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Going the Distance: Exploring Variation in Access to High-Quality PreK by Geographic Proximity, Race/Ethnicity, Family Income, and Home Language

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Abstract

This study leverages six years of public prekindergarten (PreK) and kindergarten data (N = 22,469) from the Boston Public Schools (BPS) to examine enrollment in BPS PreK from 2012–2017 for students from different racial/ethnic, socioeconomic, and linguistic groups. The largest differences in enrollment emerged with respect to race and ethnicity—and for enrollment in programs in higher-quality schools (defined as schools scoring in the top quartile on third grade standardized tests)—with disparities increasing over time. Although there were no differences across groups in proximity to BPS PreK programs in general, Black students lived about a quarter of a mile further than their White peers from the nearest program in a higher-quality school, with gaps widening over time. Closer proximity was associated with a higher likelihood of enrollment in a program in a higher-quality school. Implications for future research and policy are discussed.

Keywords: *PreK, access, enrollment, equity*

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Expanding access to high-quality public PreK has emerged as a key policy lever for supporting young children's development (Chaudry et al., 2021) and is thought to be a tool for promoting more equitable learning for children from marginalized groups (Bloom & Weiland, 2015; Phillips et al., 2017; Puma et al., 2010; Weiland & Yoshikawa, 2013). Yet, there are sizable disparities in *availability of* and *enrollment in* early childhood education programs—and high-quality programs in particular—depending on children's racial/ethnic, linguistic, and socioeconomic backgrounds (Barnett & Yarosz, 2007; Latham et al., 2020). As federal and state policymakers make historic proposals to expand the availability of high-quality PreK across the country, there is a critical need to examine patterns of equitable enrollment in PreK across time and to identify the key factors that facilitate and inhibit enrollment for students from families with lower incomes, Dual Language Learners (DLLs), and those from racially/ethnically marginalized groups.[1]

To address this need, we leverage six recent years of data on all children's enrollment in the well-known, high-quality Boston Public Schools (BPS) prekindergarten (BPS PreK) program to consider how patterns of enrollment vary by children's racial/ethnic, linguistic, and socioeconomic backgrounds. Importantly, as is the case in many large cities in the U.S., BPS allocates seats in its public school-based PreK program via a centralized school choice system. As we detail, this system plays a role in enrollment as families' placements also rest on their choices. Following Latham and colleagues' (2021) work on New York City's universal PreK (UPK) program, we focus on children's *enrollment* patterns by demographic groups, regardless of application and choice behaviors. Identifying patterns of

[1] In this paper, we use the terminology "equitable enrollment" to describe enrollment patterns that would be at least proportionate to the demographics of the four-year-old population in Boston or even more ideal, allocate a *larger* number of slots in the higher-quality schools to students from marginalized groups.

inequities, regardless of their origins, is essential for future work on causes and potential remedies.

We make five specific contributions to the literature on PreK enrollment. First, we examine enrollment patterns within each of our six focal years and *across time*, which allows us to understand whether any disparities in enrollment are growing or contracting. Second, we access data on students' enrollment in community-based programs that do not participate in the centralized school choice system and that are partnering with the district to implement the BPS PreK model in order to examine these patterns in the context of a new mixed-delivery system for the final two cohorts. Next, we consider how enrollment in a program in a *higher-quality school* – defined as schools scoring in the top quartile of all BPS elementary settings on third grade state standardized tests – varies for students from socioeconomically, racially/ethnically, and linguistically marginalized groups and whether those differences have changed over time. Importantly, we recognize that test scores are an imperfect measure of school quality. However, because district leaders in BPS view and use test scores as indicators of quality, we also argue that there is strong policy relevance for examining these relationships in this context. In conducting these analyses, we are able to compare enrollment in the program in general and enrollment in the types of higher-quality settings theorized to offer the strongest educational opportunities in the early years and shown to have sustained impacts on children's development in the Boston context (Unterman & Weiland, 2020).

Fourth, we consider a key malleable factor potentially affecting students' enrollment in the program by examining residential proximity to PreK in general and to a higher-quality school, considering how proximity varies by race/ethnicity, family income, and home language, and testing whether it predicts enrollment for children from different groups. Finally, we use geospatial mapping techniques to highlight variation in enrollment across neighborhoods in Boston across time. As federal, state, and local policymakers continue to push for universal PreK (UPK) for three- and four-year old

students, there is a clear need to learn from existing programs in order to build equitable systems at-scale. Findings provide information on factors associated with equitable enrollment in high-quality early learning experiences across time in a large-scale public PreK system.

Variation in Enrollment in PreK in Higher-Quality Settings

High-quality, center-based PreK programming has long been discussed as a policy prescription for directly addressing racial/ethnic, income, and home language-based disparities in children's scores on assessments of school readiness (Bassok et al., 2016; Bradbury et al., 2015; Cannon & Karoly, 2007; Reardon & Portilla, 2016). And high-quality PreK as a tool to promote more equitable learning outcomes does have empirical support with some studies finding that the highest quality programs yield the biggest impacts (Burchinal et al., 2010; Camilli et al., 2010) and other work detecting the largest benefits for students from families with lower-incomes, racially marginalized groups, and DLLs (Bloom & Weiland, 2015; Cascio, 2021; Phillips et al., 2017; Puma et al., 2010; Weiland & Yoshikawa, 2013). Across studies, Chaudry et al. (2017) find that PreK programs on average close about 40% of the gap between children from lower- and middle-income households on assessments of reading and math skills at kindergarten entry, and the most successful programs close nearly all of this gap. Yet, these findings are not universal. Other work using nationally representative data has found that all groups of students tend to benefit similarly from PreK programming (Valentino, 2018) or that White students actually benefit more (e.g., Montrosse-Moorhead et al., 2019). This latter pattern extends to studies examining long-term outcomes as well (e.g., Gormley et al., 2017; Gray-Lobe et al., 2021).

Attention to these differences is especially important because enrollment in PreK programs among children from marginalized groups has been increasing over time (Cannon & Karoly, 2007; Friedman-Krauss et al., 2020). Yet, the literature has also consistently found that Black and Hispanic children and those from families with low incomes are less likely to be in the highest quality and most

cognitively stimulating programs relative to their White and more economically advantaged peers (Bassok et al., 2016). For example, Bassok and Galdo (2016) used neighborhood-level information and data from Georgia's state PreK program to show that in communities with higher proportions of non-White families and families with low-incomes, state PreK classrooms consistently rated lower on observed PreK classroom quality, measured with the Classroom Assessment Scoring System (CLASS; Pianta, LaParo, & Hamre, 2008). These findings align with earlier research from California (Karoly et al., 2008) and a multi-state sample of PreK programs (Early et al., 2010). Enrolling in PreK programs in the highest quality settings – operationalized using both observed measures of PreK classrooms and indicators of broader school quality like third grade standardized test scores – is strongly linked to achieving equitable learning outcomes in the short- (Bartik & Hershbein, 2017) and longer-term (Unterman & Weiland, 2020).

Disparities in enrollment in PreK programs in higher-quality settings have emerged even in UPK systems where *all* age-eligible children can access publicly funded programming. For example, New York City began implementing UPK in 2014 with over 70,000 eligible students enrolling in the program by 2019 (Reid et al., 2019). Students were assigned to programs via a centralized school choice program (similar to Boston). Latham and colleagues (2021) found that White students and students from families with higher incomes were significantly more likely to enroll in UPK programs with the highest levels of instructional quality, emotional support, and classroom organization, as defined using program-level data on the CLASS aggregated across three years (CLASS, Pianta et al., 2008). Valentino (2018) re-examined the NCEDL-SWEEP data and found that Black and Hispanic students, DLLs, and students from families with lower incomes enrolled in lower-quality programs as measured with the CLASS, ECERS, Emerging Academic Snapshot, and other indicators of process quality—on the order of .30 to .70 standard deviations—than their White, non-DLL, and more economically advantaged peers.

Differences in program quality mirrored the magnitude of differences in assessed skills between these groups at the start of kindergarten.

Despite associations between student demographic characteristics – such as family income – and standardized tests (Owens, 2018), we argue that scores on third-grade math and English Language Arts state tests may also an important indicator of overall school quality to consider when examining trends in PreK enrollment (for programs located in public schools where those data are available). Importantly, these measures are typically available on a yearly basis, allowing for examination of how enrollment patterns and access to PreK programs in higher-quality schools change over time. Reardon (2019) also argues that average third-grade test scores are measures of early educational opportunities in a given context. And there is empirical support for this theory. Zhai et al. (2012) conducted a randomized trial of a PreK enhancement intervention and followed up with students as they transitioned to K-12 settings. The research team found that impacts only persisted into elementary school for students who attended elementary schools with higher third grade state test scores. And in an experimental study of the PreK program in Boston, Unterman & Weiland (2020) similarly found that there were only long-term impacts for children who attended programs in the top quartile of the third grade standardized test score distribution. They conducted similar analyses examining demographic characteristics of schools – like the proportion of students in the school from families with low-incomes – and found no evidence that those characteristics were associated with impact variation. Given this theoretical and empirical evidence base – and district policymakers' focus on test scores as their key metric of quality – the third-grade standardized test scores before students enroll in the school serve as a proxy for the school's efficacy from PreK to third grade in educating students. They also capture the broader average early educational opportunities afforded children in the school and for the types of students attracted to it.

Factors Promoting Equitable Enrollment in PreK Programs in Higher-Quality Settings

There is a further need to examine the key *structural* factors that are associated with more equitable enrollment in PreK in higher-quality settings in the context of publicly funded, scaled programs. There is clear evidence that all parents' key driver in choosing care for their child is program quality (Bassok et al., 2018; Crosnoe et al., 2016; Grogan, 2012). But not all parents are able to access the highest quality programs due to a number of constraints. For example, past work has found that physical proximity is perhaps the strongest predictor of whether families enroll their child in a given early care and education program or not (Connors et al., 2021; Crosnoe et al., 2016), particularly in the context of a centralized school choice process (Glazerman & Dotter, 2017). Social capital theory would suggest that parents' informational networks are more salient for the PreK programs located in their neighborhoods, where other families in their social network to whom they are directly and indirectly tied also send their children (Sommer et al., 2017; Warschauer, 2003). In addition to ease of transport, parents' greater knowledge of these programs increases their comfort with sending their own children there, as compared to a program which may appear higher quality but lacks the same level of information via the local network. Access to transportation may be an additional cost barrier, particularly among families with low incomes (Tang, Coley, & Votruba-Drzal, 2012).

Location as a priority choice characteristic may play a key role in the *disparities* that emerge in the groups of children that are most likely to enroll in programs in the highest-quality settings. For example, in the study by Latham et al. (2020) discussed above, students who lived in majority Black census tracks were significantly less likely to live within .25 miles of a high-quality UPK program. This study did not detect differences in proximity to high-quality UPK programs for children living in majority Hispanic and majority Asian census tracts but was not able to measure students' location at a more granular level, such as block group or address. And program location is a key factor that can be intervened on by policymakers and may change over time. Connors and colleagues (2021) found that

policies in Chicago focused on intentionally placing full-day PreK classrooms in neighborhoods with larger proportions of age-eligible children from racially marginalized families and historically low rates of enrollment in Chicago Public Schools (CPS) PreK did increase the number of children who enrolled over time.

Ability to pay for PreK programs is also a clear factor associated with enrollment. As reviewed by Shapiro et al. (2019) there is unequal coverage of free, publicly-funded PreK programs nationwide, affecting the extent to which families with differing levels of income are able to enroll their children. Full-day PreK for a 4-year-old costs $8,000 on average, which is almost 15% of pretax average family income and >25% of earnings for families in the bottom two income quartiles (Child Care Aware of America, 2014; Noss, 2014). Only about 31% of income-eligible 3- to 5-year-olds in the United States are served by Head Start, and capacity in state- and locally-funded public programs varies considerably (National Head Start Association, 2017; Friedman-Krauss & Barnett, 2020).

Other research on the topic of PreK choice has examined how parents' preferences for different types of early care and education vary by race/ethnicity, family income, and linguistic background. For example, mothers with higher levels of education are more likely to enroll their young children in center-based PreK (Greenberg, 2011), while parents of DLLs are more likely to prefer relative care (Sandstrom & Gelatt, 2017). Other work has found that families in neighborhoods with higher immigrant populations and those with lower average incomes are less likely to enroll in center-based PreK (Liu & Anderson, 2012). Some have hypothesized that these preferences are a function of these families having stronger social networks and enrollment in friend, family, and neighbor care (e.g., Brandon, 2004; Suárez-Orozco & Suárez-Orozco, 2009; Takanishi, 2004) as well as concerns about safety (Bandy & Moore, 2009).

The Boston Public Schools PreK Program and Enrollment in High-Quality Early Learning

The Boston Public School (BPS) district offers a unique opportunity to explore patterns of enrollment in PreK (and PreK in higher-quality schools) across a recent time period**.** The BPS district is well-known across the country for offering a full-day, free PreK program to all age-eligible four-year-old children living in the city. The program consists of two evidence-based curricula: an adapted version of Opening the World of Learning (Schickedanz & Dickinson, 2005), a language and literacy curriculum that includes a social-emotional skills component in each unit, and Building Blocks (Clements & Sarama, 2007), an early mathematics curriculum that also promotes language development by requiring children to explain their mathematical reasoning verbally. Until the 2012-2013 year, the model was implemented solely in public schools, co-located with later elementary school grades. It then expanded to include a total of eleven partner community-based organizations by 2016, supported by funding from the federal PreK Development Grant program (Hofer et al., 2018) before beginning the move to a fully universal model in 2019 by partnering with several additional community-based providers across the city (Guerrero-Rosada et al., 2021). Prior to the move to UPK, however, the public school PreK program had the capacity to serve about 2800 students total across its 81 programs, or about 60% of the students who eventually would enroll in the city's public kindergarten program. Thus, although all age-eligible children in the city could apply to the program, the city did not have sufficient capacity to serve all applicants during the study period (Weiland et al., 2020).

After establishing positive short-term impacts of the program (Weiland & Yoshikawa, 2013), Weiland & Unterman used an experimental lottery-based design to examine the impacts of the BPS PreK program on state test scores, grade retention, and special education in third grade, for the 25% of all PreK applicants who applied to over-subscribed programs and were randomized in or out of the program. This study detected no average impacts of the BPS PreK program for this subgroup on these third grade outcomes, relative to the highly-served comparison group (Weiland et al., 2020).

Importantly, however, further work considering heterogeneity of treatment impacts found that there *were* substantial lasting effects for children who were able to enroll in PreK in the *highest-quality* schools, operationalized as those schools scoring in the top quartile of third grade state test scores (Unterman & Weiland, 2020). Winning a spot in a school in the top quartile of the test score distribution also substantially increased the likelihood that students would remain enrolled in that high-quality elementary school setting through third grade (and likely beyond). Important questions remain about which children are able to enroll in the BPS PreK program in general as well as the PreK programs in the highest-performing schools.

Key to this work as well is to consider how changes in the enrollment process may have affected patterns of enrollment for different groups *across time*. Prior to the 2014 – 2015 school year, children were able to rank up to 10 public PreK programs and were not restricted by their choices. For schools that were ranked highly by many students and were oversubscribed because they had more applicants than available slots, students received priority for living within a walk zone of the school and for having a sibling at the school. This process changed in the fall of 2014, with the district removing the walk zone priority and providing parents with a list of the 10 schools located closest to their home to rank in order of preference. Importantly, given concerns about equity, this process was adjusted if needed to ensure that every student had at least two higher performing schools – operationalized as those scoring in the top quarter of the distribution on state standardized tests – that they were able to rank on their list. If needed, those additional schools were identified from outside the pool of the physically closest schools as an approach to preserve equitable access to higher-performing settings. The district itself uses *test scores* as their primary indicator of quality in this case and provided information on third grade test scores to parents to use to rank their choices (Josette Williams, personal communication, September 19th, 2022). The list also included information on how the schools ranked in terms of overall quality,

measured as a combination of past academic performance, school climate, culturally responsive teaching, and diversity, among other factors (personal communication, Josette Williams, March 16th, 2022). The original goal of this adjustment in the enrollment process was to promote greater equity in accessing higher performing schools. Prior to the change, students from families with higher incomes had a greater ability to choose schools because they could transport themselves there and deal with constraints like lack of free aftercare and availability of hours. To date, there has been no empirical investigation into how the policy change may have influenced equitable enrollment across time.

The Current Study

The current study leverages data from 2012-2013 through 2018-2019 on students who applied to the BPS PreK program and/or eventually enrolled in BPS public school kindergarten—and were thus eligible to attend the public PreK program—to address the following research questions:

1. To what extent does enrollment in BPS PreK and enrollment in a program in a higher-quality school (defined in our study as schools in the top quartile of third grade standardized tests for that year) differ by children's race/ethnicity, family income, and Dual Language Learner status? How, if at all, did any of these differences change between 2012 and 2018?
2. How does residential proximity to a BPS PreK program and a program in a higher-quality school differ by children's race/ethnicity, family income, and Dual Language Learner status? How, if at all, did any of these differences in proximity change between 2012 and 2018?
3. How does residential proximity to a BPS PreK program and a program in a higher-quality school predict enrollment in those same programs for students across this time period? And how do those associations vary by children's race/ethnicity, family income, and Dual Language Learner status?

Findings aim to highlight key disparities in enrollment in PreK in the context of a well-regarded, scaled public program working to expand access to programming for children from marginalized groups.

Method

Participants

The full sample for the current study consists of 29,355 students who applied to PreK in a BPS public school between 2012-2013 and 2017-2018 *or* enrolled in kindergarten in a BPS public school

between the 2013-2014 and 2018-2019 academic years and would have been eligible based on age (four years old by September 1st of the coming academic year) to attend the public BPS PreK program in the year prior to starting kindergarten.[2] We restrict our main analyses to N = 22,469 students within this group who have complete data on whether they enrolled in BPS PreK or not, *and* whether they enrolled in a program in a higher-quality school or not, allowing for direct comparability across all models. Within this sample—which is our best attempt to capture as many age eligible students as possible—55% (N = 12,332) did enroll in BPS PreK for at least one day, while 45% (N = 10,137) did not.

Our approach excludes any age-eligible students in Boston who never interacted with the public school system and instead attended private school or were homeschooled. However, the study sample is representative of the students in Boston who may be most likely to enroll in the public PreK program given the opportunity, as indicated by their interest in public PreK or kindergarten.

In addition, this analysis focuses on enrollment in the district's public school PreK program, including partner community-based organizations that implemented the BPS model in 2016-2017 and 2017-2018. The study does not uniquely account for enrollment in any other community-based, Head Start, or private PreK or community-based programs associated with BPS before 2016-2017. This is important to note because the large majority of children who did not attend the public PreK program likely did enroll in some other type of formal PreK in the year prior to kindergarten (Weiland et al., 2020). Indeed, work by Shapiro et al. (2019) examining students who eventually enrolled in BPS

[2] We examined mobility rates for the 2017 5-year American Community Survey estimate to understand the validity of this approach. We found that 16.3% of Boston residents ages 1–4 moved within the past year. Within this group, 10.8% of young children moved within the city, 2.7% moved from a different county/city in Massachusetts, 1.3% moved from a different state, and 1.5% moved from abroad. As such, the large majority of mobility was happening within the city of Boston. The overall mobility rate was slightly higher than for young children (19.5%). There was some variation across racial/ethnic groups: White residents had a 22.0% mobility rate, Black residents had a 13.2% mobility rate, Hispanic residents had a rate of 17.6%, and Asian residents had a rate of 26.1%. Unfortunately, however, we cannot break down type of mobility (in or out of the city) by these demographic characteristics. Given the size of the disparities we observe in the data, however, and the fact that White residents – the group with overrepresentation in the BPS PreK program – are actually more likely to move than Black and Hispanic residents, it is unlikely that these differences in overall mobility rates would substantively change our results. We do return to this issue in our limitations section.

kindergarten during the 2008-2009 and 2009-2010 school years found that although half did enroll in BPS PreK, 17% enrolled in private PreK, 17% attended Head Start, 2% attended a non-BPS public option, 3% enrolled in family daycare and only 10% did not enroll in any form of center-based PreK. More detail on the counterfactual is included below.

As illustrated in Table 1, 33% of the children in the analytic study sample were Black, 18% White, 40% Hispanic, 8% Asian, and 2% identified as being another race or multiracial. About 71% of students across years were eligible for free or reduced price lunch and 49% were Dual Language Learners. Children were 5 and a half years old (*SD* = .30) on September 1st of the kindergarten year. Students in the analytic sample were demographically representative of the full population of students who applied to BPS PreK and/or enrolled in BPS kindergarten (see full comparison in Appendix G).

Setting

Application to the BPS PreK program is open to any age-eligible child in the city regardless of income or demographic factors. To enroll, children need only turn four years old by September 1st of the academic year. In the years examined in the current study (the 2012-2013 to 2017-2018 academic years), the program was mostly based in the public schools (*N* = 81 total), but also expanded to include a total of eleven partner community-based organizations (CBO) by 2016-2017.[3] At least one teacher in every CBO classroom implementing the BPS PreK model had a minimum of a BA in early childhood education or a related field. And teachers in partnering CBOs received a pay boost to ensure parity with the entry-level salary of teachers in public school settings. Public school teachers were subjected to the same educational requirements of K–12 teachers (e.g., a master's degree within 5 years and grade range certification); CBO lead teachers had to have a BA. The program in both public schools and CBOs offered families a full school day of care (6.5 hours per day), with before- and after-school options

[3] As noted above, the district began to implement a mixed-delivery UPK model in Fall 2019. The current study, however, only examines access prior to implementation of the UPK model.

available in most schools. PreK students who lived more than a half mile from school were provided bus transportation following the same policies that were applied to elementary-age children.

Although the BPS PreK program has been expanding in size since 2005, there were fewer available seats in the program than eligible children for each year examined in the current study (Hofer et al., 2018; Shapiro et al., 2019). For example, including students enrolled in CBOs in 2016-2017 and 2017-2018,[4] the program served an average of 2,825 PreK students per year, compared with a population of approximately 4,498 kindergarten students who enrolled in BPS elementary schools in each subsequent year. In the public school PreK system, BPS uses a school choice mechanism to assign children to schools, employing a lottery when demand for seats exceeds supply (see Appendix F for details on school lottery processes as well as Weiland et al., 2020). Students applying to CBOs do not participate in this centralized process but rather apply to and enroll in CBOs individually and directly. Families can apply to both types of programs. Our analysis focuses on inequities in enrollment *regardless of families' choices*. Future work will examine causes of any identified inequities.

Students in the current study sample attended schools located all over the city of Boston (see Figure 1 for school locations in 2017-2018 overlaid on a map of Boston with CBO partner schools included) and enrolled in 84 different schools for kindergarten across the six study years. Eighty-one of these elementary schools offered the BPS PreK program during at least one year and 84% offered PreK during all six years of the study. On average, 34% of students in elementary schools offering PreK were Black, 40% Hispanic, 16% White, 8% Asian, and 2% another race or more than one race. Schools had 68% of students eligible for free or reduced price lunch and 50% were Dual Language Learners (DLLs).

Counterfactual PreK opportunities. Due to data restrictions and the simplification of

[4] Systematic data on enrollment in the partner CBOs are available beginning in 2016-2017. There are children enrolled in the CBOs for the cohorts prior to this year that are currently included as children who did not access the BPS PreK program. However, this is likely a very small percentage of the sample.

enrollment forms, we are not able to access student-level information on the PreK experiences of children who did not apply for or enroll in the BPS PreK program. However, we are able to gain some understanding of their likely experiences from concurrent sources of data. In the years prior to our study (2008-2009, 2009-2010), Shapiro et al. (2019) reported that of the children who did not apply to the BPS PreK program, about 32% attended another private program, 36% attended Head Start, 22% did not attend PreK at all, 7% enrolled in family daycare, and 3% attended a charter program. We were also able to access Quality Rating and Improvement System (QRIS) data from the MA Department of Early Education and Care (EEC) on all licensed center-based programs serving four-year-olds during the final two years of our study – 2016-2017 and 2017-2018. These QRIS ratings were not available before then. The more than two thirds of non-BPS PreK applicants who attended private and Head Start programs were likely to be enrolled in one of the programs with QRIS ratings. EEC ratings for those two years averaged 2.10 (SD = .56, range 1 – 4). Quality was low to moderate but did vary substantially with about 20% of programs receiving ratings of 3 or 4. Work done in community-based organizations in Boston during the early period of this study has also found that classroom and instructional quality in general was lower than the observed quality in the public school BPS PreK program (Yudron et al., 2016). Taken together, these data suggest that children enrolled in BPS PreK likely experienced higher instructional quality than children who did not enroll in or apply for the program.

Data

We accessed the majority of the data for this study from the Boston Public School district's Office of Data and Accountability. These data included schools' locations, whether schools implemented the public PreK program and during which years, school-level demographic characteristics, de-identified student-level characteristics including geocodes as proxies for students' home locations, and student-level information on PreK and kindergarten application and enrollment. We

accessed Census data and information from the American Community Survey (ACS) to describe the neighborhoods where students lived and to identify where the schools in the study were located. Below, we describe the data that we used to operationalize study variables.

Student school assignment and demographic characteristics. The BPS district provided de-identified information on students who applied for and enrolled in a public PreK program between 2012-2013 and 2017-2018 and all children who applied to and enrolled in kindergarten between 2013-2014 and 2018-2019. These datasets included information on whether each child had applied to the public PreK program, their choice ranking of public PreK programs, the school they were assigned to, whether they enrolled in a school for PreK and which school, whether they enrolled in BPS kindergarten and which school they enrolled in, as well as any changes in classroom or school during each year. These data also allowed the team to identify students who enrolled in a community-based partner PreK program in the final two study years in addition to those who applied to BPS PreK but ultimately enrolled in a community-based partner program (N = 94 in the analytic sample from the final two years of the study). The datasets included information on children's demographic and background characteristics that parents provided when completing enrollment paperwork. The research team used these data to create demographic variables describing students' sex (female = 1; not female = 0), age (in years), race/ethnicity (binary mutually exclusive indicators for Black, White, Asian, Hispanic, and mixed or other race), Dual Language Learner status (1 = DLL; 0 = not DLL), first language (English, Spanish, or other language), eligibility for free or reduced price lunch (FRPL) (1 = yes; 0 = no), whether the student had an Individualized Education Plan (IEP) (1 = yes; 0 = no), and whether the child enrolled in a community-based PreK program. For FRPL and IEP status, which are time-variant characteristics, we used the student's status from their first BPS year.

Distance to nearest PreK program and PreK program in a higher-quality school. We used

district administrative data to identify where each study participant lived in Boston in PreK or kindergarten. Because the administrative data were de-identified, we did not have information on each student's home address. However, the district did provide a "geocode" for each student record, which is an indicator used to narrow the home address of students to a roughly three-block area (average size of 0.06 square miles). To maintain consistency with Shapiro et al. (2019), we took the geocode from the participant's PreK-eligible year school records. If the student did not have a BPS school record for their PreK eligible year (typically because they did not apply to PreK), we used their kindergarten school record. Ideally, we would have been able to determine where all students lived in their PreK-eligible year, given the possibility that families moved to or within Boston between the PreK and kindergarten years. While we cannot assess what proportion of non-PreK applicants moved before kindergarten, we can infer from the proportion of students who have different geocode values in their PreK and kindergarten years (10%) that a small but non-negligible proportion of students likely moved to or within Boston between the PreK-eligible year and kindergarten year.[5] Despite this asymmetry in data availability, we chose to use the earliest geocode available because home address influences both priority status in the school assignment process (for the first two study cohorts) and the number of non-BPS options near a child's home. We return to this issue in our limitations section.

School context and quality data. We accessed data on school context and quality from the district and from publicly-available sources. We used school-level information from the year prior to kindergarten enrollment to examine school-level demographic characteristics (% of students from low-income families, English language learners, students who speak a non–English language at home,

[5] Due to concerns about variation in students' geographic mobility by our key subgroups, we examined the extent to which student movers varied by race/ethnicity, family income, and DLL status. We found that compared to the general sample (69%) the movers were more likely to be eligible for free or reduced price lunch (84%). In addition, the movers were more likely to be Hispanic (46% of movers compared to 40% of full sample), less likely to be White (10% of movers compared to 18% of full sample) and more likely to be DLLs (57% of movers compared to 51% of full sample). Despite these differences, the numbers are fairly small and it is unlikely that mobility would affect the substantive results.

students with disabilities, male students, and students who are Asian, Black, Hispanic, or White), school size, and third grade state English/Language Arts (ELA) and math standardized test scores.

Following Unterman and Weiland (2020), we used the publicly available information on schools' third grade standardized test scores to create a binary variable to operationalize higher-quality (1) compared to lower-quality (0) schools *within each study year*. To do this, we first calculated the average of the percentage of students scoring proficient on the third-grade math and ELA exams. We then assigned the top quartile of these schools a value of 1 and the schools in the bottom three quartiles a value of 0. By calculating this variable within years, we were able to account for changes in the set of higher-quality schools across time. Scores required to be in the top quartile varied across years but ranged from a low of having 42.5% students proficient in math and ELA exams in 2016-2017 to 58% of students proficient in 2013-2014. As summarized in Appendix A we find some mobility across time in being included in the higher-quality group; 61% of schools were never in the higher-quality group across the six years, 13% were in the higher-quality group for 5 or 6 of the study years, 8% were in that group for 3 or 4 study years, and 18% were included in the group for just 1 or 2 study years. Importantly, there were 12 total schools across all cohorts ever designated by the district as Early Education Centers (EECs) that offered PreK but did not offer third grade and were originally missing state test data. For these cases, the district provided data on a subset (N = 4) of elementary schools that students from specific EECs would likely feed into. We applied those test score data to the EECs to maintain consistency in data and retain information on school quality for the largest possible sample. Follow-up analysis (see more in Appendix A) revealed that of those students who persisted in BPS after leaving their EEC, about three quarters did enroll in their associated feeder elementary school.

As noted in the introduction we concur that this test score measure of quality is imperfect and likely to be confounded with student demographic characteristics (Owens, 2018). Although we argue

that it does represent the educational opportunities available during the PreK – 3rd grade period (Reardon, 2019), we also believe it is important to assess whether these test score indicators of school quality measures are indeed associated with other features of *PreK quality* specifically, such as the domains of the Classroom Assessment Scoring System (CLASS; Pianta et al., 2008) or aspects of instructional quality, such as time spent on language/literacy and math instruction (Weiland & Guerrero-Rosada, 2022). We had access to CLASS scores from a complementary, concurrent study (see Guerrero-Rosada et al., 2021) for the 2016 – 2017 PreK cohort. We found moderate and statistically significant bivariate correlations between our indicator of being a "higher-quality school" and classroom instructional support ($r = .26$, $p < .001$) and emotional support ($r = .27$, $p < .001$). We were also able to access measures of school climate – as reported by teachers – for the final two cohorts of the study. Climate measures mapped onto earlier work done in BPS by Rochester et al. (2019). We found moderately large correlations between our indicator of high-quality and school-level supports for diversity ($r = .34$) and parental engagement ($r = .45$). There were also smaller correlations between the indicator of quality and school-level emotional support ($r = .12$), and academic support ($r = .14$).

In another paper by our team that used the CLASS data we did not find significant disparities in observed measures of PreK quality by race/ethnicity, family income, and home language (Guerrero-Rosada et al., 2021). Yet, results from that study also show that PreK programs in general did not help to close gaps in children's assessed skills. These results highlight the importance of exploring broader structural factors – perhaps captured by measures like standardized test scores and approximating PreK – 3rd grade educational opportunities – and their role in contributing to or diminishing such disparities.

Neighborhood-level data. We used 5-year ACS census block group estimates to measure and describe the characteristics of the surrounding neighborhood of kindergarten enrollees. We pulled estimates in accordance with the year students were in kindergarten. That is, cohort 1 (2012-2013)

estimates are 5-year ACS estimates from 2013. ACS 5-year estimates are generated with 60 months of data collected over 5 years and estimate the average number of people in a given category within a census geography (U.S. Census Bureau, 2020). We decided to use ACS estimates from the year children were in kindergarten and not PreK primarily because the estimates are generated with data collected for a full five-year period. As such, for 2013 kindergarten enrollees, the estimates reflect the years 2009 – 2013 (and so on for future years). Because the address data sometimes included kindergarten address as a proxy for PreK, it was appropriate to similarly use information that would include data from both the kindergarten and PreK year. The ACS estimates are also quite stable across years so this decision was unlikely to change our interpretation of findings. Census block groups are the smallest area that the U.S. Census Bureau creates estimates for and are generally defined to contain between 600 and 3,000 people (U.S. Census Bureau, 2020). Unlike the decennial census, which counts all persons in the United States in a census year, ACS estimates are generated with a random sample of 3.5 million households and collected on a monthly basis. The 5-year estimates are averages of these monthly surveys over the past 60 months. As such, the 2013 5-year estimates reflect polling data from 2009-2013. To describe the neighborhood characteristics of our sample participants, we include indicators of race (Asian, Black, White, more than one race, and other), ethnicity (Hispanic/Latino), and median household income. Appendix B illustrates neighborhood characteristics for students in our sample who did and did not enroll in the BPS PreK program. We aligned the variables examined with work by Shapiro et al. (2019).

Analytic Approach

Descriptive statistics. We first used descriptive statistics to examine the characteristics of the sample and the extent to which students from each racial/ethnic group, students from families with lower-incomes, and DLL students enrolled in BPS PreK in general and a BPS PreK program in a higher-quality school compared to students who did not. We also calculated the average distance that students

from each of these demographic groups lived from the nearest PreK program in general. Finally, as illustrated in Figure 1, we created visual maps to illustrate the locations of PreK programs in general and programs in higher-quality schools across the city of Boston in the last cohort of our sample (earlier years are illustrated in Appendix C), denoting in the maps how locations varied for neighborhoods with different racial/ethnic and socioeconomic compositions in the first and last years of our study. The map for the last year also includes community-based PreK programs that implemented the BPS PreK model.

Research question 1. Variation in enrollment for key subgroups and across time. To answer our first research question, we fit a series of linear probability models with clustered standard errors for kindergarten school wherein we modeled each of the two binary outcomes of interest—enrollment in BPS PreK and enrollment in BPS PreK in a higher-quality school (coded as 1)—as a function of race/ethnicity (Black, Hispanic, Asian, Multiracial/other race with White as the reference group), eligibility for free or reduced price lunch, and DLL status, controlling for child age and gender and indicators for cohort year. As such, differences in enrollment that we observe between groups are conditional on the other characteristics in the model. We used this approach in order to account for the intercorrelation of key demographic characteristics of interest and to isolate the factors that were most strongly associated with patterns of enrollment. As discussed further below, we also fit each characteristic of interest in a separate model on its own, only adjusting for child age, gender, and cohort in order to examine whether results were generally consistent across modeling approaches or whether unique findings emerged when we isolated the effect of each demographic characteristic, controlling for the others. Findings are illustrated in Table 2. We also fit all analyses using logistic regressions so that we could interpret findings in odds ratios and probabilities (see Appendix A for results) (Cohen et al., 2003). Finally, we added interactions between cohort effects and indicators for race/ethnicity, DLL status, and eligibility for free or reduced price lunch in order to examine whether patterns of enrollment

changed across time.

Research Question 2. Proximity and enrollment. We then used OLS regressions with clustered standard errors for kindergarten school to model each student's distance to the nearest BPS PreK program (1st set of models) and program in a higher-quality school (2nd set of models) on the same set of characteristics as we included in research question 1 analyses. The coefficient on each characteristic thus represents the difference in miles between that particular group and its reference group, controlling for time and the other demographic characteristics in the model. We interacted the indicators for cohort and the dummies for race/ethnicity, eligibility for free/reduced price lunch, and DLL status to examine whether and how variation in distance to nearby PreK programs across groups changed over time.

Research Question 3. Variation in associations between proximity and enrollment by key subgroups. In order to combine information from the prior two questions, we fit a final series of linear probability models with clustered standard errors for kindergarten school predicting enrollment in BPS PreK (1st set of models) and enrollment in BPS PreK in a higher-quality school (2nd set of models) as a function of all the demographic characteristics of interest, indicators for cohort, and the proximity to the nearest PreK or nearest PreK in a higher-quality school (specific to outcome) (we also fit logistic regressions, described below in robustness checks). The coefficient on the proximity variable represents the relation between distance to the nearest program and likelihood of enrollment on average, controlling for time and all demographic characteristics. We then interacted the proximity variables with the demographic characteristics of interest to test whether these linkages appeared to be more or less salient for particular groups of students across the study period.

Results

Descriptive results. We present results from our initial descriptive analysis in Table 1. With

respect to enrollment in any public PreK program, descriptive differences between enrollees and non-enrollees were fairly small. White students, on average, were overrepresented in the BPS PreK program by 3 percentage points, while Black students were underrepresented by 2 percentage points. Dual Language Learners and students with IEPs were also underrepresented in the program by 3 and 6 percentage points, respectively. We found larger differences when examining PreK enrollment in a higher-quality school. On average, students in the sample lived .30 (*SD* = .18) miles from the nearest BPS PreK program and .82 (*SD* = .49) miles from the nearest program in a higher-quality school. While distance in general was fairly consistent for students from different racial/ethnic, socioeconomic, and linguistic backgrounds, larger differences between racial/ethnic groups emerged for distance to the nearest PreK in a *higher-quality school*. The biggest difference was that Black students lived about a quarter of a mile farther away from the nearest program in a higher-quality school than White students.

Figure 1 shows maps of Boston block groups by racial composition and proximity to PreK programs in 2018. Complemented further by maps in Appendix C (for earlier years and broken out by family income as well), this figure highlights stark Black-White residential segregation as well as a smaller degree of Hispanic and Asian segregation. The map further shows that BPS PreK programs are clustered in more southern neighborhoods that tend to be racially mixed or predominantly non-White. These neighborhoods are also where children comprise a higher percentage of the total population.[6] Figure 1 denotes programs in higher-quality schools' programs in red and also illustrates that those settings tend to be located closer to more predominantly White neighborhoods. Adding PreK programs to existing public schools serving elementary school aged students appeared to facilitate this even distribution of enrollment. And including community-based partners in 2016 did appear to succeed in offering more equitable access in communities with large proportions of Black residents in particular.

[6] http://www.bostonplans.org/getattachment/4cda8ee0-6ebf-49ca-ae8f-90c577546c60/

Research question 1. Results from the first set of linear probability models examining enrollment in any BPS PreK program revealed that—among all students who applied to BPS public PreK or kindergarten—Black (γ = -.09, p < .001), Hispanic (γ = -.11, p < .01), and Asian (γ = -.10, p < .05) students were 9, 11, and 10 percentage points less likely to enroll in BPS public PreK in general than their White peers, adjusting for family income, home language, gender, race, and cohort year. Interestingly, however, Dual Language Learners were actually 5 percentage points *more* likely to enroll in the PreK program than their peers, all things equal (γ = .05, p < .01). Enrollment in BPS PreK was similar for children eligible and not eligible for free or reduced price lunch and for other race children compared to White children.

In Figure 2, we illustrate patterns of enrollment across the study period by plotting enrollment probability for subgroups using a smoothed line (estimates were created using probabilities from logistic regression results; see Appendix A). The average BPS kindergarten student had a 48% likelihood of enrollment in BPS PreK in 2012-2013 compared to 62% in 2017-2018. The overall probability of enrollment increased consistently each year as BPS added slots to the public school PreK program and also included community-based partners. Patterns of enrollment did change across time by group (see Figure 2) with White students' probability of enrolling increasing steadily across time, compared to Black and Hispanic students who maintained similar levels of enrollment despite overall increases in available slots. There were also changes over time for Asian students where probability of enrollment increased through 2016-2017 but then was reduced.

When we considered enrollment in BPS PreK in a *higher-quality school,* we found large differences in enrollment by race/ethnicity. Specifically, Black (γ = -.17, p < .001) and Hispanic (γ = -.15, p < .001) students were 17 and 15 percentage points less likely to attend a BPS PreK program in a higher-quality school compared to White students. Other race (γ = -.09, p < .001) students were also 9

percentage points less likely to enroll in these programs than White students but the magnitude of the difference was less stark. There were disparities for children eligible for free- or reduced-price lunch compared to their peers with higher family incomes on the order of 5 percentage points ($\gamma = -.05$, $p < .001$) but this difference was smaller than the difference by race/ethnicity. There were no differences in DLL and non-DLL students' enrollment in a program in a higher-quality school.

And as illustrated in Figure 2, differences in enrollment in PreK in higher-quality schools between White students and their Black and Hispanic peers grew larger across the study period. As noted above, BPS did add more schools offering PreK across the study period meaning that the probability of any student enrolling in PreK in a higher-quality school grew from 9% in 2012-2013 to 13% in 2017-18. Compared to this benchmark, White students had a 22% probability of enrolling in a program in a higher-quality school in 2012-2013 and that likelihood increased to 32% six years later. In contrast, all else equal, the probabilities of Black and Hispanic students enrolling in PreK in a higher-quality school were 6% and 7%, respectively in 2012-2013 and only increased slightly to 8% for both groups by the final cohort year.[7]

Research question 2. Results from proximity analyses are presented in Table 3. The unit of distance that we examined is miles. Controlling for other demographics and cohort year, there were some differences across groups in proximity to the nearest BPS PreK program in general, but they were quite minimal in size. Negative coefficients in these models indicate less distance to the nearest school compared to the reference group. On average, Black ($\gamma = -.03$, $p < .05$) and Hispanic ($\gamma = -.05$, $p < .001$), children lived .03 and .05 miles closer, respectively, to a BPS PreK program than their White peers.

[7] It is also important to consider how special education placement may have be associated with enrollment. Having an IEP was associated with a *higher* likelihood of enrollment in BPS PreK in general and in a program in a higher-quality school. We then found that Black and Hispanic students with IEPs were more likely to enroll in both BPS PreK and a PreK in a higher-quality school than their White peers (which is the opposite of the main analysis), while Asian students with IEPs were more likely than White students with IEPs to enroll in a BPS PreK program in a higher-quality school only.

Students eligible for free- or reduced-price lunch (γ = -.03, p < .001) also lived .03 miles closer to the nearest BPS PreK. These distance measures remained similar across time (see Figure 3).

We found a different picture when we examined proximity to the nearest PreK program in a *higher-quality school*. In those models, we found that, after controlling for family income, home language, age and gender, Black and Hispanic students lived about .22 miles ($p < .001$) and .13 miles ($p < .001$), respectively, farther away from the nearest PreK program in a higher-quality school than White students. Asian students, in contrast, lived about .10 miles closer ($p < .05$) to the nearest PreK program in a higher-quality school than White students. There was also a statistically significant difference in distance by DLL status, but that was fairly small—.03 miles ($p < .05$) —and likely less meaningful. There were some changes in distance across time with Black and Hispanic students living slightly further away from the nearest BPS PreK program in a higher-quality school over time (see Figure 3).

Research question 3. In the final set of models, we considered the role of proximity in explaining enrollment across diverse groups of students. Results are illustrated in the bottom panel of Table 2. With respect to enrollment in any BPS PreK program, we found no association between distance and likelihood of enrollment across the sample. Moderation analyses, however, revealed that this pattern was moderated by race and ethnicity. Compared to White students, when Black and Hispanic students lived farther away from any BPS PreK program they were actually slightly *more* likely to enroll in one (see Appendix D Figure 1).

In contrast, we found that students who lived further away from the nearest program in a *higher-quality school* were less likely to enroll in a program in a higher-quality school (γ = -.09, p < .001), all things equal. Translated into probabilities, students who lived .25 miles from a PreK program in a higher-quality school had, on average, a 16% probability of enrolling in a program in a higher-quality school, while students who lived 1 mile away only had a 6% probability of enrolling. Moderation

analyses revealed that this association was stronger for DLLs compared to non-DLLs but again not in the expected direction. Rather, when DLL students lived further away from a program in a higher-quality school they were *more* likely to enroll (see Appendix D Figure 2).

Exploratory analyses. We also considered the intersectionality of our demographic characteristics and how being a member of multiple marginalized groups could further disadvantage students. Results from these follow-up analyses are included in Appendix E. Although family income and DLL status on their own did not have large associations with enrollment in BPS PreK after controlling for race/ethnicity (as we reported above), these characteristics considered together did reduce the likelihood of enrollment in both BPS PreK and a program in a higher-quality school in the sample.

Robustness checks. For the sake of brevity, we report the full details of all our robustness and follow-up checks in Appendix A. We examined how sensitive results were to modeling each demographic characteristic on its own, fitting models in the full sample, fitting logistic regressions rather than linear probability models for RQs 1 and 3, and examining application to BPS PreK as the outcome rather than enrollment, among other checks. We also conducted follow-up analyses related to mobility and choice sets. The pattern of results was consistent across robustness checks, with no major changes to substantive findings.

Discussion

As policymakers continue to debate whether and how to expand access to PreK, our findings demonstrate that inequities in enrollment deserve ongoing policy and research attention. Data from our study period—during which time the BPS district was increasing the number of available PreK slots in both public school and community-based settings—showed that Black and Hispanic students in particular were less likely than their White peers to enroll in the BPS PreK program, with disparities growing across the study period. However, we initially did not find differences in enrollment by family

income and also found that DLLs in the more recent cohort were *more* likely to enroll than non-DLLs across time. Results were consistent when we considered application—rather than enrollment—as our outcome and used alternative modeling approaches better aligned with prior work in this context (Shapiro et al., 2019).[8]

Findings from this more recent cohort suggest that race and ethnicity—and being Black or Hispanic specifically—are the strongest predictors of enrollment in BPS PreK for our study period. Like most urban settings in America, Boston is a racially and ethnically segregated city with likely structural differences in both formal and informal information across neighborhoods (DiPrete et al., 2011). Even when public programs are located in largely Black and Hispanic neighborhoods, families may not prefer their local BPS PreK program if there are better-known alternative options in the community (Chaudry et al., 2011). Moreover, given a history of systemic racism in Boston, it is also quite possible that Black families in particular may fear racism and discrimination against their young children in the public school setting and prefer delaying interactions with that system until the start of formal elementary school (Posey-Maddox et al., 2021). In contrast, in neighborhoods with majority White families, the system could work in the opposite direction via informal networks and little fear of discrimination (Reardon, 2016). The centralized school choice system too might present administrative burdens or hurdles that are more difficult to navigate for some groups of families compared to others.

When comparing our results to earlier work on applications to Boston PreK (Shapiro et al., 2019), it is also important to consider variation across the study periods and how disparities in

[8] Earlier work primarily examined application patterns but also looked at enrollment as a robustness check, finding similar results across the two outcome types (Shapiro et al., 2019). The authors found that non-appliers in general were more likely than appliers to be non-White. However, that study also found that children from families with low-incomes and DLLs were *less* likely to apply to the program in general. When we also looked at application patterns we also found that family income predicted a lower likelihood of enrollment. However, the magnitude of the difference continued to be much smaller than for race/ethnicity—specifically being Black or Hispanic—in predicting the likelihood of application or enrollment.

application and enrollment appeared to change over time. In the 2008-2009 and 2009-2010 school years that were the focus of prior work, the current version of the BPS public PreK program was fairly nascent, having just launched a set of systematic activities to enhance quality at-scale in 2005 (see Weiland et al., 2018). In 2013, Weiland and Yoshikawa (2013) reported large, positive, short-term impacts on children's skills that garnered significant attention not just in Boston but across the country (Rochman, 2013). The data for the current study come from the period after the program had developed a national reputation as a high-quality provider. It is possible that a disproportionate number of White families had better information via their social networks on how to enroll in the program – and programs in higher-quality schools – during this more contemporary period.

Variation in Enrollment in PreK Programs in High-Quality Schools

Importantly, disparities in BPS PreK enrollment by race and ethnicity were not nearly as large as the differences we observed in enrollment in PreK programs in *higher-quality school*s by race/ethnicity. This is particularly important in light of prior work finding causal evidence that enrollment in PreK in one of those schools (relative to a control group heavily served by other care options) has sustained impacts on children's academic outcomes through third grade (Unterman & Weiland, 2020). In the somewhat mixed literature on differential effects of PreK programs, there are some examples of studies finding small or null effects for children from marginalized groups even when students from other groups continue to benefit (Gormley et al., 2018; Montrosse-Moorhead et al., 2019). Variation in enrollment in PreK in a higher-quality school may be part of the explanation for this inequitable variation. Admittedly, our indicator of quality in this study is limited as it uses standardized test scores to operationalize quality (Owens, 2018). These test score metrics reflect the achievement levels of third grade students rather than the children enrolling in PreK in this study. Even so, we argue that these test scores are policy relevant for decision-makers in this context and are shared as indicators of PreK

program quality in the information parents receive to rank schools. And our own correlational work has found that test scores are moderately associated with the widely-used measures of PreK process and instructional quality reported on in similar studies (e.g., Latham et al., 2021).

Relatedly and critically, the city did change the process for applying to the program during our study period. Whereas in the earlier application process students received priority for living within a walk zone of the school—but were able to apply to any school in the city—the district revised the process for the 2014-2015 school year, removed the walk zone priority, and allowed parents to rank the ten schools located closest to their home. This process was adjusted if needed to ensure that every student had at least two higher performing schools (based on standardized tests) that they were able to rank on their list. For example, if a students' initial list of ten schools did not include any higher-performing options, they received the option to rank *two additional schools* that were identified to be higher-performing. This list also included information on how the schools ranked in terms of overall quality, measured as a combination of academic performance, school climate, culturally responsive teaching, and diversity, among other factors (personal communication, Josette Williams, March 16th, 2022). While these changes were implemented to help provide parents with more information to help them rank their school choices, it is possible that they affected other decision-making processes. For example, our work showed that Black and Hispanic families tended to live slightly further away from PreK programs in higher-quality schools than their White peers. As such, the lists these Black and Hispanic families received to rank likely included fewer schools in the higher-quality group. And the PreK programs in higher-quality schools that were in that group were located farther away from the homes of families in those groups, compared to White families. This is particularly true if those higher-quality schools had to be added on to their initial list. Thus, changes to the application process may have contributed to growth in enrollment disparities across time, among a range of other factors. More

rigorous research – possibly leveraging strategies like an interrupted time series design – may be able to shed light on this possibility. That work must consider parents' choice sets, the percentage of higher-performing schools they received to rank, and how changes in choice sets affected enrollment for diverse groups of students.

Importantly, given more limited choice sets, families may have decided not to apply to *any public PreK program at all* if there were alternative care options in the neighborhood, such as community-based PreK providers and Head Start programs, that they preferred. Although all families are primarily motivated to choose PreK programs for their children that are high-quality and developmentally appropriate (Bassok et al., 2018; Grogan, 2012), there are also key issues that affect families' PreK enrollment decisions that have led to cities' adoption of mixed delivery systems – where programs are implemented in both public schools and community-based partner organizations – when implementing public programs. And this is the approach that BPS also began implementing in the fall of 2019 in the first year of their Universal PreK Expansion (Guerrero-Rosada et al., 2020). CBO programs may better meet some families' needs, preferences, and values and increase the likelihood of a cultural and/or race/ethnicity match between the family and program staff, a factor shown to promote children's learning outcomes in rigorous causal studies (Blazar & Lagos, 2021; Gershenson et al., 2016; Gershenson et al., 2018). CBOs may offer families access to a greater range of wraparound care options, may allow them to enroll their child at the same school as their younger sibling(s), and to have their children attend a center that is most conveniently located for them (Ackerman et al., 2009). In building a stronger universal model that delivers high-quality programming to children in both public school and CBO settings, districts like BPS can address these selection issues but also work to build equitable early learning opportunities across systems. Key to this is avoiding what has been described as a "two-tier system" where CBOs receive fewer supports and offer lower-quality programming than their public

school counterparts (Weiland et al., 2022).

Residential Proximity and PreK Enrollment

Finally, we found that proximity to any BPS PreK program in BPS was fairly equitable across our study period with respect to race/ethnicity, family income, and DLL status. As illustrated on our map of all programs in Figure 1, programs were allocated throughout the city in all neighborhoods. Adding PreK programs to existing public schools serving elementary aged students appeared to facilitate this even distribution of access. And including community-based partners in 2016 also appeared to succeed in offering more equitable access in communities with large proportions of Black residents. Likely due to the broad range of offerings that the district has invested in and all students' general proximity to programs, we did not find that distance was a statistically significant predictor of enrollment in any BPS PreK program when we took the whole sample into account.

Interestingly, however, we did find that Black and Hispanic students were more likely to enroll in the program if they lived *further away*. This pattern could again reflect the information that parents had access to about the program and the alternative care options that they had in their community. For example, prior work by Shapiro et al. (2019) and Weiland et al. (2020) found that there were a wide range of alternative care options in BPS and the large majority (87%) of students who enrolled in BPS kindergarten did attend some type of non-residential care in the year prior. Students in heavily served communities likely have many alternative options in addition to their local public PreK program (although they may be lower quality, as demonstrated by our review of QRIS scores for community-based programs in the final two cohorts of the study). In contrast, the public PreK option – which offers bussing to students who live more than half a mile away – may be more attractive to families who have fewer local, feasible, alternative choices (Wei et al., 2021).

Importantly, this pattern was not reflected when we examined enrollment in BPS PreK in a

higher-quality school. In contrast, we found that students who lived closer to programs in higher-quality schools were substantially more likely to enroll in them. This finding likely reflects the endogeneity discussed above between schools' standardized test scores and the students who select into them. Even so, it raises critical implications for equity as it demonstrates strong associations between key structural factors that are not easily malleable – residential proximity in this case – and patterns of PreK enrollment. Even as the district has made significant investments to enhance program quality across all early learning programs (e.g., McCormick et al., 2020), it is extremely challenging to ensure equitable enrollment in the highest-quality settings in the context of a PreK program that is universally available to all age-eligible children. Strategies to address disparities in access to high-quality early learning—such as bussing, mandatory integration, and preference priorities—are politically challenging to implement yet may hold promise for promoting more equitable learning opportunities for children from marginalized groups (Billings et al., 2014).

Limitations

Despite the strengths of this study, there are a number of key limitations. First, this is a descriptive study and none of the associations should be interpreted causally. Second, we used the measure of school quality in this study based on prior work demonstrating its salience for understanding lasting impacts of BPS PreK (Unterman & Weiland, 2020). However, as we note above, test scores on their own are a proxy for the skills and socioeconomic backgrounds of the students attending the school and may not reflect the full range of domains that make a school higher-quality (Owens, 2018). At the district-level we did not have access to observational information on children's classroom microsystems. The study would have benefited from more nuanced measures of process and instructional quality (Weiland & Guerrero-Rosada, 2022) as well as equitable instructional practices (e.g., Curenton et al., 2020). Moreover, given the focus on test scores as indicators of quality it is difficult to disentangle to

know whether the benefits of BPS PreK in the higher-quality settings are more likely to persist due to higher-quality subsequent learning experiences or the general quality of the PreK program itself. Capturing more nuanced information at-scale on the quality of early learning distinct from the quality of future learning environments is needed to better explore these pathways and determine the factors most critical for supporting equitable learning and development across time.

Third, we are explicitly focused in this paper on enrollment in the BPS PreK program implemented in public schools and by community-based partners. This paper does not include data to describe the types of programs that children who did not enroll in the program attended. Although we have some understanding of the QRIS ratings of programs in the community, and have earlier data on non-applicants' enrollment decisions, having this information would perhaps have provided more context related to families' decision-making—particularly on their enrollment in alternative care options—and future work will examine these data more thoroughly. And relatedly, we were only able to capture whether students did enroll in partner CBOs for the final two cohorts of the study. Fourth, this paper does not examine nuances in families' choice sets and rankings of programs. Having established growth in disparities in enrollment in the PreK programs in the highest-quality schools, further research is needed to better understand how parents make rankings and choices and how that affects ultimate enrollment patterns. Key to this will also be exploiting the policy change that occurred in 2014 affecting how parents are able to rank their preferred schools and understanding more rigorously how that may have contributed to disparities in enrollment. Next, we did rely on kindergarten enrollment data to capture our possible pool of applicants. We lacked access to information on all *possible* applicants. And finally, while this investigation is generalizable to the BPS school district, it is not necessarily reflective of other large urban districts with public PreK programs. As the country seeks to expand universal PreK, prioritizing work examining equitable enrollment in high-quality PreK is of paramount importance.

Implications

Although findings from this paper are descriptive, they help to identify key considerations for policymakers. First, it is important to better understand *why* there are clear racial/ethnic disparities in the students who do and do not attend the BPS PreK program and who gains access to the highest-quality settings. Our work uncovered that racial/ethnic disparities were actually *growing* over time and primarily after the introduction of new policies for ranking school preferences. Such findings highlight that these policies may be undermining the district's goals to ensure equitable access to higher-performing settings not just in PreK but throughout schooling. Indeed, gaining access to a PreK spot in a higher-quality school guarantees students a spot in that setting for the duration of elementary school and experimental evidence has shown sizeable impacts of winning a spot in a given PreK program and continued enrollment in that elementary school setting (Weiland et al., 2020). More experimental research on this topic is needed but results highlight the need for policymakers to examine the implications of these enrollment policy changes for future years.

Findings also point to the importance of continuing to expand the high-quality public school program to a broader range of community-based settings that primarily serve students from racially/ethnically marginalized groups. Boston has begun moving to a fully universal PreK model by implementing a mixed-delivery system through partnerships with community-based programs (Weiland et al., 2021). Ensuring that quality in these new partner programs is on par with or exceeding quality in the public schools will be of paramount importance. And exploring policy interventions to improve quality in existing public school settings serving a disproportionate number of Black and Hispanic students is clearly needed to address these gaps and move toward a more equitable system. More broadly, findings broadcast the importance of all districts doing early childhood work to examine how investments in universal PreK – designed as a tool to promote equity – are or are not achieving that goal.

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Table 1

Demographic Characteristics of Students in Analysis Sample

		Analysis sample				
Characteristic	All study participants	BPS PreK non-enrollees	BPS PreK enrollees	Sig.	BPS PreK non-enrollees in a higher-quality school	BPS PreK enrollees in a higher-quality school	Sig.
Female	0.48	0.49	0.47	*	0.48	0.47	
Child age on 9/1 of kindergarten	5.51 (0.30)	5.50 (0.30)	5.52 (0.29)	***	5.51 (0.30)	5.52 (0.29)	
Eligible for free or reduced price lunch	0.69	0.71	0.68	***	0.72	0.48	***
Race/ethnicity							
Black	0.33	0.34	0.31	***	0.34	0.17	***
Hispanic	0.40	0.41	0.39	***	0.41	0.26	***
Asian	0.08	0.08	0.08		0.07	0.13	***
Other race or multiracial	0.02	0.02	0.02		0.02	0.03	**
White	0.18	0.15	0.20	***	0.15	0.41	***
Dual Language Learner	0.51	0.49	0.52	***	0.52	0.42	***
Home language							
English	0.58	0.56	0.58	***	0.57	0.70	***
Spanish	0.21	0.23	0.19	***	0.22	0.11	***
Other language	0.13	0.15	0.12	***	0.13	0.13	
Student has IEP	0.14	0.08	0.18	***	0.13	0.18	***
Student attended community-based PreK partner	0.02	-	0.02		0.02	-	
PreK eligibility year							
2012 - 2013	0.19	0.22	0.16	***	0.19	0.16	***
2013 - 2014	0.18	0.19	0.17	***	0.18	0.15	***
2014 - 2015	0.15	0.14	0.15		0.15	0.12	***
2015 - 2016	0.15	0.14	0.16	***	0.15	0.16	
2016 - 2017	0.18	0.17	0.18	***	0.17	0.22	***
2017 - 2018	0.16	0.14	0.18	***	0.16	0.19	***
Sample size (*N*)	22469	10137	12332		20022	2447	

Table 2

Results of Linear Probability Models Examining Associations Between Students' Race/Ethnicity, Family Income, Dual Language Learner Status and Enrollment in BPS PreK and a Program in a Higher-Quality School

	Enrolled in BPS PreK						Enrolled in BPS PreK program in a higher-quality school					
	Research Question 1			Research Question 3			Research Question 1			Research Question 3		
	b		SE	*b*		SE	*b*		SE	*b*		SE
Cohort (compared to 2012-2013)												
2013 - 2014	0.04	*	0.02	0.04	*	0.02	0.00		0.02	-0.01		0.02
2014 - 2015	0.09	***	0.02	0.09	***	0.02	-0.01		0.02	0.00		0.02
2015 - 2016	0.11	***	0.02	0.11	***	0.02	0.02		0.02	0.02		0.02
2016 - 2017	0.09	***	0.02	0.09	***	0.02	0.04		0.02	0.04		0.02
2017 - 2018	0.14	***	0.02	0.14	***	0.02	0.03		0.03	0.04		0.03
Student characteristics												
Female	-0.01	*	0.01	-0.01	*	0.01	0.00		0.00	0.00		0.00
Age on Sept. 1st	0.08	***	0.01	0.08	***	0.01	0.02	*	0.01	0.02	**	0.01
Student race/ethnicity												
Asian	-0.10	*	0.04	-0.10	*	0.04	-0.05		0.04	-0.06		0.04
Black	-0.09	***	0.03	-0.09	***	0.03	-0.17	***	0.03	-0.15	*	0.03
Hispanic	-0.11	**	0.03	-0.11	***	0.03	-0.15	***	0.03	-0.14	*	0.03
Other race	-0.04		0.03	-0.03		0.03	-0.09	***	0.03	-0.09	*	0.03
DLL	0.05	**	0.02	0.05	***	0.05	-0.01		0.01	-0.01		0.01
Eligible FRPL	-0.01		0.01	-0.01		0.02	-0.05	***	0.02	-0.05	***	0.01
Distance from BPS PreK				0.07		0.05						
Distance from PreK in higher-quality school										-0.09	*	0.01

NOTE: *** $p < .001$, ** $p < .01$, * $p < .05$

Table 3

Associations Between Students' Race/Ethnicity, Socioeconomic Status, Dual Language Learner Status and Distance in Miles to Nearest BPS PreK and Nearest Program in a Higher-Quality School

	Distance to nearest BPS PreK program		Distance to nearest BPS PreK program in a higher-quality school	
Predictors	*b*	SE	*b*	SE
Cohort (compared to 2012-2013)				
2013 - 2014	-0.01 **	0.00	-0.06 ***	0.01
2014 - 2015	0.00	0.00	0.13 ***	0.01
2015 - 2016	-0.01 **	0.00	0.06 ***	0.01
2016 - 2017	-0.01 ***	0.00	0.07 ***	0.01
2017 - 2018	-0.01 ***	0.00	0.09 ***	0.01
Student characteristics				
Female	0.00	0.00	0.00	0.01
Age on Sept. 1st (centered)	0.00	0.00	0.00	0.01
Student race/ethnicity (White is reference group)				
Asian	-0.01 **	0.01	-0.10 ***	0.01
Black	-0.03 ***	0.00	0.22 ***	0.01
Hispanic	-0.05 ***	0.00	0.13 ***	0.01
Other race	-0.02 *	0.01	0.02	0.02
DLL	-0.01 **	0.00	0.03 ***	0.01
Eligible free or reduced price lunch	-0.03 ***	0.00	0.02 **	0.01

NOTE: *** $p < .001$, ** $p < .01$, * $p < .05$

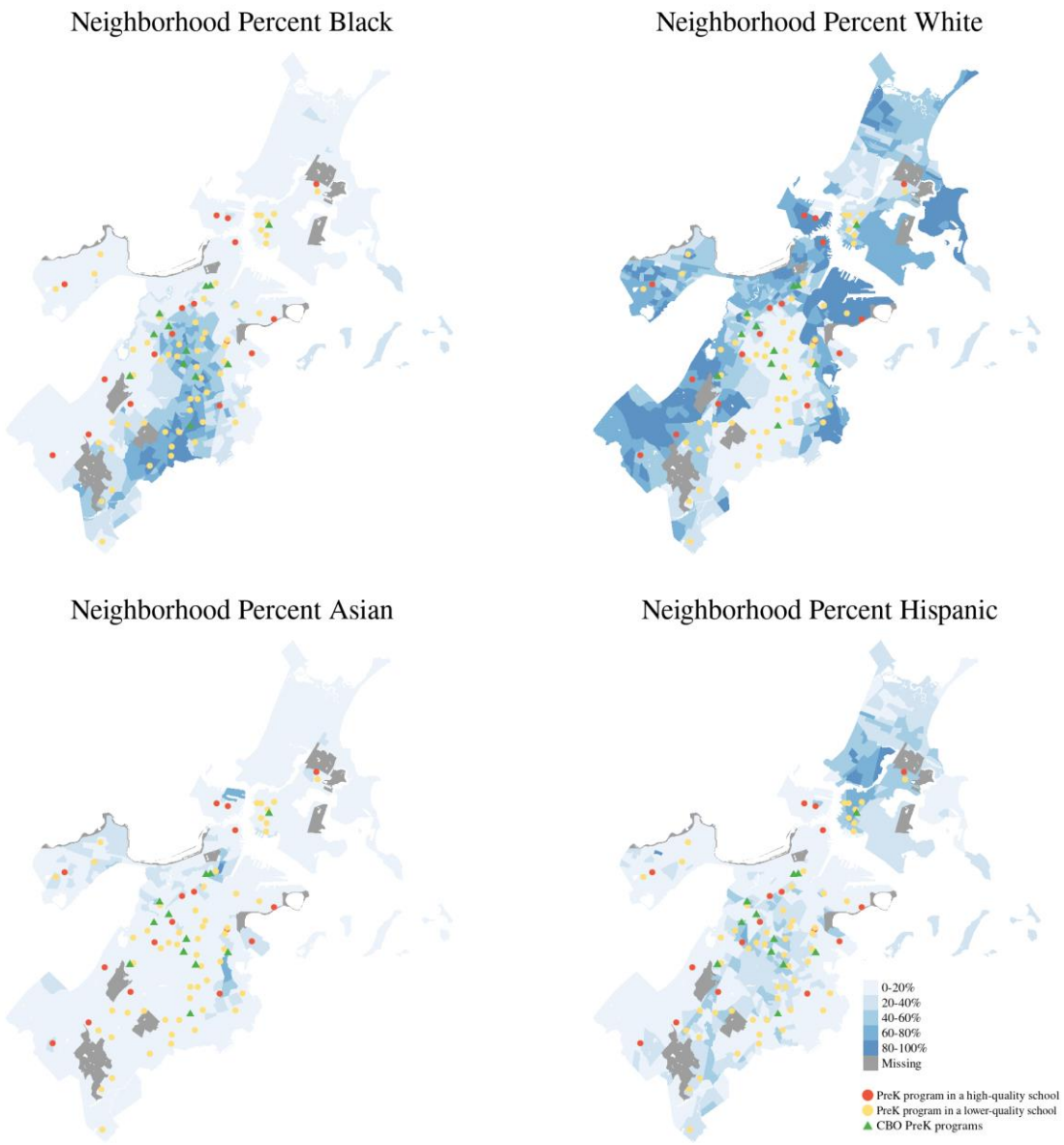


Figure 1

Locations of BPS Public School and CBO PreK Programs in 2018, by Neighborhood Racial/Ethnic Composition

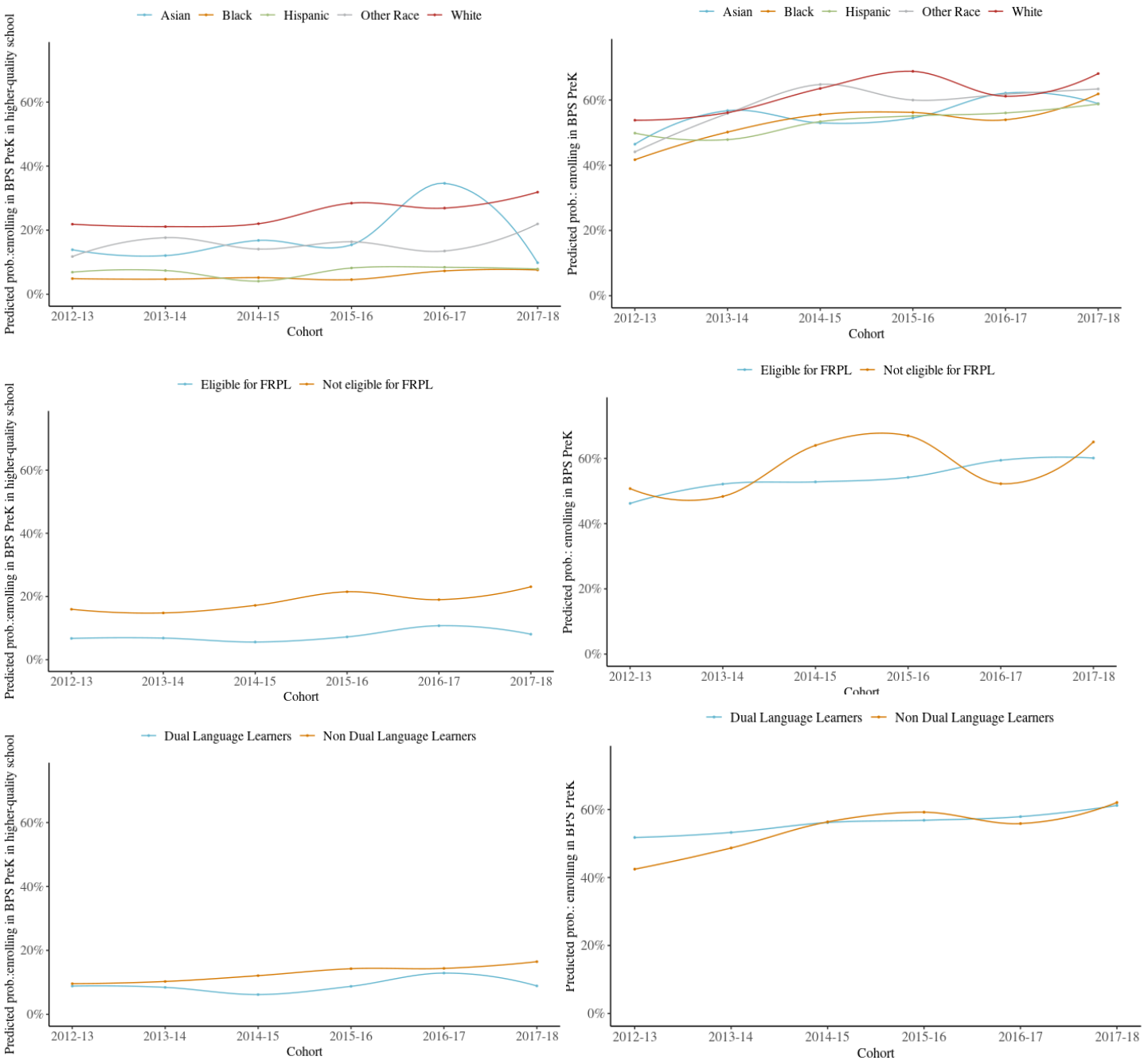


Figure 2

Students' Probability of Enrolling in BPS PreK and PreK in a Higher-Quality School by Race/Ethnicity, Socioeconomic Status, and Dual Language Learner Status Between 2012-2013 and 2017-2018

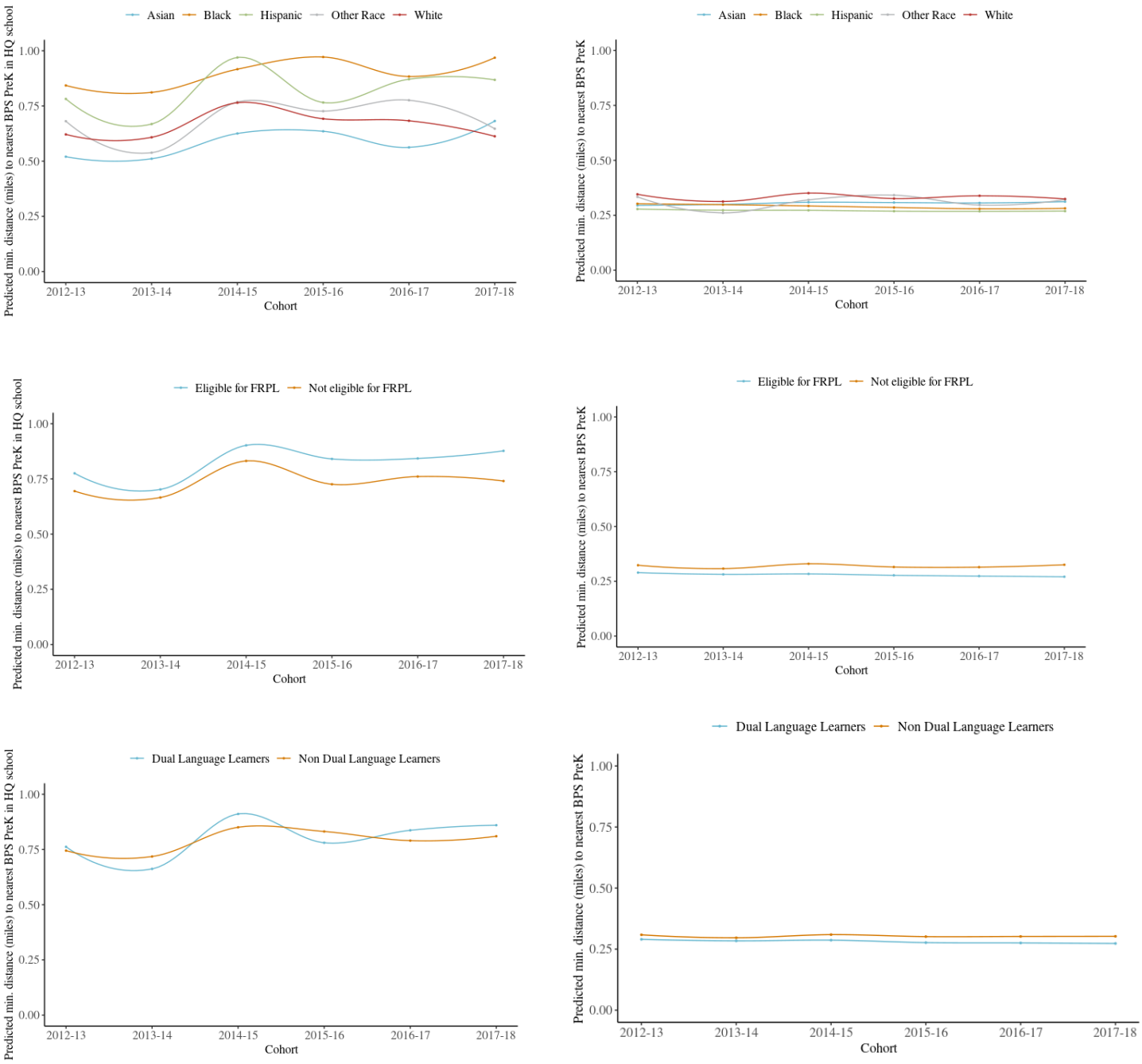


Figure 3

Students' Distance in Miles to Nearest BPS PreK Program and PreK in a Higher-Quality School by Race/Ethnicity, Socioeconomic Status, and Dual Language Learner Status Between 2012-2013 and 2017-2018.

Supplemental Material: List of Appendices

Appendix A: Summary of all sensitivity and follow-up analyses and corresponding tables

Appendix B: Neighborhood characteristics of study sample by enrollment in BPS PreK

Appendix C: Maps of Boston from 2012 – 2017 overlaid by location of BPS PreK programs, including programs in higher-quality schools and community-based programs where available

Appendix D: Figures illustrating variation in associations between geographic proximity and BPS PreK Enrollment by race/ethnicity and DLL status

Appendix E: Results from models considering intersectionality between race/ethnicity, family income, and DLL status in predicting the likelihood of enrollment in BPS PreK

Appendix F: Details on the lottery process for slots in the BPS PreK program

Appendix G: Comparison of analytic sample to full sample

Supplemental Online Material

Appendix A: Summary of Robustness Checks

We conducted multiple robustness checks and follow-up analyses to examine the sensitivity of our results and to further probe our findings. Below we describe each of the robustness checks and summarize the corresponding results.

Fitting models on full sample, rather than restricting to the analytic sample. When presenting results, we decided to fit all analysis models on a consistent sample of students with non-missing data on all key study variables. We did this to maintain consistency across samples for all of the analyses presented in the main body of the paper. However, by making this decision we excluded a portion of students from the analysis that did enroll in kindergarten during one of our study years. Descriptive analyses presented in the main text of the paper confirmed that our analytic sample was demographically representative of the full set of students. Even so, we decided to fit analyses again on all available sample members to confirm that the results were consistent across both approaches. As shown in Table A1 and Table A2 the bulk of the substantive study results remained consistent. There were, however, three differences in results when we examined the larger sample. First, students who identified as being from another non-white racial/ethnic group or were multiracial were less likely to enroll in BPS PreK compared to their White peers (log(odds) = -.20, *SE* = .09, $p < .05$, OR = .89). Second, residential proximity to BPS PreK was no longer a statistically significant predictor of enrollment in any BPS PreK program once we accounted for the full sample (log(odds) = .11, *SE* = .07, $p = .11$, OR = 1.12). Further, in the full sample there was no evidence that family income was associated with the distance from a BPS PreK program in a higher-quality school (log(odds) = .01, *SE* = .03, $p = .70$, OR = 1.01). Our main set of findings from this study – most notably that race and ethnicity are

particularly salient predictors of access to different types of BPS PreK programs – remained consistent.

Examining demographic predictors of interest in separate models. We opted to include all demographic characteristics of interest in a block together when fitting our predictive models because we wanted to make sure that each coefficient captured the unique association between the characteristic of interest and the outcome, net of the others. However, this modeling decision may have masked some important links between individual student characteristics and enrollment that might be important for understanding the nature of the associations. As such we fit additional models examining each individual student characteristic separately predicting each outcome, controlling only for cohort year, gender, and child age. Although most estimated associations remained the same in terms of magnitude and statistical significance (see Tables A3 and A4), we did find that family income on its own was associated with a lower likelihood of enrollment in any BPS PreK (log(odds) = -.13, *SE* = .03, $p < .01$, OR = .88), and Dual Language Learner status on its own was associated with a lower likelihood of enrollment in BPS PreK in a higher-quality school even in the models adjusting for the minimum distance from the nearest program in a higher-quality school (log(odds) = -.38, *SE* = .04, $p < .001$, OR = .68). Also, unlike our main analysis where we found that DLL status and family income had small positive associations with distance to a BPS PreK in a higher-quality school, our robustness check revealed a different set of results. Family income had a larger and statistically significant association with distance to BPS PreK in a higher-quality school (b = .09, *SE* = .01, $p < .01$). And DLL status had a smaller but still statistically significant association with proximity to BPS PreK in a higher-quality school (b = .01, *SE* = .01, $p < .10$). Overall, however, the general pattern of substantive results was consistent and does not affect our overarching set of conclusions.

Examining *application* to the BPS PreK program rather than *enrollment*. In our study we were primarily interested in examining enrollment in BPS PreK because that was an indicator of the students who actually took up the program. However, examining *application to the BPS PreK program* can provide further insight into how different types of families are making choices and potentially considering the BPS PreK program, even if they do not ultimately enroll. Prior work examining access and equity to BPS PreK done by Shapiro et al. (2019) examined application to the program and it is important to be able to compare findings across these studies and time periods. Follow-up research using these data will further delve into the issue of applications to better understand how families' choice sets affect patterns of enrollment across groups. In the current study we did fit all of our models again using application to BPS PreK as a binary variable of interest to understand how that difference affected the pattern of results. Even though most of the associations remain the same in magnitude, direction, and statistical significance, one difference we found when we looked at application (rather than enrollment) is that eligibility for free or reduced price lunch had a larger and statistically significant association with applying to any BPS PreK program (log(odds) = -.45, *SE* = .03, $p < .001$, OR = .64). Findings from this check are presented in Table A5 and A6. Our main set of findings identifying a statistically significant association between race and access to BPS PreK remains the same when we consider application to BPS PreK. However, the associations between race/ethnicity and application are slightly larger in magnitude for Black (log(odds) = -.74, *SE* = .05, $p < .001$, OR = .48) and Hispanic students (log(odds) = -.70, *SE* = .05, $p < .001$, OR = .49) compared to race/ethnicity and enrollment. These findings do map onto the earlier work by Shapiro et al. (2019) and even reveal slightly larger differences in application by race, ethnicity, and family income for the more contemporary cohort of PreK applicants.

We found that there were similar associations between the distance between the first school that BPS PreK applicants applied to and these demographic characteristics. See Table A6 for detailed results. Black (b = .22, *SE* = .0, $p < .0001$) and Hispanic (b = .22, *SE* = .0, $p < .0001$) students were more likely to live further away from their first choice school than White students. Students from families with lower income also lived further away from their first choice school than students from higher income families. In contrast, Dual Language Learners actually lived slightly closer to their first choice school than non-DLLs (b = - .06, *SE* = .02, $p < .05$). Taken together, findings suggest that Black students, Hispanic students, and students from families with lower-incomes had less geographic proximity to their preferred schools and slightly less structural access than their peers who were White and/or from higher income families.

Restricting analyses to only children who enrolled in BPS kindergarten. Prior work done by Shapiro et al. (2019) used data on all BPS kindergarten enrollees to examine patterns of applications to the BPS PreK program. The current study, however, expanded that group to also include students who had ever applied to BPS PreK or kindergarten, even if they never enrolled in kindergarten. Although 92% of our study sample did eventually enroll in BPS PreK this is an important analytic decision that differs between this study and prior work. As such, we refit our models for research questions 1 – 3 restricting the sample to just those students who enrolled in kindergarten. Findings are summarized in Tables A7 and A8. As illustrated, all of the associations based on the main analysis sample remain the same in magnitude and statistical significance when we only take into account students who enrolled in kindergarten.

Exploring distance to nearest program *applied to* and nearest higher-quality program *applied to*. Related to this issue of application is the challenge of understanding whether students were even applying to the BPS PreK programs that were located closest to

them and/or the higher-quality schools located closest to them. This could shed some light on how different types of families were making choices based on distance or not. Although we cannot examine application for all students in the sample – but only for those who actually applied – we did look within that group to examine the distance between their home and the first, second, and third school that they applied to (in ranked order). Results are presented in Table A9 (see there for statistics on variation). On average, we found that BPS PreK applicants lived about 1.07 miles from their first choice school, 1.13 miles from their second choice, and 1.24 miles from their third choice. Table A9 further disaggregates this by race/ethnicity, DLL status, and family income. That analysis revealed that Black and Hispanic students lived the furthest away from their first choice of school (1.17 and 1.15 miles away respectively), compared to White students who lived about 0.89 miles from their first choice of school.

We then examined the distance between the student's home and the first higher-quality school that they ranked on their list, if they ranked any higher-quality schools. We found that 23% of students who applied to BPS PreK ranked a PreK program in a higher-quality school as their first choice. On average these students lived 0.99 miles away from the first higher-quality school they ranked on their list. There were differences in that distance measure in our subgroups. As shown in Table A10, Black student on average lived furthest away from their first-choice higher-quality school (1.21 miles), followed by Hispanic students (1.13 miles) and students from lower-income families (1.10 miles). Further analyses in follow-up papers will explore application patterns as they relate to access to the program in line with families' choice sets and enrollment decisions.

Exploring distance to nearest program enrolled in and nearest program in a higher-quality school enrolled in. As another descriptive follow-up analysis, we looked at the subgroup

of students who did enroll a BPS PreK program (and in a program in a higher-quality school) to examine the distance between their home and the programs enrolled in, as well as differences in that metric by race/ethnicity, family income, and DLL status. We found that, on average, students enrolled in PreK programs that were about 1.2 miles (SD = 1.17) from their home. As such, students actually enrolled in schools that were about a mile further away from their homes than their *nearest* public PreK program. We then considered how these distances varied by race/ethnicity, family income, and DLL status (see Table A11 for detailed breakdown by student characteristics). On average, we found that Black students enrolled in schools that were about 1.29 miles from their home (SD = 1.22) and Hispanic students enrolled in schools 1.25 miles (SD = 1.23) from their home. These distances were a bit further than White students, who enrolled in schools about 1.02 miles (SD = .98) from their home on average. We did the same comparison for the subsample of children who ultimately enrolled in a PreK program in a higher-quality school, a group already quite different from the broader sample of eligible students. We found that Black students who enrolled in programs in higher-quality schools lived 1.47 miles (SD = 1.25) away from those schools while Hispanic students lived 1.37 miles (SD = 1.31) and White students lived 0.91 miles (SD = .77) from the programs in higher-quality schools that they enrolled in. Findings suggest that it is important to further unpack the role that distance plays in children's access to PreK and to explicitly consider disparities in where programs are located relative to where children from diverse backgrounds live and ultimately enroll.

Fitting logistic regressions in addition to linear probability models. We present linear probability models in the main text. However, binary outcomes do not have a normal distribution and logistic regression may be a more appropriate way to model these data. As such, we fit all of

our linear probabilities models using logistic regressions as a second approach. All results are shown in Table A12. Substantive results were consistent across approaches.

Check to examine the extent to which children who attend BPS early learning centers did enroll in "feeder" elementary schools. We used feeder elementary schools as described by the district to link students from BPS's early learning centers (which typically serve students in PreK to first grade) to corresponding third grade state test scores. However, we then examined the extent to which students actually did enroll in these feeder schools within our first cohort as a check to see how accurate those matches were. There were 4 pathway elementary schools we had information about - one of them starts in first grade, one in second grade, and two in third grade. We used the most conservative possible approach, examining the students who enrolled in BPS PreK or kindergarten in the early learning center and did stay enrolled in BPS until third grade. We found that among the students in early learning centers with a clear BPS pathway in our first cohort (*N*=283), 60% were still in BPS in third grade, and about half of those who were still in BPS enrolled in the corresponding third grade school.

Changes in PreK programs located in higher-quality schools. We conducted an analysis to examine the extent to which PreK programs included in the higher-quality group remained consistent over time. We found that among the schools who offered PreK and had data on the third grade test scores in at least one of our study years, 61% were never flagged as high-quality during our study. Thirteen percent of schools were in the higher-quality group for 5 or 6 of the study years, 8% were in that group for 3 or 4 study years, and 18% were included in the group for just 1 or 2 study years. As such, there was some mobility in and out of being in the higher-quality group.

We also refit our models and reconsidered what it meant to be considered a PreK program in a "higher-quality school." Specifically we examined the pattern of results for RQs 1 and 3 using two different definitions of being a "higher-quality" school. In the first check, schools had to be in the top quarter of the distribution on state test scores in five or more years to be considered "higher-quality." In the second check, they had to be in the top quarter in at least 3 out of the 6 years to be considered "higher-quality." Results are presented in Appendix A Table 15. As illustrated, we actually found larger disparities in enrollment patterns when we changed the outcome measure and didn't consider mobility in and out of being in the "higher-quality" group.

Changes in availability of slots over time across different types of schools. We examined how enrollment in BPS PreK and PreK in a higher-quality school changed over time on average. However, this analysis did not drill down to more specifics on where the number of slots were increasing the most each year. We conducted a follow-up descriptive analysis to answer this question. For each year, we calculated the increase in the number of slots at each school between cohort 1 and 6. We then used those numbers to operationalize three groups (schools with more than 20 new slots, schools with 1-20 new slots and schools with no new slots or a loss in slots over time) and examined school-level demographics within each group. Results revealed that schools with the greatest increase in slots were a bit more likely to be in the group considered higher-quality across time. For example, schools that experienced the largest increase in slots were considered to be in the higher-quality group 1.48 times across six years compared to 1.22 times for the schools that added 1 – 20 slots and 1.21 times for the schools that added no slots or lost slots. There was also some variation across groups in racial/ethnic composition. As illustrated in Table A13, schools that increased in slots did have a slightly larger proportion of

Hispanic students and smaller proportion of Black students. However, differences were generally small and not statistically significant.

Number of choices listed for BPS PreK program. Families who applied to the BPS PreK program could rank up to 10 schools provided to them by the district. We sought to understand the extent to which the number of schools applied to varied by race/ethnicity, family income, and DLL status. This can provide a signal about the families' access to programs outside of BPS. For example, if families are applying to fewer programs, that is likely an indication that they have alternative choices that they are considering if they do not get their top BPS choice or choices. We found that, on average, Asian (mean = 3.97, SD = 2.75) and White (mean = 4.41, SD = 2.72) students applied to fewer BPS prekindergarten programs than Black students (mean = 4.83, SD = 3.08) and students who identified as multiracial or of another race (mean = 5.03, SD = 2.67). Hispanic students to applied to 4.69 programs (SD = 2.79) on average.

Students eligible for free or reduced price lunch also applied to slightly fewer schools (mean = 4.48, SD = 2.93) than students who were not eligible for free or reduced price lunch (mean = 4.85, SD = 2.74). There was no difference in the number of programs applied to between DLL (mean = 4.60, SD = 2.89) and non-DLL (mean = 4.63, SD = 2.85) students.

Variation in student mobility by race/ethnicity, family income, and DLL status. Finally, due to concerns about variation in students' geographic mobility by our key subgroups, we examined the extent to which student movers that made up 10% of the total sample (using changes in geocodes between PreK and K to create the measure) varied by race/ethnicity, family income, and DLL status. We found that compared to the general sample (69%) the movers were more likely to be eligible for free or reduced price lunch (84%). In addition, the movers were more likely to be Hispanic (46% of movers compared to 40% of full sample), less likely to be

White (10% of movers compared to 18% of full sample) and more likely to be DLLs (57% of movers compared to 51% of full sample). Despite these differences, as noted in the paper, the numbers are fairly small and it is unlikely that mobility would affect the substantive results.

Appendix Table A1

Results of Models Examining Associations Between Enrollment in BPS Prekindergarten or Higher-Quality BPS Prekindergarten and Children's Race/Ethnicity, Socioeconomic Status, Dual Language Learner status and Year of Enrollment (All Available Sample)

	Enrolled in BPS prekindergarten						Enrolled in high quality BPS prekindergarten					
	Research Question 1			Research Question 3			Research Question 1			Research Question 3		
	log(odds)	SE	OR	log(odds)	SE	OR	log(odds)	SE	OR	log(odds)	SE	OR
Cohort (compared to 2012-2013)												
2013 - 2014	0.08 †	0.04	1.08	0.07	0.04	1.07	-0.07	0.07	0.93	-0.11	0.08	0.90
2014 - 2015	0.19 ***	0.04	1.21	0.17 ***	0.04	1.19	-0.20 *	0.08	0.82	-0.06	0.08	0.94
2015 - 2016	0.42 ***	0.04	1.52	0.41 ***	0.04	1.51	0.14 †	0.07	1.15	0.21 **	0.07	1.24
2016 - 2017	0.31 ***	0.04	1.36	0.31 ***	0.04	1.36	0.33 ***	0.07	1.40	0.39 ***	0.07	1.48
2017 - 2018	0.54 ***	0.04	1.71	0.53 ***	0.04	1.69	0.32 ***	0.07	1.38	0.39 ***	0.07	1.48
Student Characteristic												
Female	-0.07 **	0.02	0.93	-0.07 **	0.02	0.94	0.01	0.04	1.01	0.00	0.04	1.00
Age on Sept. 1st	0.34 ***	0.04	1.40	0.34 ***	0.04	1.41	0.16 *	0.07	1.18	0.19 *	0.07	1.21
Student race/ethnicity												
Asian	-0.45 ***	0.06	0.64	-0.44 ***	0.06	0.64	-0.25 **	0.08	0.78	-0.34 ***	0.08	0.71
Black	-0.38 ***	0.04	0.69	-0.37 ***	0.04	0.69	-1.44 ***	0.06	0.24	-1.22 ***	0.06	0.30
Hispanic	-0.44 ***	0.04	0.64	-0.43 ***	0.04	0.65	-1.13 ***	0.06	0.32	-1.02 ***	0.06	0.36
Other race	-0.20 *	0.09	0.82	-0.19 *	0.09	0.82	-0.54 ***	0.13	0.58	-0.55 ***	0.13	0.58
DLL	0.20 ***	0.03	1.22	0.20 ***	0.03	1.22	-0.12 *	0.05	0.88	-0.07	0.05	0.93
Eligible FRPL	0.01	0.03	1.01	0.01	0.03	1.01	-0.51 ***	0.05	0.60	-0.50 ***	0.05	0.61
Minimum distance from BPS PreK				0.11	0.07	1.12						
Minimum distance from high quality school										-1.23 ***	0.05	0.29

NOTE: *** $p < .001$, ** $p < .01$, * $p < .05$

Appendix Table A2

Results of Models Examining Variations in Proximity to BPS Prekindergarten and Higher-Quality BPS Prekindergarten by Children's Race/Ethnicity, Socioeconomic Status, Dual Language Learner status and Year of Enrollment (All Available Sample)

	Distance to BPS prekindergarten		Distance to high quality BPS prekindergarten	
	b	SE	*b*	SE
Cohort (compared to 2012-2013)				
2013 - 2014	-0.01 **	0.00	-0.05 ***	0.01
2014 - 2015	0.00	0.00	0.14 ***	0.01
2015 - 2016	-0.01 ***	0.00	0.06 ***	0.01
2016 - 2017	-0.01 **	0.00	0.04 ***	0.01
2017 - 2018	-0.01 **	0.00	0.10 ***	0.01
Student Characteristic				
Female	0.00	0.00	0.00	0.01
Age on Sept. 1st (centered)	0.00	0.00	0.01	0.01
Student race/ethnicity				
Asian	-0.01	0.00	-0.10 ***	0.01
Black	-0.02 ***	0.00	0.21 ***	0.01
Hispanic	-0.04 ***	0.00	0.12 ***	0.01
Other race	-0.01	0.01	0.02	0.02
DLL	0.00 *	0.00	0.03 ***	0.01
Eligible FRPL	-0.02 ***	0.00	0.01	0.01

NOTE: *** $p < .001$, ** $p < .01$, * $p < .05$

Appendix Table A3

Results of Models Examining Individual Associations Between Enrollment in BPS Prekindergarten or Higher-Quality BPS Prekindergarten and Children's Race/Ethnicity, Socioeconomic Status and Dual Language Learner status

	Enrolled in BPS prekindergarten						Enrolled in high quality BPS prekindergarten					
	Research Question 1			Research Question 3			Research Question 1			Research Question 3		
	log(odds)	SE	OR	log(odds)	SE	OR	log(odds)	SE	OR	log(odds)	SE	OR
Student Characteristic												
Student race/ethnicity												
Asian	-0.27 ***	0.06	0.77	-0.26 ***	0.06	0.77	-0.49 ***	0.07	0.61	-0.59 ***	0.07	0.55
Black	-0.37 ***	0.04	0.69	-0.36 ***	0.04	0.70	-1.74 ***	0.06	0.18	-1.51 ***	0.06	0.22
Hispanic	-0.34 ***	0.04	0.71	-0.32 ***	0.04	0.72	-1.48 ***	0.06	0.23	-1.34 ***	0.06	0.26
Other race	-0.14	0.10	0.87	-0.14	0.10	0.87	-0.60 ***	0.14	0.55	-0.59 ***	0.14	0.56
DLL	0.10 **	0.03	1.10	0.11 ***	0.03	1.11	-0.38 ***	0.04	0.68	-0.37 ***	0.04	0.69
Eligible FRPL	-0.13 **	0.03	0.88	-0.12 ***	0.03	0.89	-1.02 ***	0.04	0.36	-0.94 ***	0.04	0.39

NOTE: *** $p < .001$, ** $p < .01$, * $p < .05$

Appendix Table A4

Results of Models Examining Individual Associations Between Enrollment in BPS Prekindergarten or Higher-Quality BPS Prekin and Children's Race/Ethnicity, Socioeconomic Status and Dual Language Learner status

	Distance to BPS prekindergarten RQ2		Distance to high quality BPS RQ2	
	b	SE	*b*	SE
Student Characteristic				
Student race/ethnicity				
Asian	-0.03 ***	0.00	-0.07 ***	0.01
Black	-0.04 ***	0.00	0.24 ***	0.01
Hispanic	-0.06 ***	0.00	0.16 ***	0.01
Other race	-0.02 *	0.01	0.03	0.02
DLL	-0.02 ***	0.00	0.01 †	0.01
Eligible FRPL	-0.04 ***	0.00	0.09 **	0.01

NOTE: *** $p < .001$, ** $p < .01$, * $p < .05$

Appendix Table A5

Results of Models Examining Associations Between Students' Race/Ethnicity, Family Income, Dual Language Learner Status and Application to a BPS PreK

	Applied to the BPS prekindergarten			
	Research Question 1			
	log(odds)		SE	OR
Cohort (compared to 2012-2013)				
2013 - 2014	0.07		0.05	1.08
2014 - 2015	0.25	***	0.05	1.29
2015 - 2016	0.20	***	0.05	1.22
2016 - 2017	0.19	***	0.05	1.20
2017 - 2018	0.43	***	0.05	1.54
Student characteristics				
Female	-0.03		0.03	0.97
Age on Sept. 1st	0.42	***	0.05	1.53
Student race/ethnicity				
Asian	-0.45	***	0.07	0.63
Black	-0.74	***	0.05	0.48
Hispanic	-0.70	***	0.05	0.49
Other race	-0.07		0.12	0.93
DLL	0.26	***	0.03	1.29
Eligible FRPL	-0.45	***	0.03	0.64

NOTE: *** $p < .001$, ** $p < .01$, * $p < .05$

Appendix Table A6

Results of Models Examining Variations in Proximity to Applied BPS Prekindergarten by Children's Race/Ethnicity, Socioeconomic Status, Dual Language Learner status and Year of Enrollment

	Distance to first choice BPS prekindergarten		
	b		SE
Cohort (compared to 2012-2013)			
2013 - 2014	0.00		0.03
2014 - 2015	-0.20	***	0.03
2015 - 2016	-0.20	***	0.03
2016 - 2017	-0.26	***	0.03
2017 - 2018	-0.32	***	0.03
Student Characteristic			
Female	0.02		0.02
Age on Sept. 1st (centered)	0.08	*	0.03
Student race/ethnicity			
Asian	0.01		0.04
Black	0.22	***	0.03
Hispanic	0.22	***	0.03
Other race	0.00		0.06
DLL	-0.06	*	0.02
Eligible FRPL	0.08	***	0.02

NOTE: *** $p < .001$, ** $p < .01$, * $p < .05$

Appendix Table A7

Results of Models Examining Associations Between Enrollment in BPS Prekindergarten or Higher-Quality BPS Prekindergarten and Children's Race/Ethnicity, Socioeconomic Status, Dual Language Learner status and Year of Enrollment For Students Who Enrolled To Kindergarten

	Enrolled in BPS prekindergarten						Enrolled in high quality BPS prekindergarten					
	Research Question 1			Research Question 3			Research Question 1			Research Question 3		
	log(odds)	SE	OR	log(odds)	SE	OR	log(odds)	SE	OR	log(odds)	SE	OR
Cohort (compared to 2012-2013)												
2013 - 2014	0.13 *	0.05	1.14	0.13 **	0.05	1.14	-0.01	0.08	0.99	-0.07	0.08	0.94
2014 - 2015	0.34 ***	0.05	1.40	0.34 ***	0.05	1.40	-0.07	0.09	0.93	0.05	0.09	1.05
2015 - 2016	0.44 ***	0.05	1.55	0.44 ***	0.05	1.55	0.22 **	0.08	1.25	0.27 ***	0.08	1.32
2016 - 2017	0.60 ***	0.05	1.83	0.61 ***	0.05	1.83	0.49 ***	0.08	1.63	0.56 ***	0.08	1.76
2017 - 2018	0.73 ***	0.05	2.07	0.73 ***	0.05	2.08	0.40 ***	0.08	1.49	0.45 ***	0.08	1.57
Student characteristics												
Female	-0.07 *	0.03	0.93	-0.07 *	0.03	0.93	0.00	0.05	1.00	-0.02	0.05	0.98
Age on Sept. 1st	0.34 ***	0.05	1.40	0.34 ***	0.05	1.40	0.23 **	0.08	1.26	0.24 **	0.08	1.28
Student race/ethnicity												
Asian	-0.48 ***	0.07	0.62	-0.48 ***	0.07	0.62	-0.20 *	0.09	0.82	-0.33 ***	0.09	0.72
Black	-0.44 ***	0.05	0.64	-0.44 ***	0.05	0.65	-1.46 ***	0.07	0.23	-1.25 ***	0.07	0.29
Hispanic	-0.51 ***	0.05	0.60	-0.50 ***	0.05	0.61	-1.15 ***	0.07	0.32	-1.05 ***	0.07	0.35
Other race	-0.14	0.11	0.87	-0.13	0.11	0.88	-0.57 ***	0.14	0.57	-0.57 ***	0.15	0.57
DLL	0.24 ***	0.03	1.27	0.24 ***	0.03	1.27	-0.13 *	0.06	0.88	-0.08	0.06	0.93
Eligible FRPL	-0.03	0.03	0.97	-0.02	0.03	0.98	-0.60 ***	0.05	0.55	-0.58 ***	0.05	0.56
Distance from BPS PreK				0.26 **	0.08	1.30						
Distance from PreK in high-quality school										-1.21 ***	0.06	0.30

NOTE: *** $p < .001$, ** $p < .01$, * $p < .05$

Appendix Table A8

Results of Models Examining Variations in Proximity to BPS Prekindergarten and Higher-Quality BPS Prekindergarten by Children's Race/Ethnicity, Socioeconomic Status, Dual Language Learner status and Year of Enrollment for Students Enrolled to Kindergarten

	Distance to nearest BPS PreK program		Distance to nearest BPS PreK program in a high-quality school	
Predictors	*b*	SE	*b*	SE
Cohort (compared to 2012-2013)				
2013 - 2014	-0.01 **	0.00	-0.06 ***	0.01
2014 - 2015	0.00	0.00	0.13 ***	0.01
2015 - 2016	-0.01 **	0.00	0.06 ***	0.01
2016 - 2017	-0.01 **	0.00	0.06 ***	0.01
2017 - 2018	-0.01 **	0.00	0.08 ***	0.01
Student characteristics				
Female	0.00	0.00	-0.01	0.01
Age on Sept. 1st (centered)	0.00	0.00	0.00	0.01
Student race/ethnicity				
Asian	-0.02 ***	0.01	-0.11 ***	0.01
Black	-0.03 ***	0.00	0.22 ***	0.01
Hispanic	-0.05 ***	0.00	0.12 ***	0.01
Other race	-0.02 *	0.01	0.02	0.02
DLL	-0.01 **	0.00	0.03 ***	0.01
Eligible FRPL	-0.02 ***	0.00	0.03 ***	0.01

NOTE: *** $p < .001$, ** $p < .01$, * $p < .05$

Appendix Table A9

Variation in Distance to Nearest BPS PreK Applied to by Demographic Characteristics

	First Choice Distance		Second Choice Distance		Third Choice Distance	
Demographic characteristic	Mean	SD	Mean	SD	Mean	SD
Full sample	1.07	1.06	1.13	1.03	1.24	1.07
Eligible for free or reduced price lunch	1.13	1.15	1.19	1.12	1.29	1.15
Race/ethnicity						
Asian	0.92	0.91	1.05	0.88	1.15	0.96
Black	1.17	1.07	1.23	1.09	1.32	1.13
Hispanic	1.15	1.20	1.18	1.15	1.28	1.14
Other race or multiracial	0.89	0.86	0.95	0.71	1.08	0.81
White	0.89	0.80	0.99	0.78	1.14	0.92
Dual Language Learner	1.08	1.13	1.13	1.06	1.24	1.10

Appendix Table A10

Variation in Distance to PreK Program Applied to in a Higher-Quality School by Demographic Characteristics

Demographic characteristic	Mean	SD
Full sample	0.99	0.92
Eligible for free or reduced price lunch	1.10	1.04
Race/ethnicity		
Black	1.21	1.02
Hispanic	1.13	1.16
Asian	0.94	0.92
Other race or multiracial	0.77	0.71
White	0.86	0.67
Dual Language Learner	1.02	1.01

Appendix Table A11

Variation in Distance to Nearest BPS PreK Enrolled in and PreK Program Enrolled in a Higher-Quality School by Demographic Characteristics

	Enrolled PreK Program Distance		Enrolled PreK Program in a High-Quality School Distance	
Demographic characteristic	Mean	SD	Mean	SD
Full sample	1.20	1.17	1.14	1.09
Eligible for free or reduced price lunch	1.27	1.23	1.33	1.26
Race/ethnicity				
Black	1.29	1.22	1.47	1.25
Hispanic	1.25	1.23	1.37	1.31
Asian	1.09	1.06	1.00	1.04
Other race or multiracial	0.92	0.84	0.76	0.60
White	1.02	0.98	0.91	0.77
Dual Language Learner	1.23	1.22	1.24	1.23

Appendix Table A12

Results of Logistic Regressions Examining Associations Between Enrollment in BPS Prekindergarten or Higher-Quality BPS Prekindergarten and Children's Race/Ethnicity, Socioeconomic Status, Dual Language Learner status and Year of Enrollment For Students Who Enrolled To Kindergarten

	Enrolled in BPS PreK								Enrolled in BPS PreK in a higher-quality school							
	Research Question 1				Research Question 3				Research Question 1				Research Question 3			
	log(odds)		SE	OR	log(odds)		SE	OR	log(odds)		SE	OR	log(odds)		SE	OR
Cohort (compared to 2012-2013)																
2013 - 2014	0.15	*	0.06	1.16	0.15	*	0.06	1.17	-0.03		0.20	0.97	-0.09		0.19	0.92
2014 - 2015	0.35	***	0.09	1.42	0.35	***	0.09	1.43	-0.11		0.29	0.90	0.02		0.28	1.02
2015 - 2016	0.43	***	0.09	1.53	0.43	***	0.09	1.54	0.15		0.17	1.16	0.24		0.17	1.28
2016 - 2017	0.38	***	0.09	1.46	0.39	***	0.09	1.47	0.34		0.25	1.40	0.46		0.25	1.58
2017 - 2018	0.58	***	0.08	1.78	0.58	***	0.08	1.79	0.27		0.29	1.31	0.36		0.28	1.43
Student characteristics																
Female	-0.05	*	0.02	0.95	-0.05	*	0.02	0.95	0.01		0.05	1.01	0.00		0.05	1.00
Age on Sept. 1st	0.32	***	0.06	1.38	0.32	***	0.06	1.38	0.21	*	0.08	1.24	0.23	**	0.08	1.25
Student race/ethnicity (White is reference group)																
Asian	-0.40	*	0.17	0.67	-0.40	*	0.17	0.67	-0.23		0.27	0.80	-0.34		0.25	0.71
Black	-0.37	***	0.12	0.69	-0.36	***	0.12	0.70	-1.52	***	0.20	0.22	-1.26	***	0.19	0.28
Hispanic	-0.45	***	0.12	0.64	-0.44	***	0.12	0.64	-1.17	***	0.14	0.31	-1.05	***	0.14	0.35
Other race	-0.15		0.11	0.86	-0.14		0.11	0.87	-0.58	***	0.16	0.56	-0.58	***	0.16	0.56
DLL	0.22	**	0.07	1.25	0.22	***	0.07	1.25	-0.14		0.11	0.87	-0.08		0.11	0.92
Eligible free or reduced price lunch	-0.03		0.06	0.97	-0.02		0.05	0.98	-0.54	***	0.12	0.58	-0.51	***	0.11	0.60
Distance from BPS PreK					0.30		0.20	1.35								
Distance from PreK in higher-quality school													-1.22	***	0.16	0.29

NOTE: *** $p < .001$, ** $p < .01$, * $p < .05$

Appendix Table A13

School Characteristics for Schools With Different Increases in New Open Slots From 2012-2013 to 2017-2018

	2012-2013 school year						2017-2018 school year					
	Schools with zero or less new slots		Schools with 1-20 new slots		Schools with more than 20 new slots		Schools with zero or less new slots		Schools with 1-20 new slots		Schools with more than 20 new slots	
School Characteristic	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Student academic performance on 3rd grade standardized tests (%)												
Avg. number of years school was high-quality							1.21	1.93	1.23	1.67	1.48	2.42
Students proficient on ELA exam	35.29	17.93	36.30	14.83	34.89	19.24	36.89	17.59	33.65	15.70	38.05	20.26
Students proficient on math exam	48.88	16.41	51.70	19.61	49.79	20.54	35.11	16.18	33.77	17.76	37.00	19.87
Teacher and school characteristics												
Exemplary teachers (%)	19.56	16.95	14.32	16.95	10.03	12.17	16.37	12.52	20.83	10.77	16.37	10.82
Proficient teachers (%)	74.04	17.88	78.88	15.73	83.24	12.57	79.86	12.33	76.46	10.86	79.64	10.64
Teacher retention (%)	82.30	6.65	81.80	12.54	82.64	5.57	79.75	12.66	80.11	14.63	78.54	11.78
Licensed teachers (%)	96.09	4.29	96.56	3.26	95.94	3.55	97.21	3.99	96.56	5.81	95.30	6.80
Student-teacher ratio	12.70	3.00	13.27	1.43	12.85	1.37	12.83	2.65	12.80	1.82	13.42	1.96
Student demographics (%)												
Black	34.03	20.80	31.54	19.01	30.33	23.05	35.11	20.22	29.68	18.09	30.27	21.77
Asian	5.52	7.11	5.29	7.82	6.73	12.81	5.95	8.66	5.93	8.86	6.85	12.44
Hispanic	39.57	16.90	47.05	21.22	46.08	22.77	38.45	17.07	45.07	20.00	43.11	22.52
Other race	4.25	2.43	3.14	2.50	2.34	1.22	4.27	2.38	3.76	1.64	3.91	1.83
White	16.65	16.30	13.00	12.42	14.54	18.01	16.19	14.87	15.54	14.21	15.87	18.39
Female	47.41	4.23	48.13	3.27	47.69	2.61	48.64	3.79	47.49	4.13	48.36	3.18
Non-English home language	42.41	18.70	43.83	18.95	46.17	21.59	44.93	21.35	43.37	17.89	44.35	20.58
English language learner	34.87	17.71	34.80	17.15	36.51	18.65	38.36	20.78	35.34	16.08	36.11	17.34
Students with disabilities	21.67	18.16	17.60	6.17	18.85	6.12	23.58	17.57	19.75	8.76	17.25	6.56
Families with low-incomes[a]	69.02	15.18	72.31	11.35	71.42	13.60						
Students economically disadvantaged[b]							57.97	15.52	59.83	12.76	61.58	16.81
Stability (%)	85.67	14.84	86.86	4.60	87.27	4.45	84.52	5.57	84.60	6.28	83.44	7.00

[a]data were available in years 2012-2013 and 2013-2014

[b]data were available for schools in 2014-2015

Appendix Table A14

Demographic Characteristics of Kindergarten Students in Different Cohorts

	School Year of Kindergarten Enrollment					
Student Characteristic (%)	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Eligible for free or reduced price lunch	0.75	0.69	0.70	0.71	0.66	0.73
Dual Language Learner	0.53	0.49	0.50	0.50	0.52	0.51
Race/ethnicity						
Black	0.33	0.33	0.32	0.31	0.32	0.32
Hispanic	0.42	0.40	0.38	0.41	0.40	0.40
Asian	0.08	0.08	0.08	0.08	0.08	0.08
Other race or multiracial	0.02	0.02	0.02	0.02	0.02	0.02
White	0.15	0.17	0.20	0.18	0.18	0.18

Appendix Table A15

Results of Linear Probability Models Examining Associations Between Enrollment in BPS PreK in Higher-Quality Schools: Recreating "Higher-Quality School" Variable to Require Being Part of that Group for Three and Five Years or More

	Enrolled in higher-quality school (3 years or more)						Enrolled in BPS PreK in a higher-quality school (5 years or more)					
	Research Question 1			Research Question 3			Research Question 1			Research Question 3		
	b		SE	*b*		SE	*b*		SE	*b*		SE
Cohort (compared to 2012-2013)												
2013 - 2014	-0.02		0.01	-0.03	*	0.01	0.00		0.01	0.00		0.01
2014 - 2015	0.01		0.01	0.03	*	0.01	0.00		0.01	0.01		0.01
2015 - 2016	0.00		0.01	0.01		0.01	0.00		0.01	0.01		0.01
2016 - 2017	-0.01		0.01	0.00		0.01	0.00		0.01	0.01		0.01
2017 - 2018	-0.01		0.01	0.01		0.01	0.00		0.01	0.01		0.01
Student characteristics												
Female	0.01		0.01	0.01		0.01	0.00		0.00	0.00		0.00
Age on Sept. 1st	0.01		0.01	0.01		0.01	0.00		0.00	0.00		0.00
Student race/ethnicity (White is reference group)												
Asian	0.01		0.13	-0.01		0.12	-0.10	*	0.05	-0.10	*	0.05
Black	-0.27	***	0.06	-0.24	***	0.06	-0.14	*	0.06	-0.13	*	0.05
Hispanic	-0.22	***	0.05	-0.20	***	0.05	-0.13	*	0.05	-0.12	*	0.05
Other race	-0.07		0.05	-0.06		0.05	-0.08	*	0.03	-0.08	*	0.03
DLL	-0.04	*	0.02	-0.04	*	0.02	-0.03	*	0.01	-0.03	*	0.01
Eligible free or reduced price lunch	-0.08	**	0.03	-0.08	**	0.03	-0.05	*	0.02	-0.04	*	0.02
Distance from PreK in higher-quality school				-0.14	***	0.03				-0.06		0.03

NOTE: *** $p < .001$, ** $p < .01$, * $p < .05$

Appendix B

Neighborhood characteristics of study sample by enrollment in BPS PreK

Neighborhood Characteristics of Study Sample

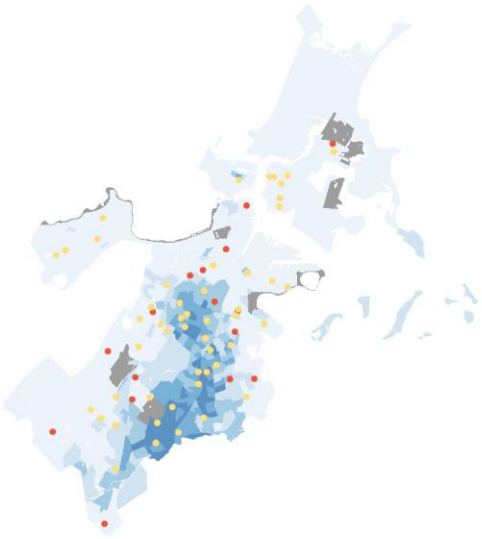
	Full sample		
Characteristic	All study participants	BPS PreK enrollees	BPS PreK non-enrollees
Median Household Income ($)	51,124	52,044	50,028
Race/ethnicity (%)			
Black	33.3	32.7	34.1
Hispanic	25.7	25.1	26.4
Asian	7.2	6.9	7.6
Other race or multiracial	4.2	4.3	4.1
White	29.1	30.6	27.5
Sample size (*N*)	29,355	15,913	13,442

Appendix C

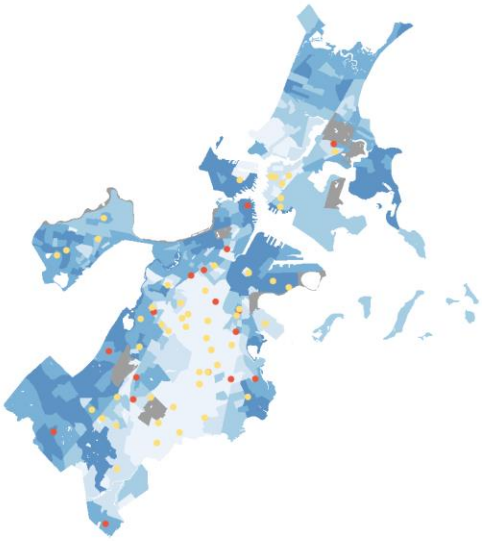
Maps of Boston from 2012 – 2017 overlaid by location of BPS PreK programs, including programs in higher-quality schools and community-based programs where available

2012-2013

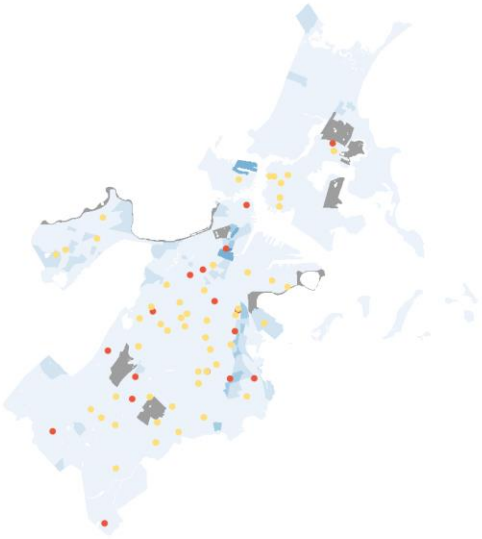
Neighborhood Percent Black



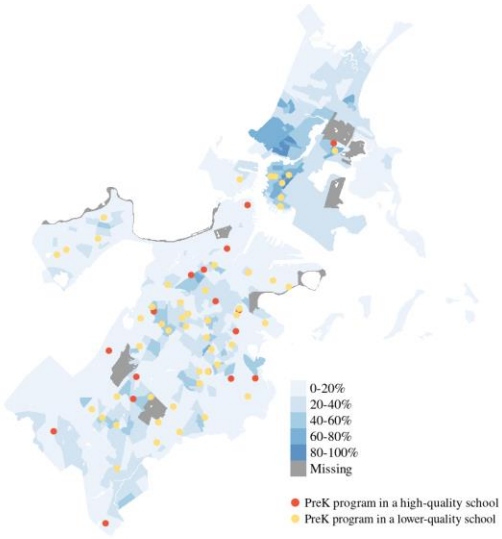
Neighborhood Percent White



Neighborhood Percent Asian

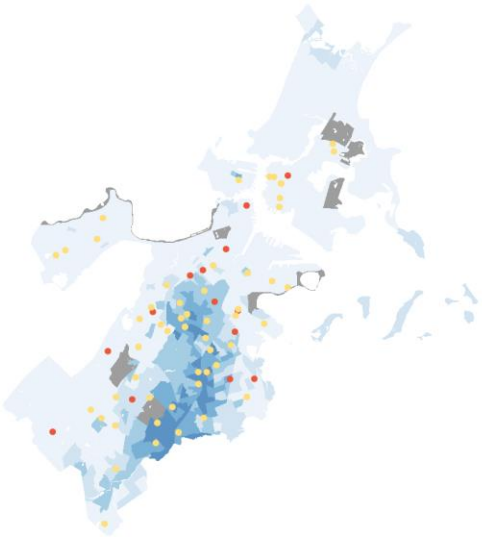


Neighborhood Percent Hispanic

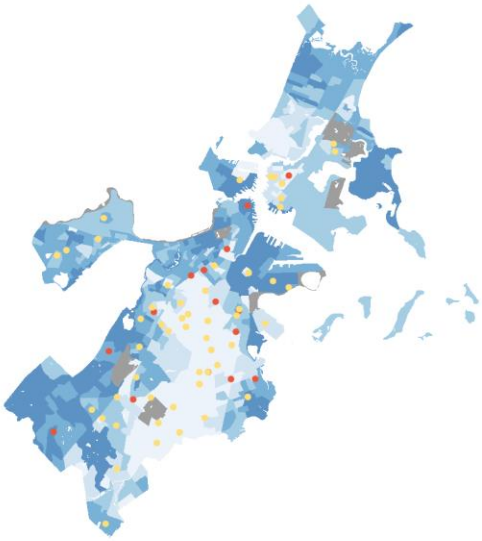


2013-2014

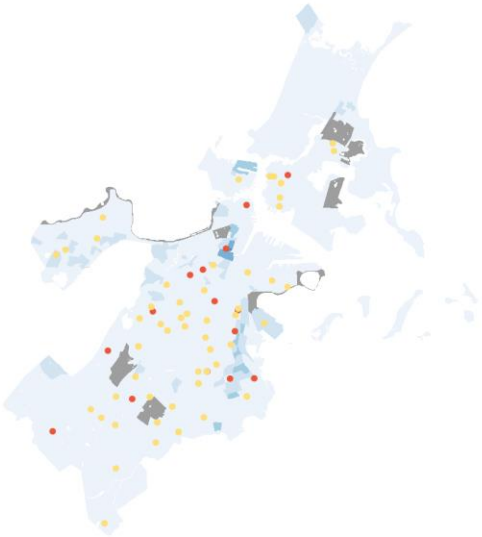
Neighborhood Percent Black



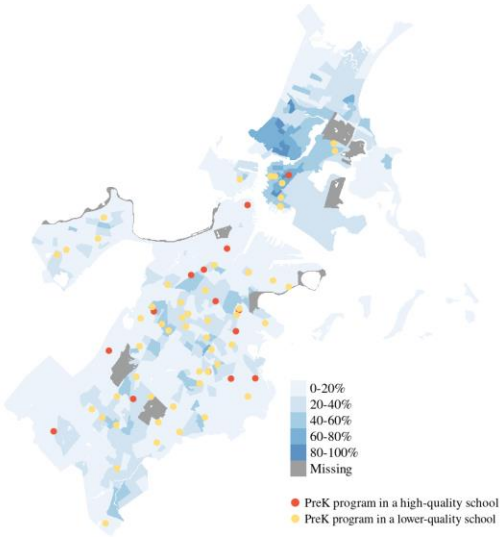
Neighborhood Percent White



Neighborhood Percent Asian

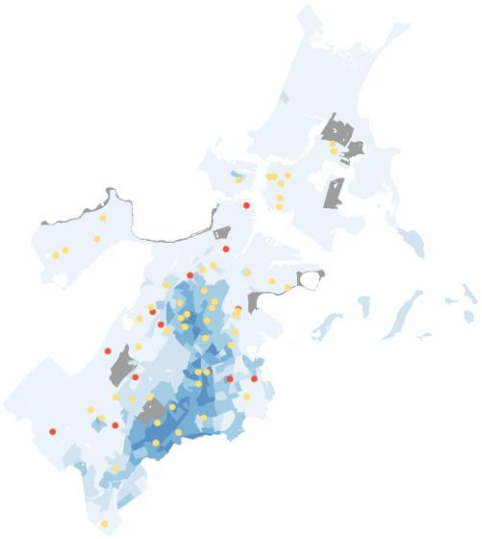


Neighborhood Percent Hispanic

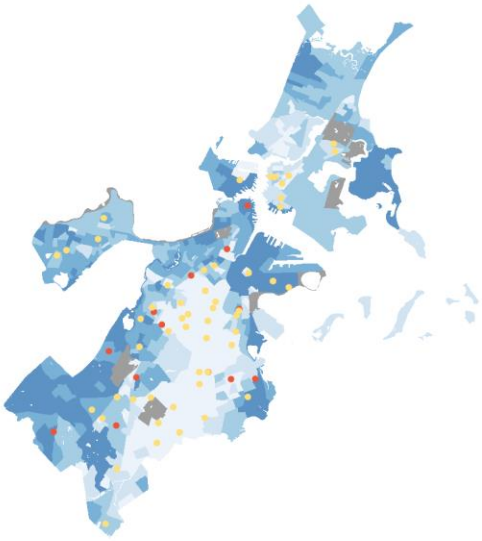


2014-2015

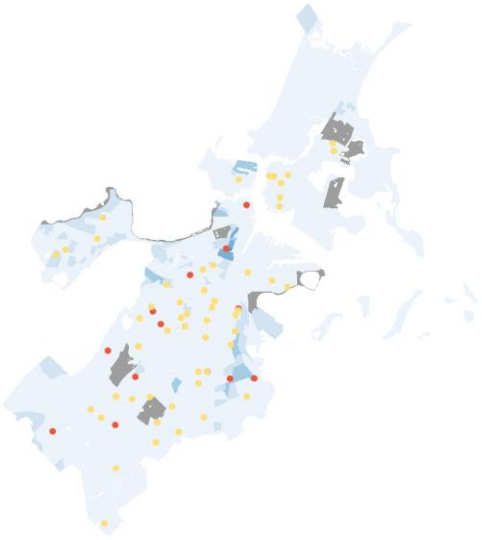
Neighborhood Percent Black



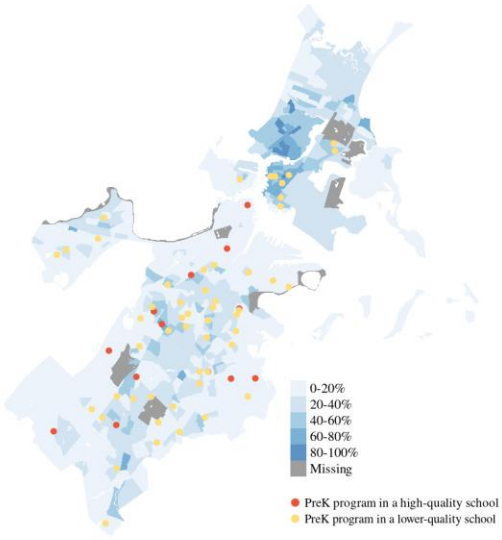
Neighborhood Percent White



Neighborhood Percent Asian

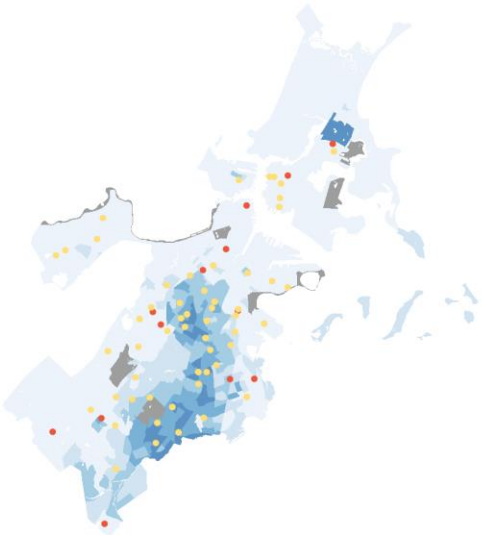


Neighborhood Percent Hispanic

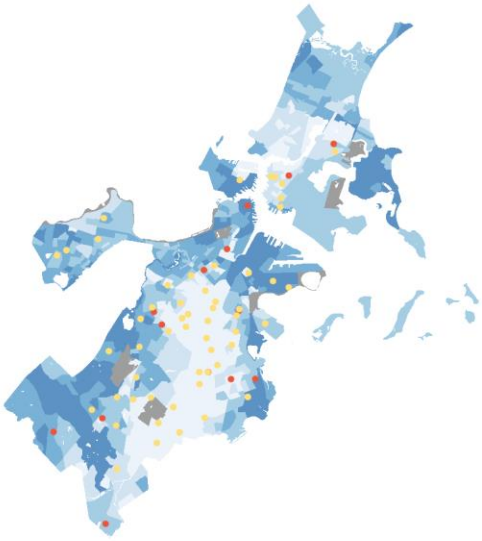


2015-2016

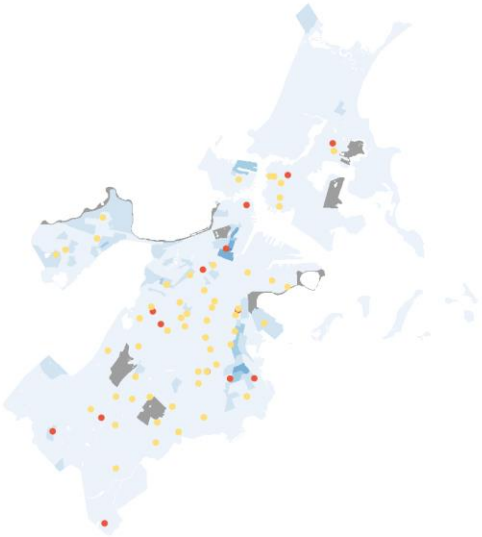
Neighborhood Percent Black



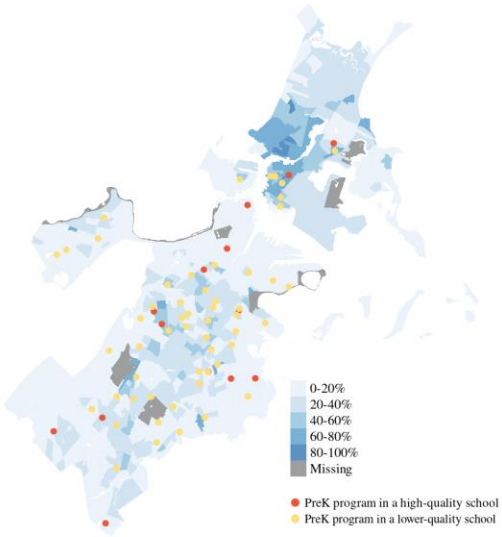
Neighborhood Percent White



Neighborhood Percent Asian

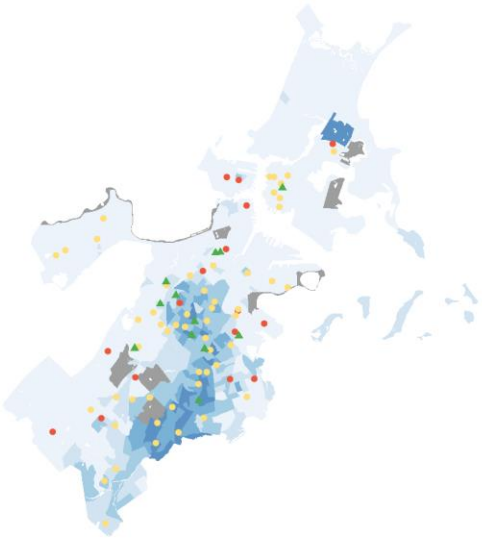


Neighborhood Percent Hispanic

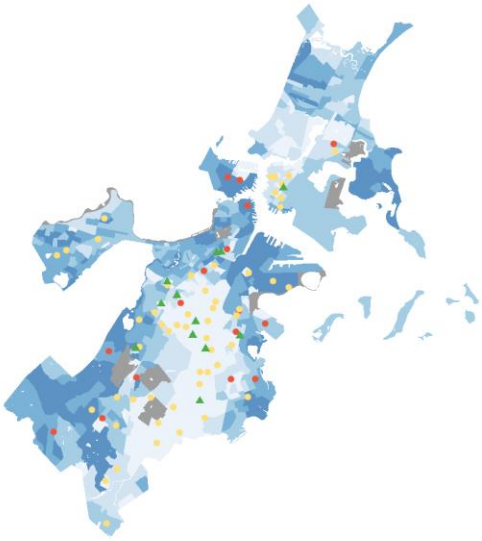


2016-2017

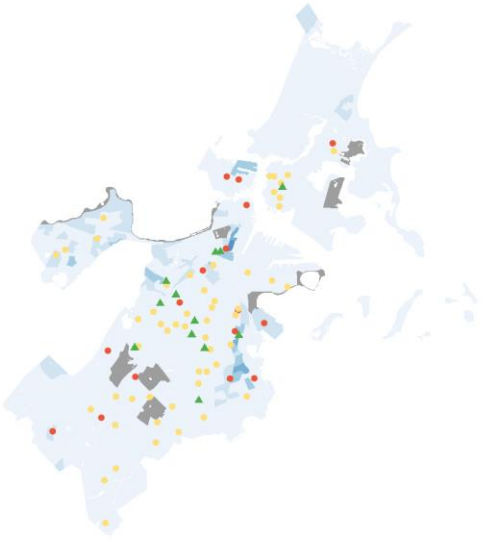
Neighborhood Percent Black



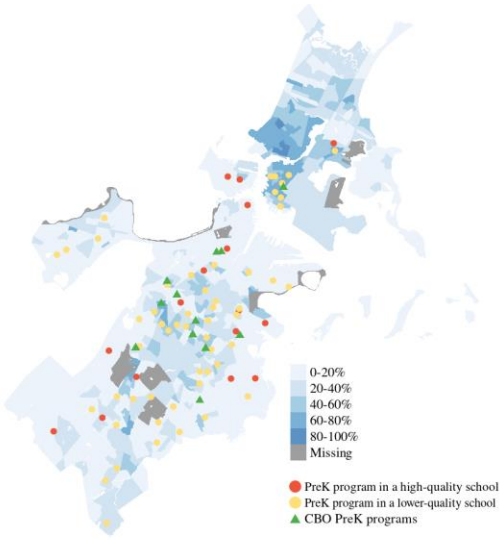
Neighborhood Percent White



Neighborhood Percent Asian



Neighborhood Percent Hispanic



Appendix D

Figures illustrating variation in associations between geographic proximity and BPS PreK enrollment by race/ethnicity and BPS PreK Enrollment in higher-quality school and DLL status

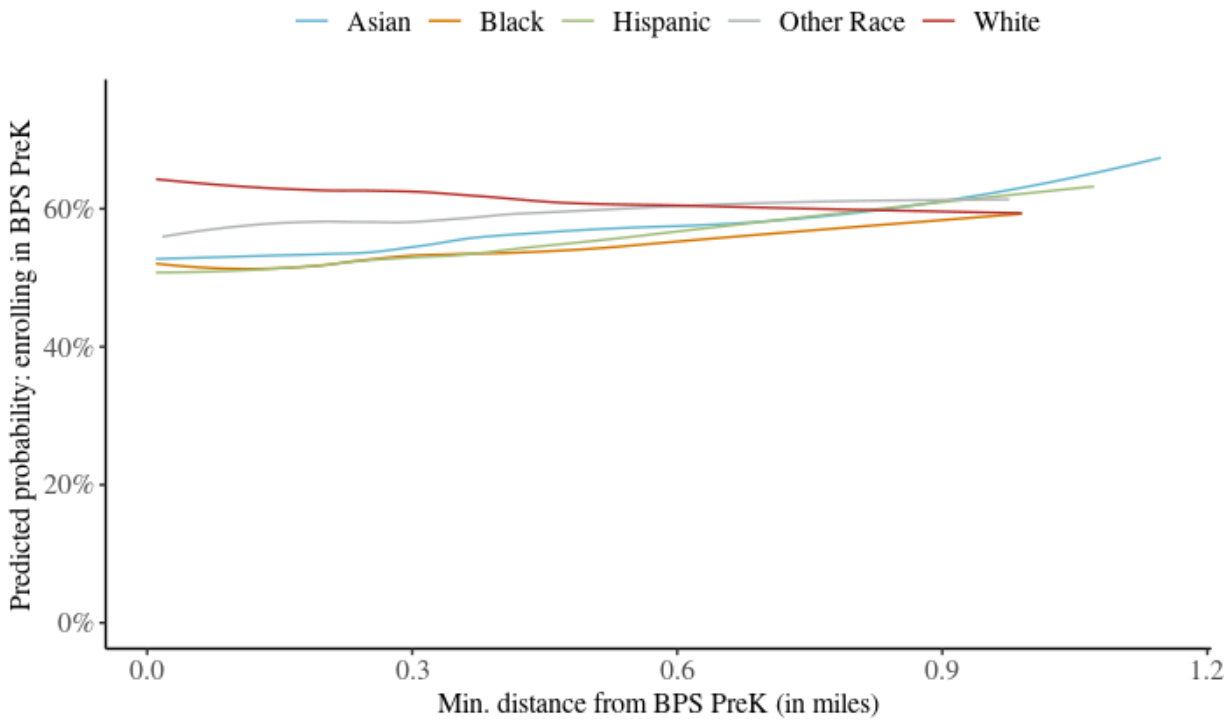


Figure 1

Students' Probability of Enrolling in BPS PreK by the Minimum Distance From a BPS PreK and Race/Ethnicity

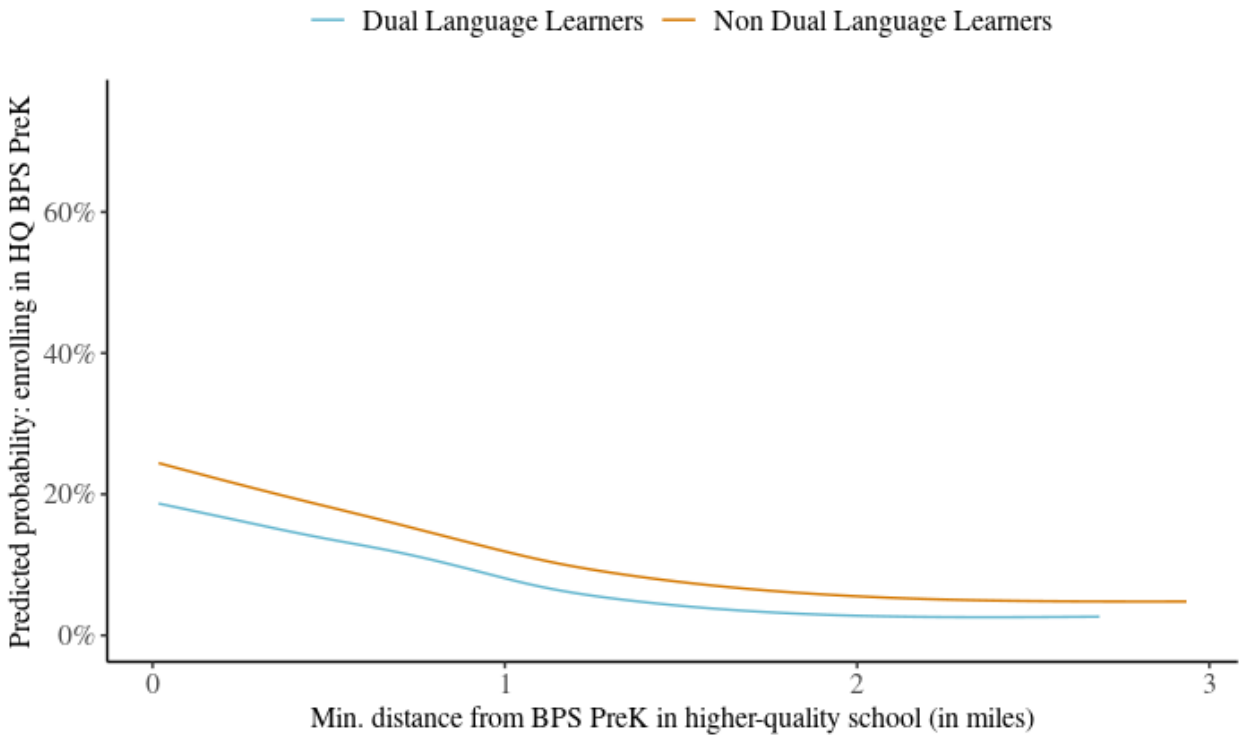


Figure 2

Students' Probability of Enrolling in BPS PreK in Higher-Quality School by the Minimum Distance From a Higher-Quality School and Dual Language Learner Status

Appendix E

Results from models considering intersectionality between race/ethnicity, family income, and DLL status in predicting the likelihood of enrollment in BPS PreK

	Enrolled in BPS prekindergarten			Enrolled in high quality BPS prekindergarten		
	log(odds)	SE	OR	log(odds)	SE	OR
Eligible FRPL x Student race/ethnicity						
Asian	0.44 ***	0.12	1.55	0.61 ***	0.16	1.84
Black	0.57 ***	0.09	1.77	0.43 **	0.15	1.53
Hispanic	0.66 ***	0.09	1.94	0.48 ***	0.13	1.61
Other race	0.04	0.22	1.04	0.01	0.33	1.01
DLL x Student race/ethnicity						
Asian	0.04	0.16	1.04	0.31	0.20	1.37
Black	0.42 ***	0.10	1.52	0.62 ***	0.15	1.85
Hispanic	0.57 ***	0.10	1.76	0.48 ***	0.14	1.62
Other race	0.91 ***	0.25	2.49	0.89 **	0.31	2.43

NOTE: *** $p < .001$, ** $p < .01$, * $p < .05$

Appendix F

Details on the lottery process for slots in the BPS PreK program

In the current study, most families applied to the Boston PreK program via the lottery, which occurs in three or four rounds (depending on application year) in the months leading up to the start of each academic year. Prior to 2014, families with age-eligible children were able to rank up to 10 PreK program choices, to which a family could have priority status based on home location and sibling enrollment.[9] Important caveats are that there were three schools (4% total schools) that did not consider home location as a priority characteristic and the walk zone priority only applied to half of the slots in the remaining schools. Starting in 2014, after a lengthy and public process, the district changed enrollment policies so that families received a specific choice list of the ten public school PreK programs located closest to their home address that they could then rank order in order of preference. Families also received information about the quality of the schools on the list to help inform their ranking. This school-level quality metric included a combination of factors like existing students' academic performance, school climate, culturally responsive teaching, and diversity, among other characteristics. After this change was made in 2014, students continued to receive priority for admission at schools that a sibling already attended but no longer received priority based on proximity.

Across all years, if there was more demand for a given program than available slots, the district used random numbers (as designed in widely used school choice algorithms; Abdulkadiroglu, Angrist, Dynarski, Kane, & Pathak (2011)) to conduct a lottery to determine which students received the slots in that school. In the cases where spaces were still available after the lottery, children could also apply and enroll in schools later in the summer or during the school year. Ultimately, BPS's PreK application

[9] In some schools, students also could have competed for slots in regular education and inclusion classrooms (e.g., intentional mix of children with and without diagnosed special needs; see Weiland, 2016 for details).

system gives families a range of school options from which to choose but does not guarantee a family their top choice or, in some cases, any choices. Because the current study is particularly interested in *access* to PreK in general and PreK in higher-quality school in particular, our primary focus is on describing the programs that students *enroll in* (rather than overall application patterns; see more about application patterns in Shapiro et al. (2019)).

Students in the current study sample attended schools located all over the city of Boston (see Figure 1 for school locations in 2017 - 2018 overlaid on a map of Boston with CBO partner schools included) and enrolled in 84 different schools for kindergarten across the six study years. Eighty-one of these elementary schools offered the BPS PreK program during at least one year and 84% offered PreK during all six years of the study. On average, 34% of students in elementary schools offering PreK were Black, 40% Hispanic, 16% White, 8% Asian, and 2% another race or more than one race. On average the schools had 68% of students eligible for free or reduced price lunch and 50% were DLLs.

Appendix G

Demographic Characteristics of Students in All of Sample

Characteristic	All study participants	Full sample: BPS PreK non-enrollees	Full sample: BPS PreK enrollees	Full sample: BPS PreK enrollees in a higher-quality school
Female	0.48	0.49	0.47	0.48
Child age on 9/1 of kindergarten	5.51 (0.30)	5.49 (0.30)	5.52 (0.29)	5.51 (0.29)
Eligible for free or reduced price lunch	0.71	0.72	0.70	0.49
Race/ethnicity				
Black	0.34	0.36	0.33	0.18
Hispanic	0.40	0.41	0.39	0.26
Asian	0.08	0.08	0.08	0.13
Other race or multiracial	0.02	0.02	0.02	0.03
White	0.16	0.14	0.18	0.40
Dual Language Learner	0.51	0.49	0.52	0.42
Home language				
English	0.58	0.56	0.58	0.70
Spanish	0.21	0.22	0.19	0.11
Other language	0.13	0.15	0.12	0.13
Student has IEP	0.14	0.08	0.19	0.18
Student attended community-based PreK partner	0.02	-	0.02	-
PreK eligibility year				
2012 - 2013	0.17	0.20	0.15	0.15
2013 - 2014	0.17	0.18	0.15	0.14
2014 - 2015	0.15	0.16	0.15	0.11
2015 - 2016	0.16	0.14	0.17	0.16
2016 - 2017	0.18	0.18	0.19	0.23
2017 - 2018	0.17	0.14	0.19	0.20
Sample size (*N*)	29355	13442	15913	2831