columns show the difference in the proportion of measures of teacher qualifications between school quartiles of concentration by student free lunch eligibility by MSA economic segregation quadrants, where "within" segregation refers to high levels of segregation within the core city schools, while "Between" refers to high levels of segregation between the core city schools and outlying schools in the MSA (see the top panel of Figure 4). "Core" refers to schools in the principal city of the MSA; "outlying" refers to schools in that MSA outside of the principal city. Estimates based on averages from 2016 and 2018.

Table 7. Summary of Estimated Returns to Experience Improvement First Five Years

Study	**Difference Years 1-5**
Atteberry et al. (2015)	0.07-0.12
Bell et al., 2021	0.05-0.10
Boyd et al., (2008)	0.14
Clotfelter et al., (2007)	0.05
Harris & Sass (2007)	0.05-0.07
Kraft & Papay (2016)	0.05-0.12
Ost (2014)	0.05-0.09
Papay & Kraft (2011)	0.06-0.08
Papay & Laski (2018)	0.08-0.18
Rivkin et al., (2005)	0.04-0.06
Rockoff (2004)	0.07-0.18

Table 8. Exposure to Novice Teachers by Core City Schools and Outlying MSA Schools, Quartiles and Economic Segregation Quadrant

Economic Segregation Quadrant	Probability Exposed Outlying, Quartile 2	Δ Core - Outlying to: 1	2	≥ 1	Δ Core ≥ 1 Novice Teachers	Δ Student Achievement Core – Outlying
		Novice Teachers				
	(1)	(2)	(3)	(4)	(5)	(6)
Within, not Between (1)	0.610	-0.038	-0.063	-0.124	0.100	-0.019
Within & Between (2)	0.405	0.078	0.094	0.201	0.147	0.029
Between, not Within (3)	0.395	0.087	0.113	0.237	0.086	0.034
Not Within or Between (4)	0.479	0.009	0.009	0.020	0.086	0.003
Total	0.472	0.034	0.038	0.084	0.105	0.012

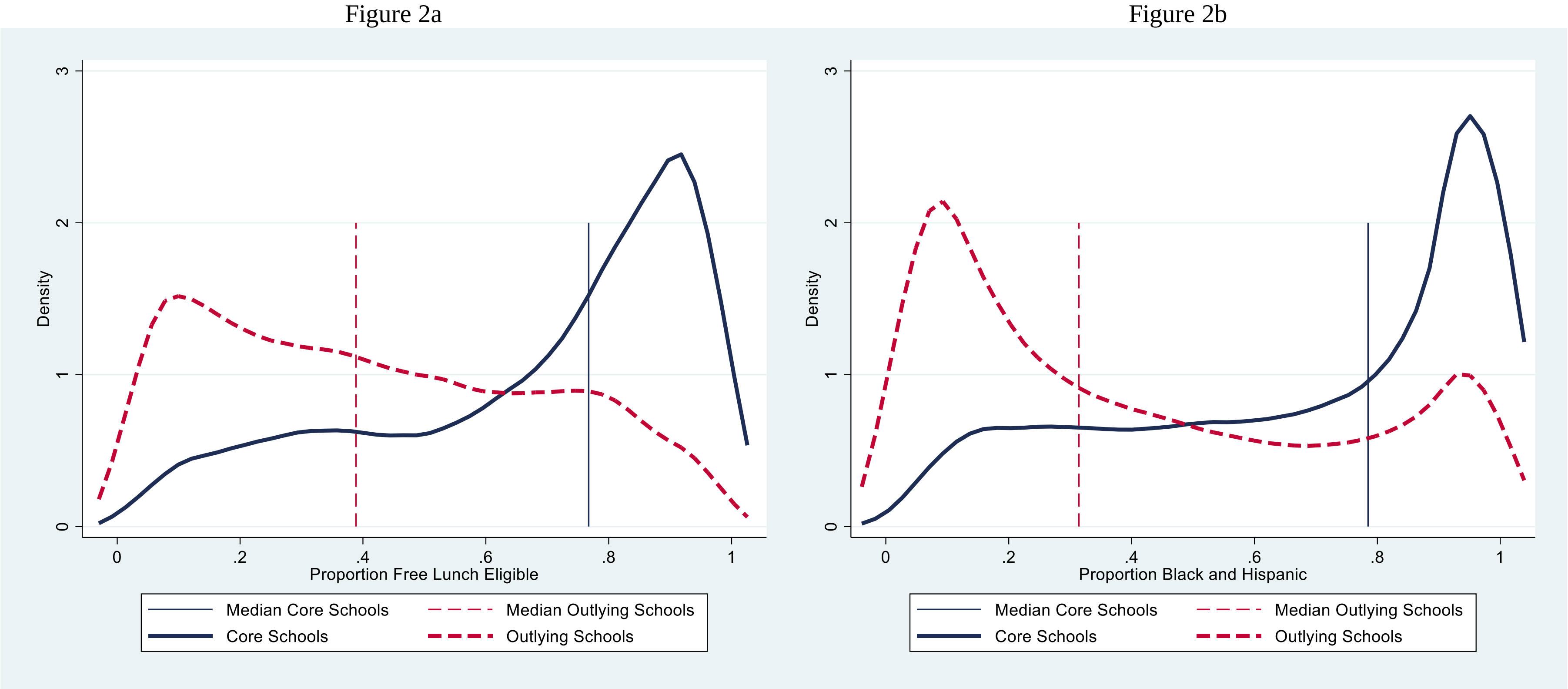
Notes: Exposure is the estimated likelihood of being exposed to a 1st or 2nd year teacher over the course of 5 years of elementary school conditional on the annual exposure rates shown in Table 6. Column (1) shows the baseline likelihood of exposure to a novice over 5 years in the 2nd quartile of school free lunch eligibility in the MSA outside the core city. Column (2) shows the differential exposure rate to exactly 1 novice teacher between the 4th quartile of core (principal city) schools and the 2nd quartile of outlying (all other) schools. Column (3) shows the differential exposure rate to exactly 2 novice teachers. Column (4) shows the differential exposure rate to at least 1 novice teacher. Column (5) shows the differential exposure rate between the core city's 4th quartile and the core city's 2nd quartile to at least 1 novice teacher. Column (6) shows the differential estimate student achievement of the column (4) exposure rates employing an estimate of 0.08 SD for each year of exposure to a novice teacher. Economic segregation quadrants are illustrated in the top panel of Figure 4; "within" segregation refers to high levels of segregation within the core city schools, while "Between" refers to high levels of segregation between the MSA's core city schools and outlying (all other) schools in the same MSA.

Table 9. Exposure to Non-Certified Teachers by Core City Schools and Outlying MSA Schools, Quartiles and Economic Segregation Quadrant

Economic Segregation Quadrant	Probability Exposed Other, Quartile 2	Δ Core - Other to: 1	2	≥ 1	Δ Core ≥ 1 Not Certified Teachers
		Not Certified Teachers			
	(1)	(2)	(3)	(4)	(5)
City, Not Other (1)	0.107	0.046	0.006	0.052	0.033
City and Other (2)	0.067	0.116	0.015	0.131	0.053
Other, Not City (3)	0.047	0.118	0.012	0.131	0.034
Not City, Not Other (4)	0.106	-0.020	-0.002	-0.022	0.012
Total	0.082	0.065	0.008	0.073	0.033

Notes: See notes to Table 8.

Figures 2a & 2b. Densities of School Proportion Black or Hispanic and free lunch, among U.S. Elementary Schools, by urbanicity, 2016 & 2018



Note: Densities based on the 27,970 schools contained in large and medium MSAs employing variable values averaged across 2016 and 2018.

Figures 3a-h. Illustrative Distributions of Proportions Free Lunch and Black or Hispanic, Elementary Schools, 2016 & 2018

Figure 3a

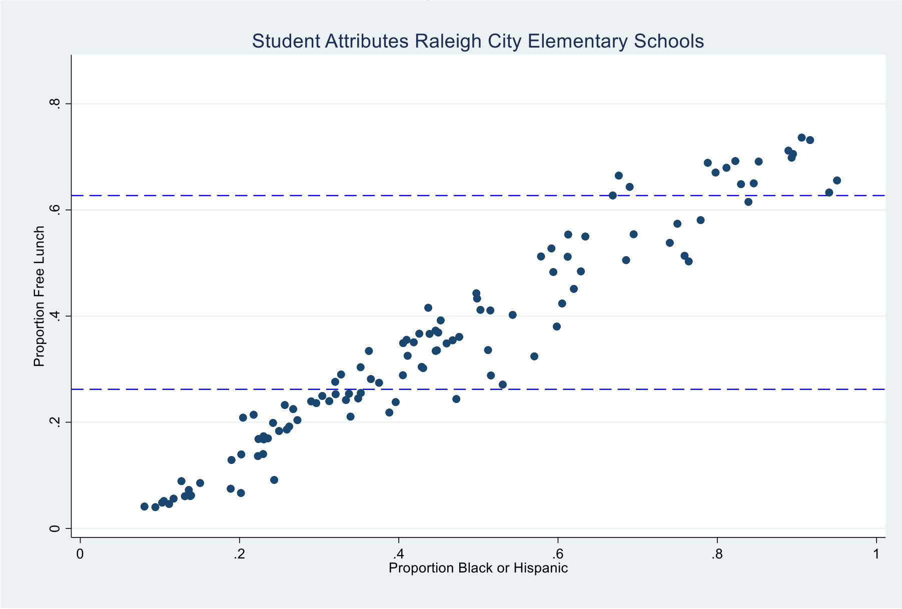


Figure 3b

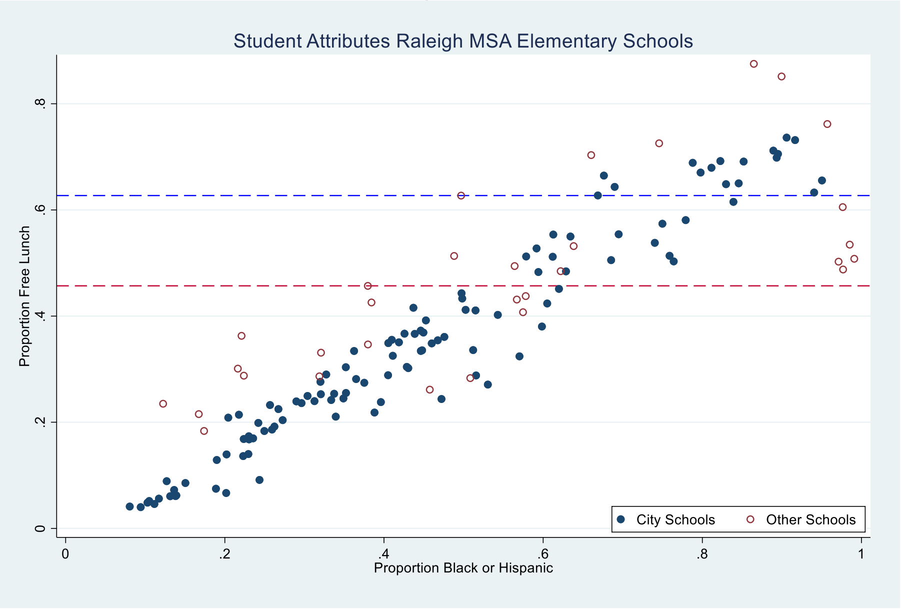


Figure 3c

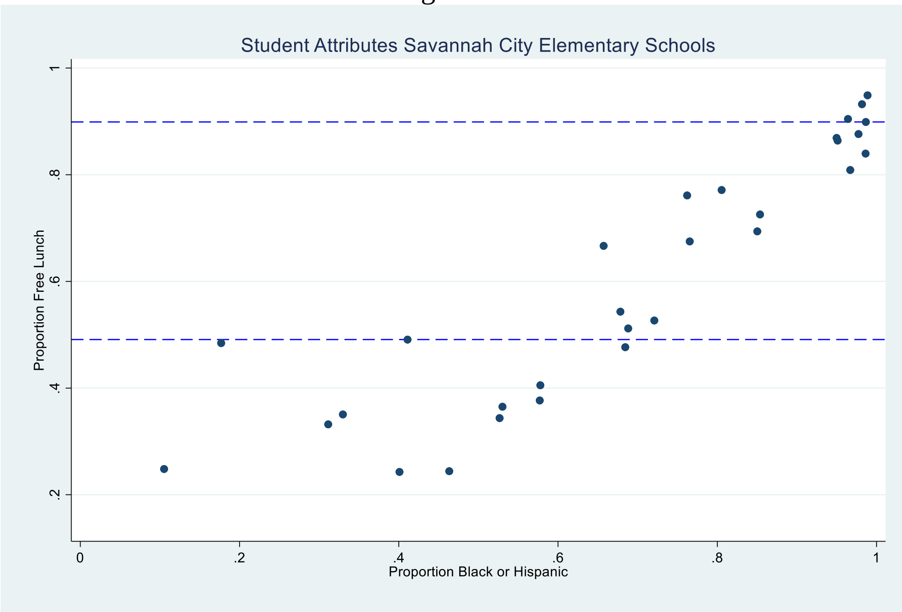


Figure 3d

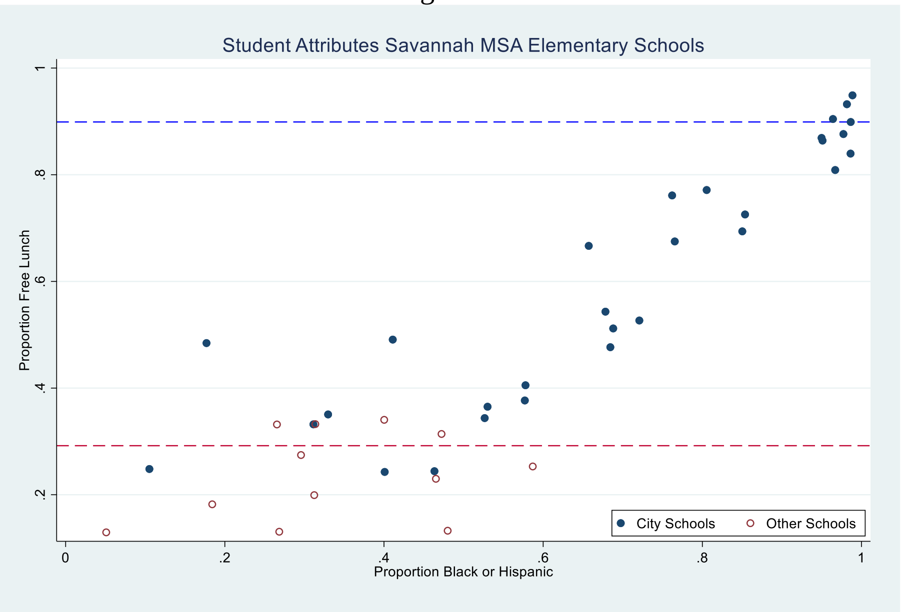


Figure 3e

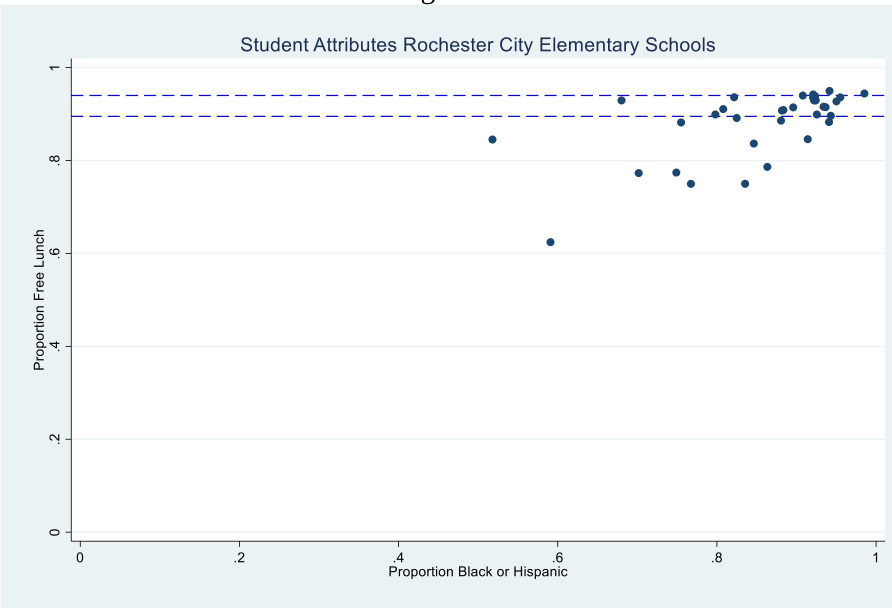


Figure 3f

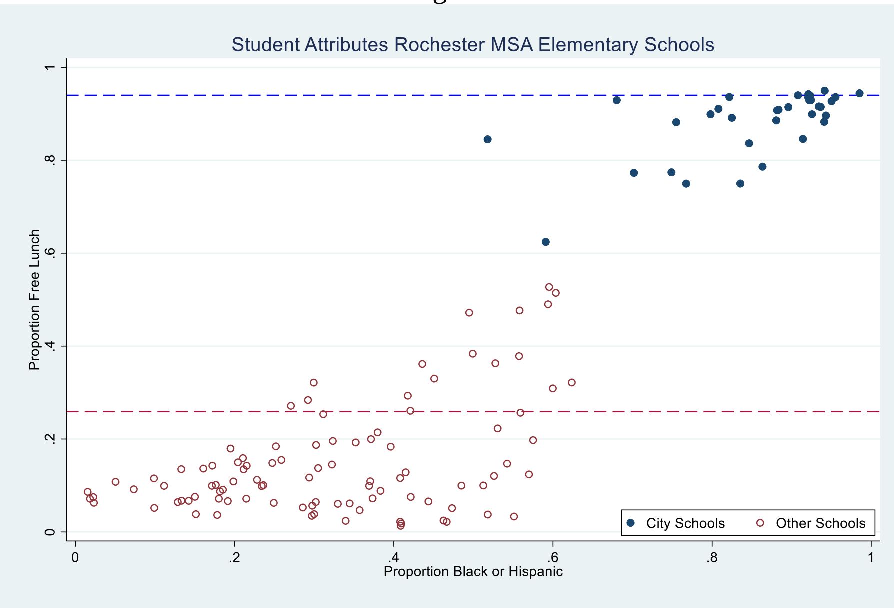


Figure 3g

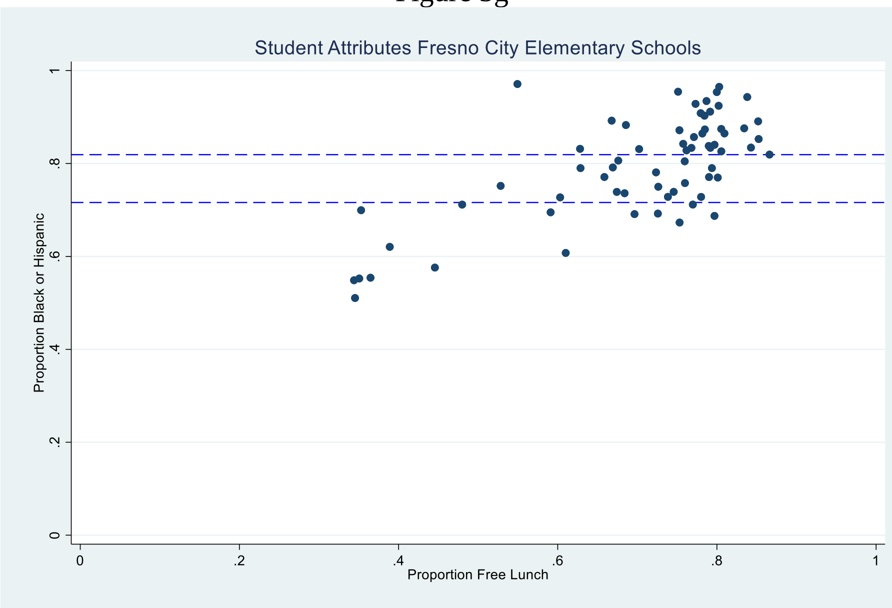


Figure 3h

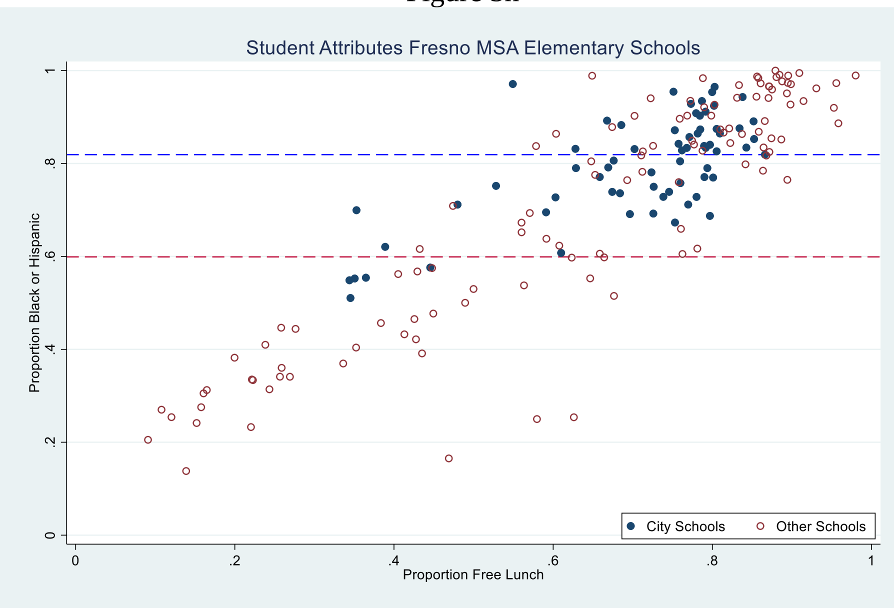
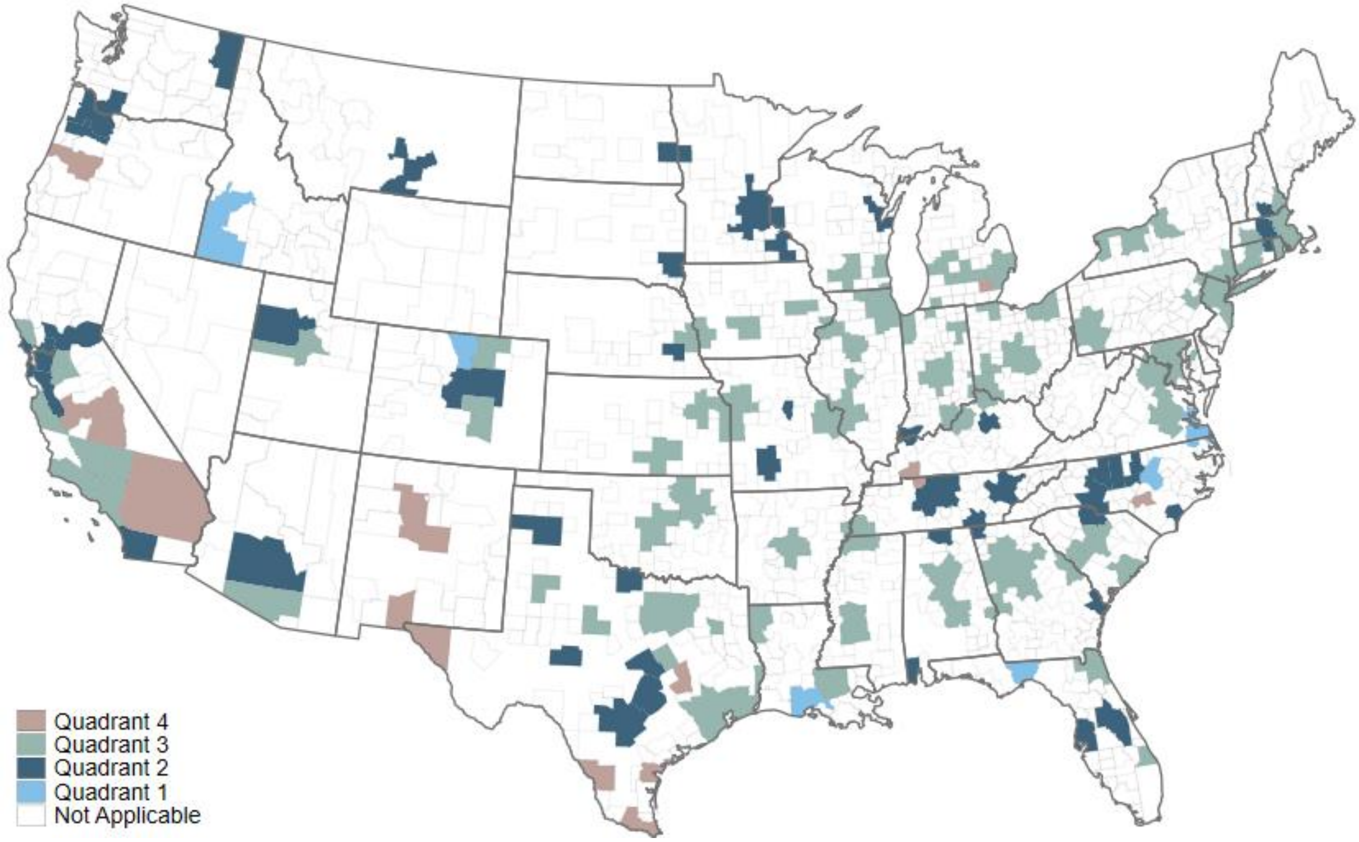


Figure 4. Differences in proportion of free lunch eligible students (top panel) or Black and Hispanic students (bottom panel) within core elementary schools and between core and outlying MSA schools, 2016 & 2018

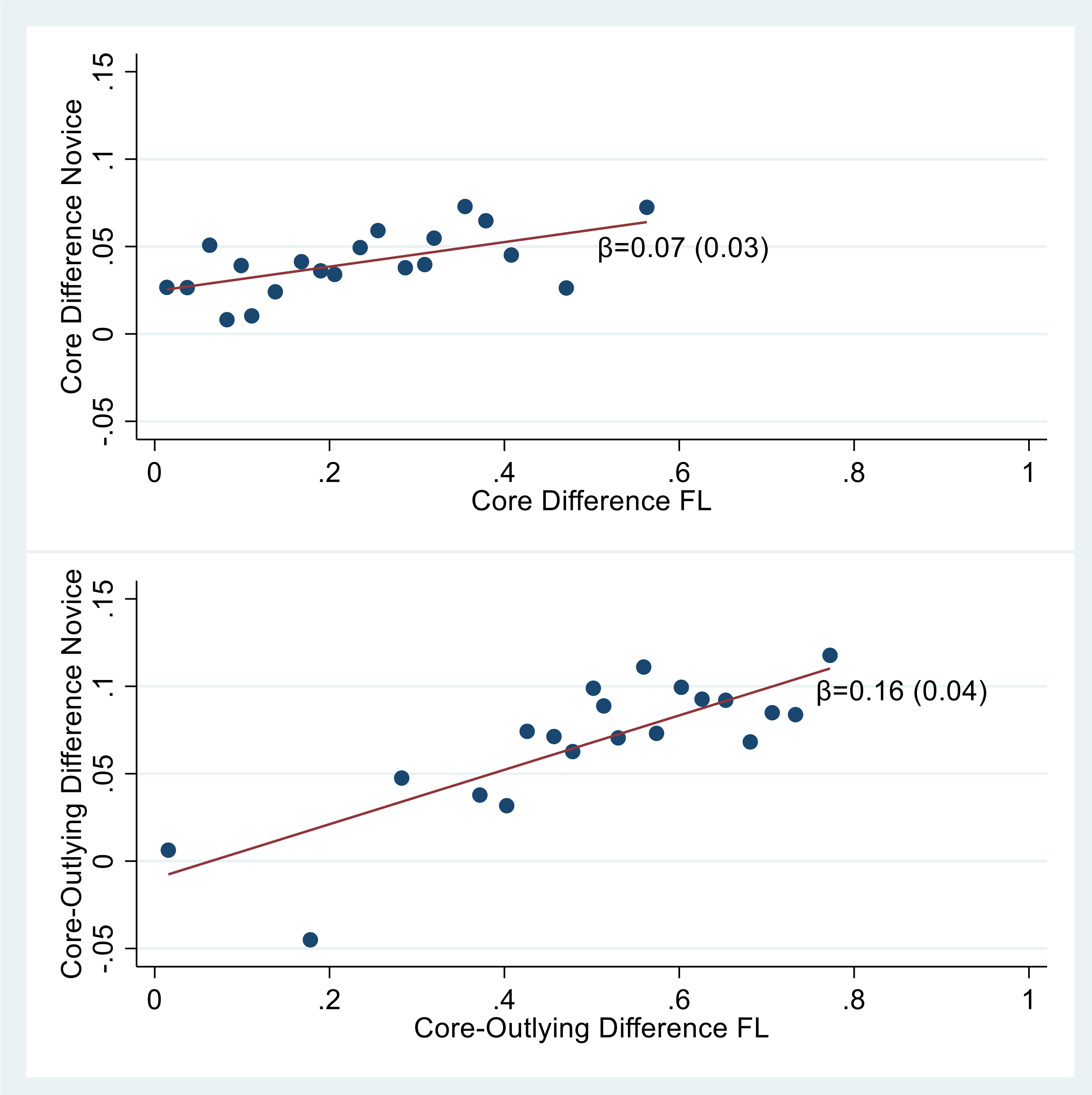
Notes: Within-MSA differences in the percentage of students in the 4th and 2nd quartiles of proportion of school's students who are free lunch eligible of core (principal city) elementary schools (vertical axis) and difference between core 4th quartile and 2nd quartile of outlying (all other) MSA schools (horizontal) axis. Red lines represent a difference that exceeds 30 percentage points. MSAs have a core city with a population of greater than 100,000. Estimates based on averages from 2016 and 2018. FL = free lunch eligibility.

Figure 5. The Distribution of Large and Medium MSAs by Economic Segregation Quadrants



Notes: MSAs coded by the economic segregation quadrant described in the top panel of Figure 4. Quadrant 1 includes MSAs with high segregation within the MSA's core LEA, but not between the core and outlying (all other) LEAs in the same MSA; Quadrant 2 includes MSAs with high segregation both within the core LEA and between the core and outlying LEAs; Quadrant 3 includes MSAs with high segregation between the core and outlying LEAs but not within the core LEA; and Quadrant 4 includes MSAs that do not have high segregation either within the core LEA or between the core and outlying LEAs.

Figure 6. The Relationship Between Economic Segregation to Exposure to Novice Teachers, Within Core LEAs and Between Core and Outlying Schools, 2016 & 2018.



Notes: Plot is a binned scatterplot. Coefficient is from regression $Difference\ Novice\ exposure = \alpha + \beta Difference\ FL + \epsilon$ with 156 MSAs, where $Difference\ FL$ is either the (within) core difference (top panel) or the (between) core-outlying difference (bottom panel) in FL (free-lunch-eligibility) rates. Core difference FL is the difference between the 4^{th} and 2^{nd} quartile of free lunch eligibility of schools within the core LEA of each MSA. Core difference novice is the difference in the proportion of novice teachers between the 4^{th} and 2^{nd} quartile of free lunch eligibility of schools. Core-outlying difference FL is the difference between the 4^{th} quartile of free lunch eligibility for the core LEA and the 2^{nd} quartile of all other ("outlying") schools in the same LEA. The core-outlying difference novice is the difference in the proportion of novice teachers between the 4^{th} quartile of free lunch eligibility of the core LEA and the 2^{nd} quartile of free lunch eligibility of outlying schools in the MSA.

Appendices

Appendix A. Robustness of Results Employing School Concentration by Race/Ethnicity to Assess Teacher Sorting

Table A1. Differences in School-Level Student Attributes Among Quartiles of Percentage of Black and Hispanic Students by Racial Segregation Quadrants

Racial Segregation Quadrant	Difference Proportion: Black or Hispanic, Within Core (1)	Difference Proportion: Black or Hispanic, Core-Outlying (2)	Difference Proportion: Free Lunch Eligible, Within Core (3)	Difference Proportion: Free Lunch Eligible, Core-Outlying (4)	Difference Mean Achievement: Within Core (5)	Difference Mean Achievement: Core-Outlying (6)	Percent of Schools (7)
Within, not Between (1)	0.426	0.203	0.363	0.187	-0.451	-0.215	1.9
Within & Between (2)	0.409	0.651	0.336	0.532	-0.515	-0.738	32.1
Between, not Within (3)	0.160	0.661	0.160	0.560	-0.253	-0.801	53.9
Not Within or Between (4)	0.127	0.124	0.228	0.208	-0.238	-0.199	12.2
Total	0.241	0.584	0.229	0.501	-0.339	-0.696	100.1

Note: Columns 1-6 show the difference in the proportion of measures of school-level student attributes between school quartiles by MSA economic segregation quadrants (see the bottom panel of Figure 4), where "within" refers to high levels of segregation within the core city schools, and "Between" refers to high levels of segregation between the core city schools and outlying schools in the MSA. "Core" refers to schools in the principal city of the MSA; "outlying" refers to schools in that MSA outside of the principal city. Achievement is calculated in school-level standard deviations. Estimates based on averages from 2016 and 2018.

Table A2. Standardized Socioeconomic Status of Residents by Race/Ethnicity, Jurisdiction, and Racial Segregation Quadrants

Racial Segregation Quadrant	All: MSA (1)	All: Core (2)	All: Outlying (3)	Black: MSA (4)	Black: Core (5)	Black: Outlying (6)	Hispanic: MSA (7)	Hispanic: Core (8)	Hispanic: Outlying (9)	White: MSA (10)	White: Core (11)	White: Outlying (12)
Within, not Between (1)	0.393	0.668	0.308	-1.742	-0.894	-0.881	-0.367	-0.031	-0.535	1.036	1.143	0.926
Within & Between (2)	0.301	-0.015	0.423	-1.859	-2.170	-1.134	-0.721	-0.905	-0.285	0.782	0.689	0.673
Between, not Within (3)	0.184	-0.713	0.470	-1.808	-2.285	-1.072	-0.895	-1.295	-0.273	0.839	0.506	0.790
Not Within or Between (4)	-0.342	-0.316	-0.432	-1.434	-1.380	-1.051	-1.065	-0.900	-0.997	0.532	0.493	0.441
Total	0.162	-0.414	0.342	-1.787	-2.135	-1.086	-0.848	-1.091	-0.370	0.787	0.575	0.713

Standardized Socioeconomic Standing

Note: SES includes information from the American Community Survey 5-year pooled samples for 2014-18 which employ data for the total residential population. SES reflects a combination of median income, percent of adults with a bachelor's degree, child poverty rate, SNAP receipt rate, single mother headed household rate, and unemployment rate for adults age 16-64. The exact details of the variable construction can be found in SEDA Documentation 4.1 at http://purl.stanford.edu/db586ns4974. MSA is the MSA-wide measure, "Core" is the measure for the principal city LEA, and "Outlying" includes all other LEAs in the MSA. See the bottom panel of Figure 4 for racial segregation quadrants; "within" refers to high segregation within the core, while "between" refers to high segregation between core and outlying schools.

Table A4. Differences in School-Level Student Attributes by Quartiles of Black and Hispanic Students and Racial Segregation Quadrants

Racial Segregation Quadrant	LEP Within Core	LEP Core-Outlying	Special Education Within Core	Special Education Core-Outlying	Chronically Absent Within Core	Chronically Absent Core-Outlying
	Difference Proportion					
	(1)	(2)	(3)	(4)	(5)	(6)
Within, not Between (1)	0.098	0.045	0.012	0.026	0.054	0.025
Within & Between (2)	0.120	0.188	0.007	0.012	0.054	0.095
Between, not Within (3)	0.046	0.160	-0.005	0.003	0.040	0.130
Not Within or Between (4)	0.109	0.116	-0.003	-0.004	0.025	0.036
Total	0.078	0.162	-0.001	0.006	0.043	0.105

Note: "Core" refers to schools in the principal city of the MSA; "outlying" refers to schools in that MSA outside of the principal city. Columns 1-6 show the difference in the proportion of measures of school-level student attributes between school deciles by school racial segregation quadrants (see the bottom panel of Figure 4), where "within" refers to high segregation within the core, while "between" refers to high segregation between core and outlying schools. Estimates are based on averages from 2016 and 2018.

A5. Geographic Structure and Revenues of School Districts by Racial Segregation Quadrant

Racial Segregation Quadrant	Proportion of City Schools in Core City LEA	Median LEAs per MSA	Median LEA Enrollment Core	Median LEA Enrollment Outlying	Median Revenue/Pupil Core	Median Revenue/Pupil Outlying
	(1)	(2)	(3)	(4)	(5)	(6)
Within, not Between (1)	0.63	4	16,181	6,197	$10,966	$10,778
Within & Between (2)	0.87	12	18,691	2,284	$12,156	$11,897
Between, not Within (3)	0.93	22	13,687	1,903	$13,372	$12,060
Not Within or Between (4)	0.78	20	15,495	2,245	$11,238	$12,732
Total	0.87	18	15,004	2,079	$12,054	$12,041

Notes: "Core" refers to schools in the principal city of the MSA; "outlying" refers to schools in that MSA outside of the principal city. The proportion of city schools in the city LEA is calculated as the portion of core city LEA schools which are classified as urban. School district revenues are for 2016 based on data from the NCES Common Core of Data School District Finance Survey (F33). Racial segregation quadrant refers to the quadrants depicted in the bottom panel of Figure 4), where "within" refers to high segregation within the core, while "between" refers to high segregation between core and outlying schools. Other data reflect median for 2016 and 2018.

A6. Differences in School-Level Teacher Qualifications by Proportion of Black or Hispanic Student Deciles by Racial Segregation Quadrant

Racial Segregation Quadrant	1st & 2nd year teachers Core (1)	1st & 2nd year teachers Core-Outlying (2)	Difference Proportion 1st year teachers Core (3)	1st year teachers Core-Outlying (4)	Teachers Not Certified Core (5)	Teachers Not Certified Core-Outlying (6)
Within, not Between (1)	0.019	-0.102	0.008	-0.087	0.004	0.007
Within & Between (2)	0.059	0.077	0.037	0.048	0.011	0.029
Between, not Within (3)	0.029	0.076	0.016	0.046	0.007	0.030
Not Within or Between (4)	0.034	0.024	0.021	0.016	0.002	0.000
Total	0.039	0.067	0.023	0.040	0.008	0.026

Note: "Core" refers to schools in the principal city of the MSA; "outlying" refers to schools in that MSA outside of the principal city. Columns show the difference in the proportion of measures of teacher qualifications between school quartiles of concentration by Black and Hispanic students by MSA racial segregation quadrants (see the bottom panel of Figure 4), where "within" refers to high segregation within the core, while "between" refers to high segregation between core and outlying schools. Estimates are based on averages from 2016 and 2018.

Table A7. Exposure to Novice Teachers by Core City Schools and Outlying MSA Schools, Quartiles and Racial Segregation Quadrant

Racial Segregation Quadrant	Probability Exposed Other, Quartile 2 (1)	Δ Core 4th - Outlying 2nd to: 1 Novice Teachers (2)	Δ Core 4th - Outlying 2nd to: 2 Novice Teachers (3)	Δ Core 4th - Outlying 2nd to: ≥ 1 Novice Teachers (4)	Δ Core 4^{th} – Core 2^{nd} ≥ 1 Novice Teachers (5)	Difference Student Achievement (6)
Within, not Between (1)	0.648	-0.107	-0.132	-0.283	0.069	-0.041
Within & Between (2)	0.400	0.082	0.101	0.215	0.158	0.031
Between, not Within (3)	0.401	0.081	0.100	0.213	0.072	0.030
Not Within or Between (4)	0.479	0.026	0.033	0.068	0.096	0.010
Total	0.482	0.021	0.025	0.054	0.099	0.008

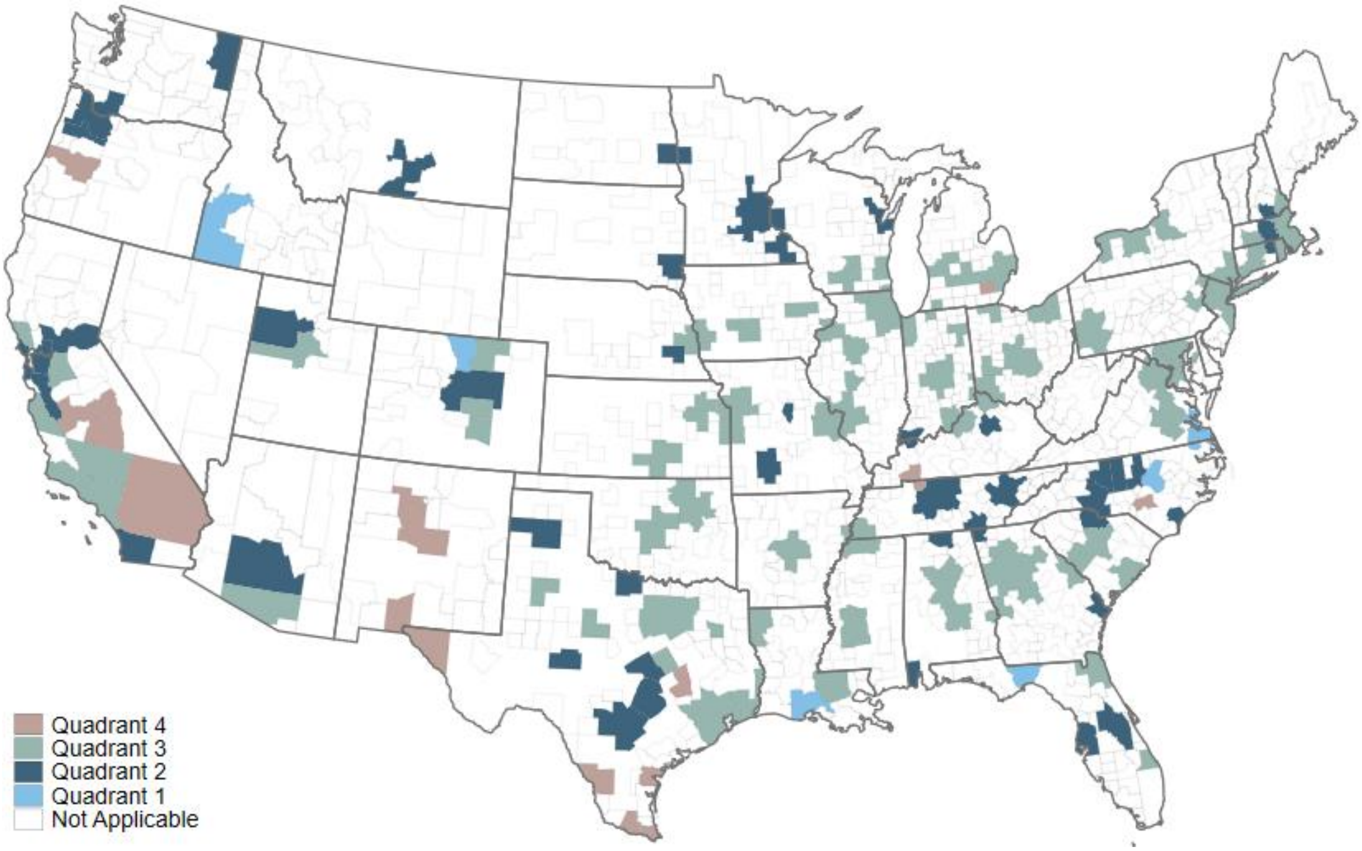
Notes: Exposure is the estimated likelihood of being exposed to a 1^{st} or 2^{nd} year teacher over the course of 5 years of elementary school conditional on the annual exposure rates shown in Table A6. Column (1) shows the baseline likelihood of exposure to a novice over 5 years in the 2^{nd} quartile of school free lunch eligibility in other schools. Column (2) shows the differential exposure rate to exactly 1 novice teacher between core (principal city LEA) and outlying (all other) schools. Column (3) shows the differential exposure rate to exactly 2 novice teachers. Column (4) shows the differential exposure rate to at least 1 novice teacher. Column (5) shows the differential exposure rate between the core schools to at least 1 novice teacher. Column (6) shows the differential estimate student achievement of the column (4) exposure rates employing an estimate of 0.08 SD for each year of exposure to a novice teacher. Racial segregation quadrants are illustrated in the bottom panel of Figure 4; "within" segregation refers to high levels of segregation within the core city schools, while "Between" refers to high levels of segregation between the MSA's core city schools and outlying (all other) schools in the same MSA.

Table A8. Exposure to Non-Certified Teachers by Core City Schools and Outlying MSA Schools, Quartiles and Racial Segregation Quadrant

Racial Segregation Quadrant	Probability Exposed Outlying, Quartile 2	Δ Core 4th - Outlying 2nd to: 1	2	≥ 1	Δ Core 4th - Core 2nd ≥ 1
			Novice Teachers		Novice Teachers
	(1)	(2)	(3)	(4)	(5)
Within, not Between (1)	0.040	0.033	0.002	0.034	0.020
Within & Between (2)	0.059	0.116	0.014	0.131	0.046
Between, not Within (3)	0.066	0.118	0.015	0.133	0.031
Not Within or Between (4)	0.044	-0.001	0.000	-0.001	0.010
Total	0.052	0.066	0.007	0.074	0.027

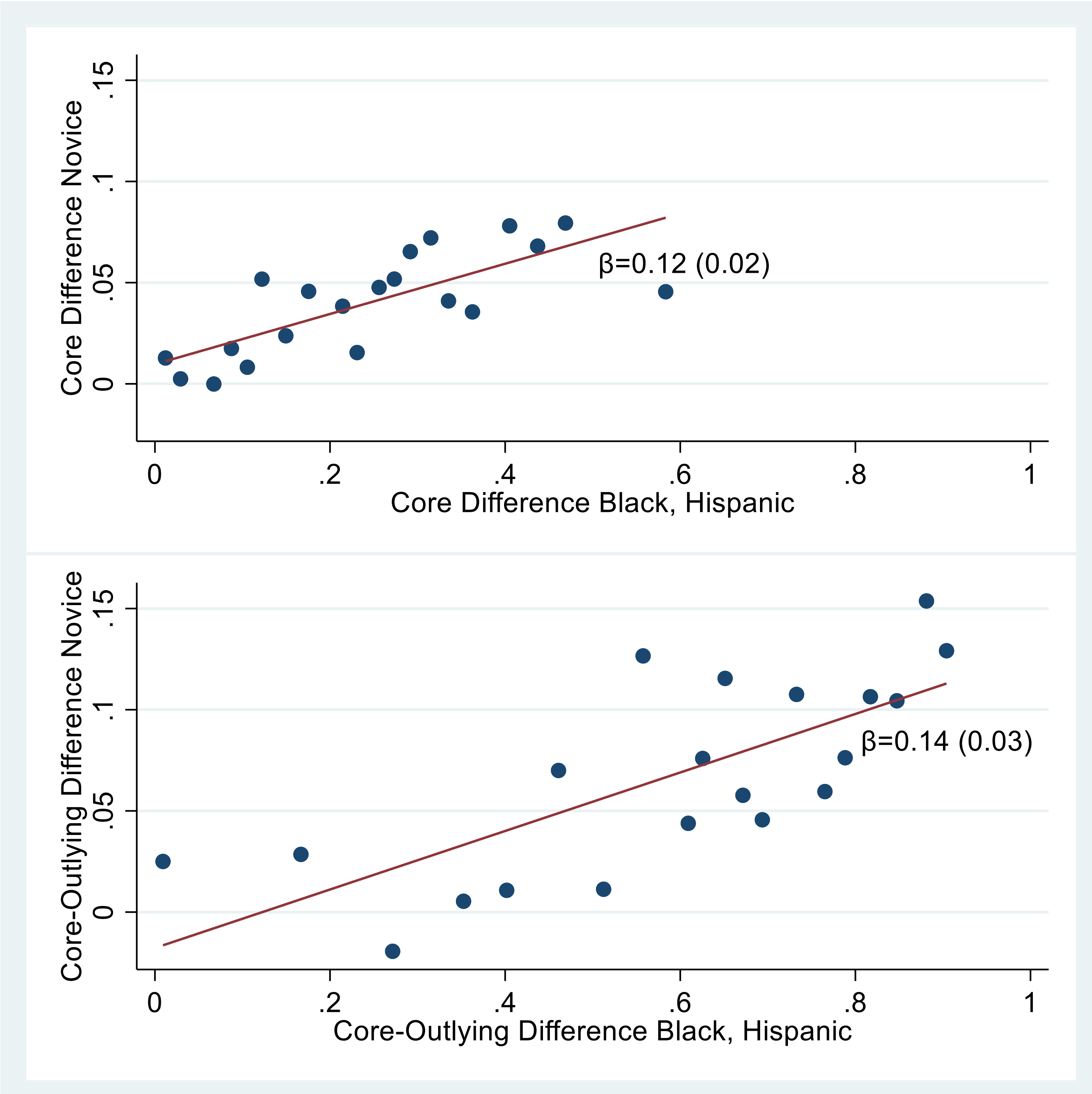
Notes: See notes to Table A7.

Figure A1. The Distribution of Large and Medium MSAs by Racial Segregation Quadrants



Notes: MSAs coded by the racial segregation quadrant described in the bottom panel of Figure 4. Quadrant 1includes MSAs with high segregation within the MSA's core LEA, but not between the core and outlying (all other) LEAs in the same MSA; Quadrant 2 includes MSAs with high segregation both within the core LEA and between the core and outlying LEAs; Quadrant 3 includes MSAs with high segregation between the core and outlying LEAs but not within the core LEA; and Quadrant 4 includes MSAs that do not have high segregation either within the core LEA or between the core and outlying LEAs.

Figure A2. The Relationship Between Racial Segregation and Differential Exposure to Novice Teachers, Within Core LEAs and Between Core and Outlying Schools, 2016 & 2018.



Notes: Plot is a binned scatterplot. Coefficient is from regression $Difference\ Novice\ Exposure = \alpha + \beta Difference\ Black, Hispanic + \epsilon$ with 156 MSAs, where $Difference\ Black, Hispanic$ is either the (within) core difference (top panel) or the (between) core-outlying difference (bottom panel) in school-level proportion of students who are Black or Hispanic. Core Difference Black, Hispanic is the difference between core LEA's 4th and 2nd quartile based on schools' proportion of students who are Black or Hispanic. Core difference novice is the difference in the proportion of novice teachers between the 4th and 2nd quartile of core LEA schools by proportion Black and Hispanic. The core-outlying difference is the difference between the 4th quartile proportion Black and Hispanic for core schools and the 2nd quartile of other schools in the MSA. Core-outlying difference novice is the difference in the proportion of novice teachers between the 4th quartile of Black and Hispanic students in the core LEA and the 2nd quartile of all other schools in the LEA.