Over Diagnosed or Over Looked? The Effect of Age at Time of School Entry On Students Receiving Special Education Services

by

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Table of Contents

List of Tables

List of Figures

Abstract

Nearly 14% of students in the United States receive special education services in public schools (NCES, 2017). Special education programs serve students with a wide range of developmental differences and vary considerably across schools and districts (National Research Council, 1997). Likelihood of identification for special education services also varies by gender, race, ethnicity, and socioeconomic status. Identifying sources of variation in special education identification, and in the placements of students once identified, has driven a wide body of work in multiple fields (e.g., Elder, Figlio, Imberman, & Persico, 2019; Hibel, Farkas, & Morgan, 2010; Skiba et al., 2006). Just as student demographics are associated with likelihood of special education placement, students who are younger than their peers when they start school are more likely to be identified with disabilities (Elder, 2010; Evans et. al, 2010; Layton et. al, 2018) and placed in special education (Dhuey, Figlio, Karbownik, & Roth, 2019; Dhuey & Lipscomb, 2010). Differences in special education identification and placement types may impact the outcomes of students who do or do not receive special education services and the school districts that operate these programs.

This dissertation includes two stand-alone manuscripts on the relationship between age and special education identification and placement. In the first study, I used a regression discontinuity design using a statewide kindergarten entrance policy in Michigan to estimate the effect of being young for grade on the likelihood of receiving special education services in each elementary and middle school grade. I find that the youngest kindergarten enrollees were 3.3 percentage points (40%) more likely to be identified for special education in kindergarten than

their oldest peers. I find no evidence of heterogeneity in the effect of school starting age by gender, race, or socioeconomic status, and no evidence of heterogeneity across school districts in Michigan. I also find exploratory evidence that these effects are driven by relative age comparisons rather than absolute age differences between students who start school a year apart in age.

In the second study, I describe the disability classifications, service prescriptions, educational settings, and likelihood of special education exit for students who are placed in special education at different ages in the same grade. Within school, year, and grade of placement, I compare the special education characteristics of students who are in the youngest third, middle third, and oldest third of their cohort by age. I also estimate these differences with and without students who are older than expected for grade due to delayed school entry or grade repetition. I find that the younger students in kindergarten are more likely to be placed for milder impairments and to exit from services whereas the oldest students have more severe disability classifications and are less likely to exit into general education, particularly those who are older than expected for grade.

The findings from this dissertation add new evidence that starting school at a younger age increases the likelihood a child receives special education services and that the types of placements students receive varies considerably within grade by age. They also motivate future research evaluating the impact of earlier identification for special education services. Finally, they have policy implications for the special education referral and evaluation process, kindergarten enrollment practices, and grade retention for students with disabilities.

Chapter 1

Introduction

Special education programs provide individualized instruction and supports to nearly 7 million students in the United States and can improve the academic outcomes for children with developmental differences (Hanushek, Kain, & Rivkin, 2002; NCES, 2017). Special education programs are also a key component of civil rights and disability law in the United States, guaranteeing children with disabilities the right to free and adequate public education (Melvin, 1995; U.S Department of Education, 2007). However, there is considerable variation in special education placement rates across states, districts, and schools. By design, the federal law that ensures that students with disabilities are served by public schools, The Individuals with Disabilities in Education Act (2004), gives states and localities discretion in determining how to ensure that students with disabilities have access to "free and adequate public education." For example, the law is intentionally vague around referral procedures, what instruments should be used in the evaluation process, or how to determine the most appropriate learning environment for a child found to be eligible for services. This leaves states and localities with significant control over designing the referral and evaluation process, which a recent Government Office of Accountability report found contributes to the variation in the percent of students served in special education across states (US Department of Education, 2011).

Parents, policymakers, and researchers across disciplines have focused on understanding variation in special education policies and practices (Aron & Loprest, 2012; MacFarlane & Kanaya, 2009), the student-level factors associated with disparities in special education

placement (Dhuey & Lipscomb, 2011; Elder et al., 2019; Hibel et al., 2010; McManus et al., 2011; Skiba et al., 2006), and the factors that influence whether teachers choose to refer students for services (Grissom & Redding, 2016; Klingner & Harry, 2006). Others have focused on financial and accountability incentives that drive placement choices (Ballis & Heath, 2019; Cullen, Jacob, & Levitt, 2006; Cullen & Rivkin, 2013; Jacob, 2005), or biases in how educators perceive disability across student groups (O'Connor & Fernandez, 2002; Skiba et al., 2006). Within this broad literature, a number of researchers have focused on how a student's age at school entry impacts disability classification. For example, there is consistent evidence that being young for grade increases a child's likelihood of being diagnosed with Attention Deficit/Hyperactivity Disorder (ADHD) across international contexts (e.g., Elder, 2010; Ma et al., 2012; Schwandt & Wuppermann, 2016).

Importantly, special education programs serve students with a much wider range of developmental differences than ADHD. Further, clinical diagnoses of disabilities such as ADHD do not necessarily confer special education placement (MacFarlane & Kanaya, 2009; National Research Council, 1997). Thus, while the evidence from the ADHD literature is instructive, it may not be directly applicable to special education placement. Only two studies to date have produced credible evidence that school starting age changes the likelihood that a child receives special education services. The first uses eligibility for school entry at an older age as an instrument for later school enrollment, finding that students who start school later are less likely to be placed in special education (Dhuey & Lipscomb, 2010). However, the measures were drawn from parental reports of disability status that are likely imperfect measures of special education receipt (Shapiro & Weiland, 2019). The second used a regression discontinuity design with a highly discretized running variable to estimate the effect of school starting age on special

education in Florida. The authors also find that being relatively old for grade decreases the likelihood of being identified for special education services (Dhuey et al., 2019).

Students who enroll in school the year after they are eligible to do so are also more likely to receive special education services in elementary school than their peers who enroll on time (Elder & Lubotsky, 2006; Fortner & Jenkins, 2017; Graue & DiPerna, 2000; Huang, 2015). Further, students who are older than expected for grade due to grade repetition are more likely to be placed in special education (Beebe-Frankenberger, Bocian, MacMillian, & Gresham, 2004; Silverstein, Guppy, Young, & Augustyn, 2009). Therefore, while students who are young for grade are more likely to be placed in special education, there is also a positive correlation between age and special education identification at the other end of the age distribution. Importantly, these high rates of placement for the youngest students and the atypically old students are likely a result of opposing mechanisms. However, few studies have looked beyond overall identification rates to explore how the characteristics of the placements of these students differ along the age distribution.

Overview of the Dissertation

This dissertation builds on the recent findings from Florida that school starting age impacts the likelihood of special education to estimate the effect of being young for grade on special education identification in Michigan. This dissertation also adds to the literature by describing how the characteristics of special education placements vary by age in grade. My dissertation is composed of two journal-length manuscripts that I intend to submit to peer-reviewed publications. Each study includes an abstract, background and motivation, research questions, a methods section, findings, and discussion of implications and limitations.

The first study uses a regression discontinuity design taking advantage of the Michigan kindergarten entrance policy that determines which children are eligible to enroll in kindergarten each year. I use this birthday cutoff to estimate an intent-to-treat effect of being eligible to enroll in kindergarten at the youngest possible age on special education placement. I then estimate the local average treatment effect of enrolling in kindergarten as the youngest student using a fuzzy regression discontinuity design in which eligibility for entry is used as an instrument for enrolling at a young age. I also estimate student-level heterogeneity in the effect of being young for grade and heterogeneity in the effects across school districts using a relatively new method of estimating impact variation that has been previously used to estimate variation in multi-site randomized control trials (Bloom, Raudenbush, Weiss, & Porter, 2017; Bloom & Weiland, 2015; Unterman & Weiland, 2019). The first study addresses the following three research questions: (1) What is the effect of being young for grade on special education service receipt in each year of elementary and middle school in Michigan? (2) Are these effects heterogeneous by gender, race/ethnicity or economic disadvantage at kindergarten entry? (3) Does the impact of being eligible to be the youngest student in a grade on the likelihood of special education identification vary across intermediate school districts (ISDs) or school districts in Michigan? Finally, I explore the hypothesis that younger students are more likely to be placed in special education than their older peers because of relative age comparisons rather than developmental differences (i.e., absolute age) using two unique characteristics of the study context.

I find that the youngest students are 3.3 percentage points more likely to be placed in special education in kindergarten ($p<0.001$) and that this higher rate of placement persists through 8th grade. I find some evidence of heterogeneity in effects by student characteristics but little evidence of heterogeneity across school districts. I also find exploratory evidence that these

effects are likely to be driven relative age effects rather than absolute age differences. I find that the effect of being young for grade is concentrated in schools where the age range of the kindergarten class is particularly wide. I hypothesize that in these schools, teachers may have particular difficulty differentiating between expected developmental differences between the youngest and oldest students and signs of developmental delay.

In the second study, I describe how age in grade is associated with the type of special education placements students receive. Using ordinary least squares (OLS) with student covariates, cohort fixed effects, and school fixed effects, I estimate the difference in the characteristics of special education placements for students who are in the youngest third, middle third, and upper third of the age distribution in their school in the grade and year they are identified for special education services. The second study addresses the following research questions: (1) How do students who are placed in special education at different ages in the same grade in elementary school differ on observable characteristics? (2) How do students placed in special education in kindergarten who are younger than average, average age, or older than average differ in disability classification, setting type, service type, and likelihood of exiting or reentering services in future years? (3) What are the disability classifications, setting type, and service types for students who are younger than average, average age, or older than average in grade who are placed in special education for the first time in 1st-5th grade? For the kindergarten placement group, I also compare the characteristics of students who are placed in special education who enrolled in school in the year they were eligible to those who delayed school entry. For the first through fifth grade placements, I compare the students who are the expected age in grade to those who are older than expected for grade either because of delayed entry or grade repetition.

For the students who are identified for special education services in kindergarten, I find that the students who are young for grade are more likely to be initially placed for speech or language impairments and more likely to exit from special education after kindergarten, whereas students who are old for grade are more likely to have severe disability classifications, receive more services at placement, and to be placed in more restrictive environments. However, much of the difference in special education placements by age in grade for the students first identified in kindergarten are driven by the students who are older than expected due to delayed school entry. Nevertheless, I find that the young students have comparatively shorter special education spells for milder impairments even when compared only to their average age and older peers who enrolled in kindergarten in the year they were eligible. I find similar patterns for the students who are first identified for special education services in first through fifth grade. These findings suggest that while the young for grade students and the older than expected age students are both more likely to be identified for special education services in kindergarten, the nature and severity of their disabilities and duration of time spent in special education differ in important ways.

The findings from these two studies add new evidence to the field that school starting age impacts the likelihood of being identified for special education services. These findings also align both with the earlier study using nationally representative survey data and the newest study using administrative data from Florida. I find precisely estimated null variation in the effect of relative age within Michigan across school districts, suggesting statewide policy solutions may be able address the disparity in placement rates by school starting age. The descriptive evidence that these younger students are more likely to have speech or language impairment placements and to exit from services than their special education peers supports prior hypotheses that

students who are on the margin of being eligible for services are more likely to be identified if young for grade. In contrast, the evidence that students receiving special education services who delayed school entry have the highest rates of severe disability classification and longest duration of service participation supports the hypothesis that one of the reasons parents may select into starting their children's schooling later than eligible is concern about developmental differences. These patterns support careful consideration of the heterogeneity of experiences with special education correlated with age in grade and motivate future research into the effects of these placements on the academic outcomes of children with disabilities. Finally, the findings from the two studies introduce policy considerations for the United States more broadly and Michigan specifically related to referral and evaluation practices for young children, the spillover effects of delaying school entry, the use of separate classroom environments for children identified for special education in kindergarten, and the high rates of grade repetition for children with disabilities in Michigan.

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Chapter II

Over Diagnosed or Overlooked? The Effect of Age at Time of School Entry on Students Receiving Special Education Services

Abstract

Much of the literature estimating disproportionality in special education identification rates has focused on socioeconomic status, race, and gender. However, recent evidence suggests that a student's school starting age also has increases the likelihood they receive special education services, particularly in the early grades. I build on the evidence that the youngest students in a grade more likely to be diagnosed with Attention Deficit/Hyperactivity Disorder and more likely to be placed in special education by estimating the effect of school starting age on special education identification in Michigan. I also estimate heterogeneity in this effect by student characteristics and across school districts. Using a regression discontinuity design exploiting variation in kindergarten starting age generated by a statewide kindergarten entrance age policy, I find that the youngest students in a kindergarten cohort are 40% more likely (3.3 percentage points, $p<0.001$) to be placed in kindergarten than the oldest students, and that this effect persists through eighth grade. I also find exploratory evidence of variation by school cohort age composition, suggesting these effects are driven moreso by relative age comparisons than absolute age differences. I find no evidence of heterogeneity by gender, race, or socioeconomic status and no evidence that these effects vary across school districts. However, I find some suggest evidence of differences in the pattern of effects by gender for white and black students respectively. Given the importance of special education services to the academic

success of children with disabilities, these findings have implications for schools and for policymakers seeking to improve special education program provision.

Introduction

Special education is one of the most federally regulated areas of education policy in the United States and constitutes more than one fifth of federal spending on public elementary and secondary schools (U.S. Census Bureau, 2016). Despite the relatively strong federal role in special education policy, there is considerable local variation in special education participation underlying the 13% of students receiving services in public schools nationwide (NCES, 2017). For example, in 2015-2016 the percent of students participating in special education in New York was nearly 18%, compared with fewer than 9% of students in Texas. Even this state-level variation masks differences in special education rates by district and school. In Massachusetts, which has one of the highest rates of special education participation in the country (18%), district-level rates vary from 10-25% and school-level rates vary from 8% to 35% in the largest urban district (Massachusetts Department of Education, 2017).

Much attention has been paid to sociodemographic disparities and the school-, district- and state-level factors associated with differences in special education identification rates that may partially explain this considerable variation in special education participation across the country (Aron & Loprest, 2012; Cullen, 1999; Dhuey & Lipscomb, 2010; Hibel et al., 2010; Jacob, 2005; McManus et al., 2011; P. L. Morgan et al., 2015; Skiba et al., 2006; Sullivan & Val, 2013). A more recent line of inquiry has also found that the age at which children begin school can change the likelihood a child is placed in special education (Dhuey et al., 2019; Dhuey & Lipscomb, 2010) or diagnosed with Attention Deficit/Hyperactivity Disorder (ADHD) (Elder, 2010; Layton et al., 2018), with the youngest students in a grade cohort more likely to receive diagnoses than are the oldest students.

Although some studies have found a larger effect of school starting age for the youngest boys in the early years (Dhuey et al., 2019; Dhuey & Lipscomb, 2010), there is little evidence of heterogeneity in the effect of being young for grade by race or socioeconomic status. This is surprising given the large literature on disproportionality in special education identification by race and socioeconomic status that suggests that special education referral and evaluation practices are not applied consistently across demographic groups (Fish, 2017; O'Connor & Fernandez, 2002; Skiba et al., 2006). In contrast to student-level heterogeneity, little attention has been paid to whether there is heterogeneity in the effect of school starting age on special education receipt within a state. Differences in the demographic composition of individual school districts, teacher experience, and approaches to special education referral and evaluation could generate heterogeneity in the effects of school starting age across districts that has previously been unexplored in the literature.

Using state-level longitudinal data from Michigan for ten cohorts of entering kindergarten students, the current study adds to this growing body of literature by estimating the effect of school starting age on special education service receipt from kindergarten through middle school. More specifically, I use a regression discontinuity design that exploits exogeneous variation in school starting age generated by the state's kindergarten entrance policy to estimate the effect of being the youngest student in a kindergarten cohort on the likelihood of being placed in special education in kindergarten through 8th grade, whether this effect varies by gender, socioeconomic status, or race, and whether the effect varies by school district.

The present study makes several contributions to the literature. First, I add evidence that being young for grade impacts the likelihood of being placed in special education in Michigan, adding to earlier work identifying the same effect in Florida (Dhuey et al., 2019). Evidence from

a new state context adds to our understanding of how the effect of school starting age generalizes to other settings with different polices and student populations. Second, I estimate heterogeneity in effects by gender-race subgroups to examine within race heterogeneity by gender. The current study is also the first study to my knowledge that has estimated cross-district variation in the effect of school starting age on the likelihood of special education identification, and the first to my knowledge to apply the mixed multi-level hierarchical linear modeling approach to estimating cross-site variation in impacts developed by Bloom et al., (2017) within a regression discontinuity framework. Finally, I also provide evidence that the effect of school starting age on special education identification is driven by relative age comparisons rather than absolute age differences. These findings have implications for how we design policy solutions to address disparities in special education identification by school starting age, particularly in identifying at what level reforms may be most impactful.

Background

Much of the evidence that school starting age impacts disability diagnoses comes from the large body of literature on Attention Deficit/Hyperactivity Disorder (ADHD) diagnoses. The youngest children in a grade cohort are more likely to be diagnosed with ADHD in the United States (Elder, 2010; Evans et. al, 2010; Layton et. al, 2018), Germany (Schwandt & Wuppermann, 2016) the Netherlands (Krabbe et. al, 2014), and Canada (Ma et al., 2012). The detected effects range from a two to five percentage point increase or a 22-30% higher likelihood of ADHD diagnosis. The majority of these studies have used regression discontinuity designs, comparing students born just before and just after the kindergarten cutoff date to estimate the effect of being younger at entry on ADHD diagnosis. Further, many of these studies found that their estimated effects on likelihood of ADHD diagnosis were not detected for other conditions

such as diabetes and hay fever in Germany (Schwandt & Wuppermann, 2016) and asthma, chicken pox, diabetes, and obesity in the United States (Evans et. al, 2010; Layton et. al, 2018) which supports the interpretation that the difference in ADHD diagnosis rates for younger students is not likely to be a reflection of absolute health differences between younger and older students.

Interestingly, a study in Denmark found no effect of age in grade on the likelihood of ADHD diagnosis after the age of 7, suggesting that differences in ADHD diagnoses are dependent on how doctors and teachers approach diagnosis in a given cultural context (Dalsgaard et. al., 2012). Further, clinicians in France uses a different diagnostic manual to characterize, diagnose, and treat the behaviors associated with ADHD, resulting in fewer children diagnosed with and treated for ADHD overall and no evidence of age-related differences in ADHD diagnostic rates (Lecendreux, Konofal, & Faraone, 2011). These findings imply that overall prevalence of diagnosis may also influence whether age-in-grade impacts the likelihood of diagnosis.

However, the ADHD literature has focused on outcomes such as clinical diagnosis or stimulant prescriptions which may not directly correspond to special education identification. This is because the federal law requires not only that a child be found to meet the requirements for qualifying disability classifications but also that their disability creates a need for special education services (Individuals with Disabilities in Education Act, 2004). Further, most disability eligibility classification under IDEA do not require that a child have a clinical diagnosis, meaning that a child can be found eligible for services under the education law but not have a medical diagnosis (National Research Council, 1997). For example, only three states require that

a child have a clinical diagnosis of Autism or an Autism Spectrum Disorder in order to be classified with a primary disability of Autism under IDEA (MacFarlane & Kanaya, 2009).

Despite the consistent evidence that the youngest students in a grade in the United States are more likely to be given an ADHD diagnosis and the potential applicability to education outcomes, less attention has been paid to the effect of starting age on likelihood of being placed in special education services across disability types more generally, including for students with ADHD. In one study using data from the Early Childhood Longitudinal Study 98-99 (ECLS-K 98), the National Education Longitudinal Study (NELS) and the Education Longitudinal Study (ELS), the authors found that an additional month of age decreases the likelihood of receiving special education services by 2-5 percentage points (Dhuey & Lipscomb, 2010). However, this study relied on parent reports of disability rather than the administrative education records or health insurance records used in more recent studies. Parent reports of disability are not always consistent with receipt of special education (Marder, 2009), which may limit the applicability of these findings to special education participation.

A more recent study that combines Florida education and health records found a similar age effect, with the oldest students who were born in September 4-6 percentage points less likely to receive special education services than the youngest students, who were born in August (Dhuey et al., 2019). Using birth month and year, the authors estimated the effect of entering kindergarten at a younger age induced by a student's birth month in relation to the statewide kindergarten cutoff using fuzzy regression discontinuity design. The primary outcomes included kindergarten readiness scores, elementary and middle school test scores, disability classification, gifted education participation, likelihood of redshirting, grade retention, and likelihood of high school graduation. This study also used rich data on maternal and child health to demonstrate

that the disability results were robust to including prenatal, birth, and family characteristics often hypothesized to be correlated with birth month. Overall, these findings provide strong evidence to support earlier findings that younger students are more likely to be given a disability classification and provide new evidence that these effects are robust to controlling for a number of family and health characteristics that had previously been understudied in this area of research.

Heterogeneity in the effect of being young for grade on special education identification

There is mixed evidence of heterogeneity by student characteristics underlying this average effect of school starting age on disability classifications. Overall, boys are more likely to be diagnosed with ADHD than girls, but authors have found conflicting evidence that the effect of school starting age on ADHD diagnoses is equal for boys and girls (Evans et al., 2010), larger for girls (Ma et al., 2012) or larger for boys (Layton et al., 2018). Similarly, boys are more likely to be placed in special education than girls and there is some evidence that the effect of school starting age on special education identification is larger for boys in the early years (Dhuey & Lipscomb, 2010) particularly for emotional impairment, autism spectrum disorder, and specific learning disability placements (Dhuey et al., 2019). Few studies have estimated heterogeneity by race or socioeconomic status on ADHD diagnosis, but there is some evidence of a larger effect of school starting age on special education identification for White students (Dhuey et al., 2019; Dhuey & Lipscomb, 2010). In light of the large literature on disproportionality in special education receipt by race and socioeconomic status, more evidence is needed to understand the interaction between demographic characteristics and disability identification.

In contrast, there has been very little research into heterogeneity in the effect of school starting age on special education identification within states, despite the large role that local

school districts play in setting special education policies. For example, states and localities have significant control over designing the referral and evaluation process, which a recent Government Office of Accountability report found contributes to the variation in the percent of students served in special education across states (2019). States also vary in which professionals are required to participate in diagnosis for each disability type (e.g., MacFarlane & Kanaya, 2009), which age ranges can qualify for a developmental delay diagnosis, and how to identify specific learning disabilities. Underlying this cross-state variation in referral practices, local education agencies are similarly able to adapt their policies to the state guidance and often produce guidance for local agencies to clarify state policy (Staskowski, 2006). Therefore, we might expect that the school district in which a child is enrolled would impact their likelihood of being placed in special education due to their school starting age.

Why are younger students more likely to be diagnosed with a disability?

Both the literature on age effects for ADHD and special education identification support the conclusion that the youngest students in a grade cohort are more likely to be placed in special education, but less is known about *why* this might be the case. Nevertheless, prior work has presented a number of hypothesized mechanisms to explain disparities in special education identification attributable to the special education evaluation process. In particular, some have hypothesized that the use of peer-to-peer comparisons to inform referral practices likely exacerbates disproportionate identification rates for the youngest students. For example, younger students could be more likely to be referred to special education because age-typical developmental differences are attributed to signs of disability while older students are less likely to be referred because developmental delays are masked by an age premium when compared to

their younger peers. If this is the case, the age of students in relation to their peers, rather than their absolute age may be driving differences in special education identification rates.

Peer comparisons are likely to play a large role in special education because the referral and evaluation process relies on parents, teachers, and other education and health professionals to identify and flag signs of disability that may be impacting a child's learning.[1] A number of studies on teacher referral practices, both in special education and gifted and talent education, have found that teacher experience, sense of self-efficacy, and gender-, race-, and ethnicity-related biases impact referral choices (Grissom & Redding, 2016; Klingner & Harry, 2006; Skiba et al., 2006). Although the percent of referrals initiated by teachers is not widely reported, teacher referrals likely make up a large proportion of total special education referrals for school-age children. Thus, we might expect that many special education referrals are based on evaluation criteria derived from peer-to-peer comparisons in a specific school or classroom (i.e., comparing children's development to the development of the other children in their "frog pond" (Davis, 1966)) and teacher beliefs about a student's ability to be successful in general education (Dunn, 2006).

In fact, peer group comparisons have been found to impact how teachers assess a child's academic performance through grading practices (Farkas, Sheehan, & Grobe, 1990) and who is referred for special education evaluation (Hibel et al., 2010). More specifically, Hibel and co-authors tested the effect of peer groups on likelihood of special education identification by comparing students with the same test scores, finding that those with high-performing peer

[1] After a student is referred for services and the parent gives consent for evaluation, schools have 60 days to complete an evaluation design an Individual Education Plan for students found eligible for services. Many states then require the use of standardized developmental assessments in making eligibility determinations (Michigan Department of Education, 2016). States are also required to have Child Find programs to identify children who may be eligible for services but have not started school yet under Part C of the Individuals with Disabilities in Education Act (2004)

groups were more likely to be referred for special education services than those with a lower-performing peer group (Hibel et al., 2010). Similarly, special education disparities by race can be impacted by peer group composition, with minoritized students with the same achievement scores more likely to be placed in special education in predominately White schools but less likely in predominately non-White schools (Elder et al., 2019).

Particularly in early grades, when performance on academic measures and age are highly correlated, we might expect that the youngest children are more likely to be referred to special education because teachers have age-inappropriate expectations for skill acquisition and classroom behavior for the youngest children. Special education referrals based on peer comparisons are also more likely to be biased towards younger children in the early grades because child development is occurring rapidly and there will be noticeable but age-typical biological and cognitive differences between students who are a year apart in age because of their entrance age eligibility (Brown & Jernigan, 2012). Thus, expecting that all students reach the same developmental benchmarks together in a grade may lead teachers to be more likely to flag the youngest students as developmentally delayed even if they fall within age-appropriate expectations.

Present Study

Drawing on the nascent literature estimating the effect of school starting age on special education identification and the hypothesis that these effects are caused by relative age differences that favor the referral of the youngest students, I address three research questions:

1. What is the effect of being young for grade on special education service receipt in each year of elementary and middle school in Michigan?

2. Are these effects heterogeneous by gender, race/ethnicity, or economic disadvantage at kindergarten entry?
3. Does the impact of being eligible to be the youngest student in a grade on the likelihood of special education identification vary across intermediate school districts (ISDs) or school districts in Michigan?

I also test for evidence that these effects are driven by relative age rather than absolute age using variation in classroom age ranges and a unique change to the kindergarten entrance date in Michigan.

Michigan is an interesting context in which to study this question for several reasons. First, children in the same kindergarten classroom can range from 4.75 years old to 6.75 years old at the start of school due to kindergarten enrollment policies.[2] Thus, the "normative standard" of skill acquisition and classroom behavior that a teacher uses to make special education referrals may be inappropriate for both the youngest and the oldest children in a grade, who can be two years apart in age on the first day of school. Second, although Michigan's overall special education rate is close to the national average, students in Michigan are much more likely to be placed in special education with a speech or language impairment in the early grades (67% in Michigan compared with 44% in the US), making the state an outlier in disability classification practices (NCES, 2017). Finally, Michigan is regionally and demographically different from Florida, the other state in which this question has been explored in depth, despite having a similar overall special education rate. For example, Michigan's public school population is roughly 70% White, 20% Black and less than 10% Hispanic, whereas Florida's is 37% White,

[2] Students are eligible to start kindergarten between the ages of 4.75 and 5.75 during the study period. However, some students choose to delay entry and others repeat kindergarten, making them between 5.75 and 6.75 years old on the first day of school.

22% Black, and 34% Hispanic. Thus, the present study allows for an exploration of whether the findings in Florida are replicable in a different context.

Method

Sample

The current study uses data from the Michigan Education Data Center (MEDC) which houses the state administrative education data collected by the Center for Educational Performance and Information (CEPI) at the Michigan Department of Education (MDE). The study sample includes all first-time kindergarten entrants between school years 2002-2003 and 2012-2013 who enrolled in a Michigan public school, including both traditional and charter schools. During this period, entering kindergarten cohorts ranged from 120,000 - 110,000 students for an overall sample of 1,285,165 students over ten cohorts. I exclude 17,822 students (1.4%) without available birthday information and 592 students whose birthdays were implausible (<0.01%). I follow all first-time kindergarten enrollees for five follow-up years after kindergarten eligibility (5th grade for most students) and for 8 follow-up years (8th grade for most students) for cohorts one through seven.

I also exclude students who entered the public schools in later grades because I cannot observe whether these students started kindergarten on time nor what their special education status was prior to entering the Michigan school system. Excluding students who don't start kindergarten in a Michigan public school limits the sample to approximately 85% of all students in grades 1-8[3]. My study sample of first-time kindergarten entrants is 49% female, 68% White, 20% Black, 7% Hispanic, 3% Asian, and 1% Asian. Approximately 42% of students qualified

[3] There are a number of reasons a students may not have enrolled in kindergarten but did so in elementary school. Some students will have moved into Michigan from another state while others may enrolled in a private kindergarten program. Additionally, kindergarten is not mandatory in Michigan though in recent years an estimated 95% of students have enrolled in kindergarten before starting first grade (Chambers, 2019)

for free or reduced price lunch in their kindergarten school year (at or below 185% of the federal poverty line) and nearly 7% were considered limited English proficient in kindergarten. The study sample is nearly identical to the full population of K-12 students on these demographic measures in Michigan during this time period (result available upon request).

Identification strategy

Until the 2012-2013 school year, which is the latest cohort included in the study sample, a child who turned five years old on or before December 1st was eligible to enroll in kindergarten in the fall of that school year (1976 PA 451). A child who turned five years old on or after December 2nd was required to wait until the following fall to enroll in kindergarten. By establishing a cutoff determining which students were eligible to start kindergarten in each year, the kindergarten entrance policy effectively sorts those students who turn five on the days leading up the cutoff and the days just after the cutoff into two conditions. The first, which I refer to as the treatment condition, is being the youngest student in a given grade cohort. Those students born on December 1st were eligible to start kindergarten at approximately 4.75 years old with peers their exact age or older. The second condition, which I refer to as the control condition, is being the oldest student in a given grade cohort. Those students born on December 2nd would not be eligible to start kindergarten until the following fall when they were approximately 5.75 years old with all peers their exact age or younger.[4]

Although the Michigan kindergarten entry law stipulates at what age children are eligible to start kindergarten, not all students who were eligible to enroll did so. There are two primary avenues for parents to modify the kindergarten enrollment of their children. The first is by choosing to delay starting school. The compulsory attendance law in Michigan does not require

[4] School years in Michigan typically start on the first Tuesday after Labor Day, so age on the first day of school may vary by a few days across years.

children to be enrolled in school until the year they turn six, meaning that parents of children born just before the kindergarten cutoff can choose to delay enrollment until the following school year and still be in compliance with Michigan law. Parents who delay their child's school entrance, a practice often called "redshirting," make their children among the oldest students in their grade even if they were eligible to enroll in kindergarten as the youngest students. During the study period, approximately 5% of all students were delayed entrants consistently across cohorts with those who turned five in the 30 days before the cutoff date the most likely to redshirt (15-18% across cohorts).

In a related practice, some school districts in Michigan offered a developmental kindergarten program during this period, giving children who would be the youngest students in their grade, or who are not yet eligible for kindergarten, the opportunity to enroll in a two-year kindergarten sequence. The first year of the program, often called "Young Fives," is intended to ease children into school settings before enrolling in a traditional kindergarten class in the second year. Given the two-year structure of the program, the students who participate in Young Fives become the oldest students in their grade during the second year of the program. Using the administrative program code for developmental kindergarten, 5-7% of students were enrolled in a developmental kindergarten program in their first kindergarten year. During this period there was little way for the oldest eligible students to enroll early.[5]

Special education policy in Michigan

Special education policy in Michigan is set by the state department of education, but implemented by two smaller administrative units. In my study period there were 57 Intermediate

[5] Under the new September 1st cutoff established in the 2015-2016 school years this has changed. Early entrance waivers allow children who are not eligible to start K based on the cutoff date to enroll early if they turn five between September 2nd-December 1st and are granted an early entrance waiver at the parents' request. Developmental kindergarten programs have also become more popular during this period.

School Districts (ISDs) which are structured as separate taxing units that provide administrative and instructional services to their member local school districts and charter districts (Michigan Association of Intermediate School Administrators, 2020). The ISDs provide a number of special education services to their member districts to ensure compliance with federal disability law, provide professional development for special educators, and promote efficient allocation of expensive but low-incidence programs. Many ISDs also operate buildings that directly serve students with disabilities. Specific approaches to special education can vary by ISD depending on available resources and preferred approaches to providing special education services. For example, some districts operate separate classroom programs for students with disabilities in the early grades while other districts offer few disability specific programs (Personal Communication, Lisa Wasacz, March 24, 2019). For this reason, there may be policy-generated variation in the effect of school starting age on special education identification across ISDs.

Underneath the Intermediate School Districts, during my study period there were between 553-548 local school districts ranging in size from large urban districts (N = 35) to small rural districts (N = 285) with the largest district serving 67,064 students in 2012 and the smallest serving fewer than 100 students in 2012. The ISDs also include public school academies or charter school agencies that can run multiple school buildings. During this period the number of charter school districts increased from 180 in 2002 to 260 through 2012. Although the ISDs are often responsible for setting special education guidelines for their member school districts, differences in student populations, teacher experience, and availability of resources may also contribute to variation in the effect of school starting age within ISDs.

Outcomes

The primary outcome of interest is special education identification as measured by having an Individualized Education Plan (IEP). I measured special education participation as a binary indicator for whether a child had an IEP in their first kindergarten eligible year and each subsequent follow-up year set to 1 if the child has an IEP and 0 otherwise. I also constructed a binary indicator for ever being placed in special education set to 1 if the child ever had an IEP in any year he or she was enrolled in a Michigan public school.

In addition to measuring special education receipt, I constructed measures of special education exit and special education reentry. Special education exit is a binary indicator set to 1 if a student had an IEP in a given year and no longer had an IEP in subsequent years, conditional on still being enrolled in a Michigan public school. Similarly, special education reentry is a binary indicator set to 1 if a student had an IEP in a given year, did not have in IEP in a subsequent year, and then again had an IEP in a subsequent year. The reentry measure is also conditional on still being enrolled in MI public school during those years. I also constructed measures of the percent of years enrolled in Michigan schools with an IEP and total number of years of service receipt as a measure of the duration of time spent in special education during Michigan public school enrollment.

Finally, I constructed a binary indicator for the primary disability associated with each student's IEP in a given year. All students with IEPs have a specified primary disability which groups students into broad categories based on service need and disability diagnosis under the guidance of the Individuals with Disabilities in Education Act (2004). I further grouped some disability categories that are low-incidence to generate the following disability categories: Intellectual impairment, speech and language impairments, specific learning disability,

developmental delay, autism spectrum disorder, emotional impairment, and physical/severe impairment.[6] For all measures described above, the indicator is set to missing if the student is not enrolled in a Michigan public school for that school year.

Predictors

Running variable. The kindergarten cutoff law creates a policy-generated discontinuity in the likelihood that a child will enroll in kindergarten as the youngest in their cohort. The variable that sorts children into either treatment or control at this cutoff (i.e., the running variable) is a child's birthday. Using student birthday, I construct the running variable as a measure of days between the child's fifth birthday and the December 1st cutoff. I center the variable to have a value of 0 on December 1st so that children born in the 182.5 days before the cutoff have negative values of the running variable and children born in the 182.5 days after the cutoff have positive values.

Eligibility indicator. The eligibility indicator is a binary indicator of whether a student was eligible for kindergarten entrance at a younger age. Students born between June 1st and the December 1st cutoff are eligible to start kindergarten in the younger half of the age range (between 4.75 and 5.25 years old) and have an eligibility indicator set to 1. Students born after December 1st and before June 1st are eligible to start kindergarten in the older half of the age range (between 5.25 and 5.75 years olds) and have an eligibility indicator set to 0.

Enrollment indicator. As described above, not all students who are eligible for kindergarten each year enroll. Thus, whether a student enrolled in kindergarten at the youngest

[6] Physical/severe impairment includes orthopedic, hearing/visual impairments, deaf-blindness, traumatic brain injuries, and severe multiple impairments in the primary specifications. I also constructed a measure of physical impairment without traumatic brain injuries and severe multiple impairments, both of which can be related to cognitive impairments as well, to test the robustness of my disability specific estimates to my choice to combine physical and severe classifications.

eligible age is partially endogenous due to selection into enrolling on time. Therefore, I construct a binary indicator for young enrollment set to 1 if a student enrolls in kindergarten between 4.75 and 5.25 years old).

Covariates. I also include measures of time-invariant or pre-treatment student characteristics in all primary specifications. These include binary indicators of gender and race and ethnicity as reported in the state-level administrative data (Asian, Black, Hispanic, White, and Other), socioeconomic status as measured by eligibility for free or reduced price lunch, receipt of special education services through public preschool or Early On (Michigan's early intervention program), and immigrant status. In addition to using these characteristics as controls in the main impact models, I use these covariates to estimate subgroup effects by gender, race/ethnicity, and socioeconomic status.

Data Analytic Strategy

To estimate a causal relationship between a child's age at time of school entry and the likelihood they are placed in special education, I used a natural experimental design called a regression discontinuity. In this study context, the running variable is a child's age (as measured by their birthday) which orders children by age, and the cutoff is the December 1st kindergarten entry policy which determines if a child's age will be the youngest or the oldest in a given kindergarten cohort. Thus, the kindergarten cutoff policy creates an exogenous source of variation in the likelihood that a child is the youngest student in her grade cohort which allows for a causal interpretation of the effect of being the youngest student on the likelihood of special education receipt. The December 1st kindergarten cutoff in Michigan has been used in regression discontinuity approach to evaluate intent-to-treat effects of eligibility age at kindergarten entry on high school graduation, academic performance in high school, and postsecondary enrollment

and persistence in a previous study (Hemelt & Rosen, 2016). In the present study, I estimate both the effect of being *eligible* to be the youngest student in a grade (i.e., the intent-to-treat effect) and the effect of *enrolling* in kindergarten as the youngest student in grade (i.e., the local average treatment effect).

I use a sharp regression discontinuity to estimate an intent-to-treat effect of being eligible to start kindergarten as the youngest student in a grade cohort on the probability of being placed in special education in kindergarten and each follow-up year. Equation 1 is the estimation equation for the intent-to-treat effect of being the youngest in grade, where *Y* is the outcome of interest for child *i* in cohort *c*, *Elig* is a binary indicator for whether child *i* is eligible to enter K at a young age in cohort *c*, *Cutdist* is the distance in days between child *i'*s fifth birthday and the December 1st cutoff in cohort *c*, X' is a vector of time-invariant or pre-treatment student characteristics for student *i* in cohort *c,* γ is a vector of cohort fixed effects and ε_{ic} is the student-level error term. The student characteristics are student gender, race and ethnicity, free and reduced price lunch status, immigrant status, and prior receipt of special education services in prekindergarten or before. I also cluster the standard errors at the kindergarten enrolling district to account for potential correlation of the error term among students enrolled in the same school district.

$$Y_{ic} = \beta_{ic} + \alpha(Elig)_{ic} + \sigma(cutdist)_{ic} + X'_{ic} + \gamma_c + \varepsilon_{ic} \quad (1),$$

Figure 1 plots the relationship between the running variable and the likelihood of entering kindergarten at a young age. If the cutoff date were completely deterministic, we would expect to see all students on the right side of the cutoff with a 100% probability of enrolling at a young age and all students on the left side of the cutoff with a 0% probability of enrolling at a young age. However, although I find a large discontinuity in the likelihood of entering kindergarten at a

young age at the cutoff, Figure 1 demonstrates that the probability of young enrollment decreases from 100% as student birthdays approach the December 1st date. For this reason, I also use a fuzzy regression discontinuity design to account for imperfect compliance with the eligibility criteria where eligibility for kindergarten entry at a young age is used as instrument for enrolling.

More specifically, I use a two-stage least squares approach in which I first estimate the probability that a child enrolls in kindergarten at a young age based on their eligibility to do so. The first stage equation (2) has the same terms as the intent-to-treat equation (1) with the exception of the outcome, which is the probability of enrolling in kindergarten at a relatively young age.

$$Enroll_{ic} = \beta_{ic} + \alpha(elig)_{ic} + \delta(cutdist)_{ic} + X'_{ic} + \gamma_c + \varepsilon_{ic} \qquad (2),$$

I then use this predicted probability of young enrollment to estimate the effect of being young for grade on the outcomes of interest (Y_{ic}) the second stage, where α is the parameter of interest.

$$Y_{ic} = \beta_{ic} + \alpha(\widehat{enroll})_{ic} + \sigma(cutdist)_{ic} + X'_{ic} + \gamma_c + \varepsilon_{ic} \qquad (3),$$

For both the ITT and LATE estimating equations, I use a non-parametric local polynomial model that uses only those observations just around the cutoff to estimate the relationship between the running variable and the outcome of interest on either side of the cutoff. Following the literature, I use a data-driven selection mechanism to select a bandwidth of observations that optimizes the bias-variance tradeoff associated with using only those observations closest to the cutoff versus including observations farther from the cutoff (Skovron & Tituinik, 2015). Based on graphical evidence of the relationship between the outcome variable and the running variable, I use a linear functional form to select the bandwidth and to estimate the effect of being young for grade. Finally, I use a triangular kernel that assigns the greatest weight to observations closest to the bandwidth with the weight decreasing linearly as

observations get farther from the bandwidth. For all procedures described above, I use the *rdrobust* package in Stata.

Student-level heterogeneity

To answer the second research question — Are these effects heterogeneous by gender, race/ethnicity or economic disadvantage at kindergarten entry? — I use the same regression discontinuity approach, fitting the primary specification for both the ITT estimates (equation 1) and the LATE estimates (equations 2 & 3) separately by gender, race and ethnicity, and socio-economic status (free or reduced price lunch eligible), using the subgroup relevant bandwidth and functional form. I then plot the estimated effect and corresponding robust confidence intervals for each subgroup to compare the magnitude and precision of the estimates. I also conduct sub-subgroup analyses to explore the possibility that gender differences vary across racial groups. To date, there is no widely accepted approach to testing the statistical significance of the difference in subgroup estimates using the local polynomial modeling approach (Carril, Cazor, Gerardino, & Litschig, 2018). For this reason, I compare the magnitude of the estimates to make inferences about the potential for heterogeneity in effects but do not interpret the findings as confirmatory evidence.

Estimating the distribution of intent-to-treat effects across sites

To answer the third research question — Does the effect of school starting age vary across intermediate school districts (ISDs) or school districts in Michigan? —I quantify the distribution of these intent-to-treat effects across the two administrative units using the framework described by Bloom et. al (2017) and applied by Weiss et. al. (2017) and Unterman and Weiland (2019). To date, this approach has only been applied to estimate variation in intent-to-treat estimates, so I limit these analyses to the intent-to-treat analysis as well. Because the

statewide cutoff is applied universally across governance units, a student who is eligible to be the youngest student in the statewide cohort is also eligible to be the youngest student in her ISD, in her school district, in her school, and in her classroom. Therefore, I consider the ISDs and school districts to be study sites nested within the broader state population. This conceptualization mirrors prior literature using this approach to estimate variation in treatment effects in multi-site randomized control trials (Bloom et al., 2017).

I first estimate an intent-to-treat effect for each site, β_j, (i.e., each ISD and each school district) and then estimate a grand mean effect (β) and the cross-site standard deviation of the distribution of these site-specific effects (τ). Following the approach of Weiss et. al., (2017) and Unterman and Weiland (2019), I use a two-level hierarchical linear model to estimate parameters β and τ where level 1 is at the student-level and level 2 is at the relevant site level. In equation 1, Y_{ij} is the outcome for child *i* from district *j*, $district_{ij}$ is equal to one if child *i* enrolled in district or ISD *j*, T_{ij} equals one if child *i* was assigned to treatment and zero otherwise in district *j*, X_{lij} is a vector of baseline covariates and cohort fixed effects (Equation 4). Because the identification strategy in this context is a regression discontinuity, I also include the running variable $cutdist_{ij}$ in the level 1 equation and restrict the analytic sample to the same bandwidth of students as in the primary RD specifications for a given outcome.

Level 1 (Individuals):

$$Y_{ij} = \sum_{r=1}^{R} \alpha_j \, District_{ij} + \, B_j T_{ij} + \theta cutdist_{ij} + \sum_{l=1}^{L} \gamma_l X_{lij} \, + e_{ij}$$

Level 2 (Sites)

$$B_j = \beta + b_J \tag{4}$$

The two-level model described above has site-specific fixed intercepts and site-specific treatment coefficients that can vary randomly across sites. The site-specific fixed intercepts account for the possibility of differing proportions of students in the treatment and control groups in each site. The site-specific treatment coefficients, B_j, are modeled as representing a cross-site population distribution with a mean value of β (i.e., the grand mean ITT effect) (equation 5) and a standard deviation of τ (equation 6). Using this approach, the residual error term b_J has a mean value of 0 and a standard deviation of τ and the individual level error term e_{ij} is assumed to have a mean of zero and a variance of $\sigma^2_{|\text{site}}$ that is allowed to differ between the treatment and control groups. To test for statistical significance of τ I use a chi-square test on a Q statistic, which is widely used in meta-analysis of heterogeneity in treatment effects (Hedges & Olkin, 1985). For further information about this approach see Bloom et. al (2017).

$$\beta = \frac{\sum_{j=1}^{J} B_j}{J} \tag{5}$$

$$\tau = \sqrt{\frac{\sum_{j=1}^{J} (B_j - \beta)^2}{J}} \tag{6}$$

Results

Effect of school starting age on special education identification (RQ 1)

In the full 5th grade follow-up sample, students who are eligible to enroll in kindergarten at the youngest age are 2.8 percentage points (p<0.001) more likely to be receiving special education services in kindergarten (Table 1). This treatment effect is a 40% increase in the likelihood of special education receipt. Further, this effect persists in both magnitude and direction through the fifth follow-up year when most students would be in fifth grade. This suggests that the initial higher identification rates of students eligible to enroll at the youngest

age in kindergarten are not balanced by higher identification rates of the oldest students in subsequent grades. The effect of enrolling in kindergarten as the youngest student in the class is 3.3 percentage points ($p<0.001$). Again, this effect persists through the fifth follow-up year in direction, decreasing slightly to 2.7 percentage points (Table 2). The magnitude, direction, and pattern of effects is similar in the 8th grade sample (Appendix, Figure A.3, Table A.2).

In addition to estimating the effect of being young for grade on special education service receipt in each follow-up year, I also estimate the overall effect on ever receiving services from kindergarten through elementary (for the fifth grade sample) and middle school (for the eighth grade sample) to align with the prior literature (Dhuey et al., 2019). I find that students who are eligible to be the youngest in grade are 3.7 ($p<0.001$) percentage points more likely to ever receive special education services. Students who enroll as the youngest in grade are 4.3 percentage points ($p<0.001$) more likely to receive services. They are also 2.2 percentage points more likely to exit special education after starting to receive services although there is no statistically significant difference in the percent of time spent in special education between the treatment and control groups (Table 3). Finally, following the prior literature, I estimated the effect of being young for grade on special education placement for specific primary disability categories. I find that the majority of the effect in kindergarten is concentrated in the more subjective classification of speech/language impairment. This is not surprising given that over 75% of all kindergarten students with IEPs have a primary disability diagnosis of speech or language impairment.

Variation by student characteristics (RQ 2)

Overall, the percent of students with IEPs in kindergarten varies by gender, with 14% of boys in special education compared with 7% of girls. White students are also slightly more likely

to have IEPs (11%) than Black and Hispanic students (9%) as are students who qualify for free/reduced price lunch (12% versus 9%). For this reason, I present the subgroup estimates in effect sizes rather than percentage points by dividing the percentage point differences between the treatment and control group by the standard deviation of the control group mean. As previously described, I do not test whether the estimated effects are statistically significantly different from each other but rather plot the estimated effects and their confidence intervals to compare magnitudes and direction.

Figure 3 shows the LATE effect of being young for grade for boys and girls in the first kindergarten eligible year and five following years. Although the estimated effect in percentage point differences is twice as large for boys as girls in kindergarten (4.4 percentage points for boys ($p<0.001$) compared with 2.2 percentage points for girls ($p<0.001$), the effect sizes are similar (0.14*sd* versus 0.10*sd*). In years one through five, the effect of school starting age is similar in magnitude for boys and girls, with the exception of follow-up year 3 when the effect for girls is half that for boys. The results do not suggest meaningful heterogeneity in the effect of being young for grade on special education identification by gender.

Figures 4 and 5 plot the estimated relative effects in effect sizes by race/ethnicity and socioeconomic status respectively. There is no evidence that the effect of school starting age is heterogeneous by race/ethnicity though the magnitude of the effects appears to be largest for White students in the early grades. In contrast, the effects appear to increase in magnitude for Black and Hispanic students in the later years although the confidence intervals for all three race group estimates overlap. The effect is also similar in magnitude for students who do and do not qualify for free and reduced price lunch although it may be somewhat larger in magnitude in the early years for students who do not qualify for free or reduced price lunch. For all subgroups,

being young for grade increases the likelihood of being in special education (see Appendix, Table A.5 for point estimates).

Although there is no clear evidence of heterogeneity by race/ethnicity for the full sample, I also estimated heterogeneity in the interaction between gender and race. Figure 6 shows the percent of young students in special education in kindergarten through 5th grade in comparison to their older peers for White and Black girls and for White and Black boys at each time period. The estimated effect of school starting age for White boys is more than double that for White girls in kindergarten and remains larger in the fifth follow up year. In contrast, the estimated effect for Black boys and Black girls is similar in magnitude in kindergarten but increases to triple the magnitude for girls as for boys in the fifth follow up year. In fifth grade, young White boys are 4 percentage points more likely to be in special education than older White boys whereas young Black girls are 6 percentages points more likely than young Black girls.

Variation across school districts (RQ 3)

Figures 7 and 8 illustrate the distribution of the intent-to-treat effects on kindergarten special education identification and ever being placed in special education through follow up year five across Intermediate School Districts (ISDs). In both cases, the estimated grand mean difference is positive and similar in magnitude to the estimate using the primary regression discontinuity specification. Although I detected a statistically significant grand mean effect on the likelihood of kindergarten special education identification, the $\hat{\tau}$ is smaller than 0.001 percentage points and statistically significant at the $p<0.05$ and $p<0.001$ levels respectively. Simply put, the standard deviation of the distribution of site-specific treatment effects is statistically significant and very small, providing no evidence of heterogeneity in effects across ISDs. I find similar results at the district level (Appendix Figures A.4 and A.5).

Robustness Checks

I also conducted a series of internal validity and robustness checks following the guidance of the What Works Clearinghouse (2017) and prior literature to test the credibility of a causal interpretation of my findings. First, I assessed the likelihood that parents could influence either the cutoff itself or their position along the running variable in response to the cutoff using contextual information, statistical tests, and graphical evidence. Contextually, there is little reason to think that parents could have influenced the cutoff itself, which was a statewide policy dating back to 1979 (1979 PA 451). It is also implausible that parents could or would plan their child's birthday to fall right at the cutoff. Although there is evidence of selection of birth in particular seasons that correlates with demographic characteristics (Bound & Jaeger, 1996) it is unlikely that parents could *precisely* plan their child's birthdate to fall within a few days of the cutoff. In fact, only an estimated 5% of babies delivered through natural child birth are born on their due dates and human gestational lengths can range up to 5 weeks making it difficult to choose an exact date of birth at conception (Jukic et al., 2013). There is also little incentive to manipulate a child's birthday right around the cutoff in this context; parents who do not want their child to enroll in school at the youngest possible age can simply choose to delay kindergarten entry until the following year.

Although contextual evidence suggests a minimal threat of manipulation to the running variable, I used graphical and statistical tests to assess whether there is smooth variation of the running variable through the cutoff. I used both the McCrary density test, which uses a local linear estimator (McCrary, 2008), and the *rddensity* test, which uses a local cubic estimator with quadratic bias correction (Cattaneo, Jansson, & Ma, 2018) to test for evidence of discontinuous density of observations on either side of the threshold. I find no evidence of a statistically

significant difference in the density of observations through the cutoff. Graphically, I used a local quadratic estimator to plot the density of the running variable at each value on either side of the cutoff. Again, I find no visual evidence of manipulation of the cutoff (Appendix, Figure A.1). I also find no evidence of discontinuities in pretreatment characteristics around the cutoff (Appendix, Table A.1). Neither the average impacts nor subgroup impacts are sensitive to how the bandwidth is selected (Appendix, Table A.4) nor to functional form (results available upon request). Similarly, the estimated cross-site distribution is robust to using four data-driven bandwidths for both the ISD and district-level analyses (Appendix Table A.5).

I tested for evidence of biasing overall and differential attrition following the guidelines for assessing attrition in regression discontinuity designs from the What Works Clearinghouse (2017). Using the same linear functional form and bandwidth selector as the primary specification, I predicted the probability of having missing values on the special education outcomes at the cutoff on each side, and then estimated the difference between these two intercepts. The overall and differential attrition rates for the special education outcomes in follow-up years 1-5 for the full 5th grade sample fall within the range of tolerable threat of bias under both cautious and optimistic assumptions. I also compared the pre-treatment covariate characteristics of those with missing data at each time period in the treatment and control groups. I find that students with missing data in the second follow-up year are more likely to be Black by 10.5 percentage points (0.25*sd*) and students with missing data in the third follow-up year are less likely to be White by 12 percentage points (0.25*sd*) but otherwise the estimated differences are small in magnitude (Appendix Table A.6).

Finally, I conducted two falsification tests. First, I generated 24 pseudo-cutoffs at two randomly selected dates in each month and tested for a discontinuity in the outcome variables at

each of those dates. I find no evidence of a discontinuity at any point other than the true cutoff (Appendix, Figure A.2). I also conducted a falsification test similar to those used in the ADHD diagnosis literature (Layton et al., 2018) using special education classifications unlikely to effected by school starting age. I estimated the effect of being young for grade on the likelihood of having an IEP or a physical or severe impairment (i.e., orthopedic, hearing/visual impairments, deaf-blindness, traumatic brain injuries, and severe multiple impairments) or for a physical impairment alone (i.e., orthopedic, hearing/visual impairments, deaf-blindness). I find no evidence of an effect of school starting age in kindergarten through 8th grade on likelihood of physical/severe disability classifications or physical disability classifications alone. In comparison, I find an effect similar in magnitude and direction to the average effect for receiving services for speech or language impairment, a classification that is more subjective (Appendix, Figure A.6)**.**

Mechanisms

My findings that the students who are the youngest in their grade are more likely to be identified for special education services are consistent with prior literature (Dhuey et al., 2019; Dhuey & Lipscomb, 2010; Elder, 2010; Layton et al., 2018). As many have noted, however, the youngest students are not just younger than their peers in terms of relative age. They are also younger in *absolute age,* which could have an effect on the incidence of developmental delays that require special education. Conversely, the oldest students in a grade are a least a year older than their youngest peers, which has been found to explain much of the positive effect of being old for grade on test scores (Black, Devereux, & Salvanes, 2011; Deming & Dynarski, 2008). As in the prior literature, I cannot disentangle whether the present study findings should be interpreted as a relative age effect, an absolute age effect, or a combination of the two. However,

using variation in cohort age composition across schools, I conducted an exploratory analysis to estimate heterogeneity in the effect of school starting age for students in schools with particularly narrow or particularly wide kindergarten cohort age distributions. In other words, I estimated the effect of school starting age for students who begin school at the same absolute age in both the treatment and control groups, but who are of different relative ages because of their peers' school starting age. Though descriptive, this approach considers how relative age may be associated with the effect of school starting age on special education independently of absolute age.

In Michigan, the age ranges of kindergarten cohorts vary considerably across schools due to differential patterns of redshirting and inconsistent developmental kindergarten program offerings across the state. In schools with wide age ranges, the youngest students born on December 1st may have many peers who are a year or even two years older than them. In schools with narrow age ranges, the youngest students may have fewer peers who are substantially older than them. Although an individual's choice to redshirt or enroll in developmental kindergarten may be endogenous to their likelihood of special education placement, I argue that peer age composition is plausibly exogenous for on time enrollees because parents who enroll their children on time cannot choose whether their child's peers delayed entry, shifting their child's relative age position as a result. However, because the characteristics of the schools that students enroll in for kindergarten are neither time-invariant nor measured prior to kindergarten eligibility, I consider these analyses exploratory.

Based on the distribution of the standard deviation of the mean age (σ^2) in each school*grade*cohort across my sample period, I constructed two groups[7]. Students in the high

[7] In my study period, the mean starting age of kindergarten cohorts within a school ranged from 5.17 years to 5.62 years old. The standard deviation of starting ages ranged from 0.29 years to 0.55 years. Thus, in the most extreme cases there were schools with the majority of kindergarteners starting between 4.9 – 5.5 years old and schools with the majority of students starting between 5 – 6.2 years old.

variance group were those who enrolled in a school where the kindergarten grade was in the upper quartile of the distribution of ages across the state (σ^2>=0.42), which is approximately 25% of students in the control group and 33% of students in the treatment group. Students in the low variance group were those who enrolled in a school where the kindergarten grade was in the bottom quartile of the distribution of ages across the state (σ^2<=0.33), which is around 22% of the control group and 25% of the treatment group.

Visually, there is a clear discontinuity in the likelihood of being placed in special education in kindergarten around the cutoff for students who were eligible to enroll in kindergarten at a relatively young age in high variance schools. In contrast, there is no clear discontinuity in the likelihood of special education identification around the cutoff for students in low variance schools (Appendix Figure A.7). Using the primary specification from the main analysis, I find that students who enrolled in kindergarten at a young age in a high variance school are 10.7 percentage points more likely to be identified for special education services in kindergarten than their older peers (p<0.001 ES=0.32). In contrast, I find no differences in the likelihood of identification in low variance schools. Similarly, the youngest students in high variance schools for kindergarten are 9.12 percentage points (p<0.001, ES= 0.21) more likely to ever be placed in special education in K-8. I find no statistically significant differences in the likelihood of ever being placed for students who enrolled in kindergarten in low variance schools (Table 4). I also conducted these analyses using four age grouping, where the high and low variance schools were each split into high and low mean subsets and find the same pattern (results available upon request).

Although exploratory, these findings indicate that higher rates of identification for the youngest students may be related to teachers or other referrers having difficulty distinguishing

difference across ages. Particularly in the early grades when development progresses quickly (Hill, Bloom, Black, & Lipsey, 2008), teachers may find it particularly difficult to differentiate between typical differences in development for children who are over a year apart in age. In classrooms with relatively narrow age ranges, teachers may be less likely to see large developmental differences among peers and therefore less likely to recommend the youngest children to special education programs. These exploratory results are also informative for interpreting the null results from the cross-district analysis. Although I find no discernable differences in the effects of school starting age across school districts or ISDs, these findings suggest heterogeneity in effects by school peer composition within school districts.

Discussion

Students who are eligible to attend kindergarten at the youngest possible age are nearly 40% more likely to be placed in special education in kindergarten as those who are eligible at the oldest possible age (3.3 percentage points, or 0.12 *SD*). These students are also more likely to be in special education programs through 8th grade, meaning that the initial age effect is not balanced by compensating higher identification rates for older students in later grades. My findings align with those found in the prior literature, and are similar in magnitude to the most recent evidence from Florida (Dhuey et, al., 2019). They also fill a gap in the literature by estimating the effect of school starting age at each year from kindergarten entry through the end of middle school rather than just in the early grades (Dhuey & Lipscomb, 2010) or ever during schooling (Dhuey et. al., 2019).

I find little evidence that the effect of school starting age is heterogeneous by gender, race, or socioeconomic status. However, I find exploratory evidence that the age effect is particularly large for White boys in the early grades and for Black girls in the later grades. These

within race gender effects have not been explored in the prior literature and raise new question for future research. Overall, the effect of school starting age on the likelihood of receiving special education services is positive for all subgroups explored in the present study. Finally, I find no evidence of cross-district variation in the intent-to-treat effect of being young for grade on special education identification in kindergarten or ever from kindergarten to eighth grade. The present study is the first of my knowledge to estimate heterogeneity in the age effect across school districts, with the implication that district-level policies do not moderate the average effect of school starting age. I also find support for interpreting these effects as primarily driven by relative age rather than absolute age differences between the oldest and youngest students, supporting the theory that comparisons of development across age biases special education identification towards the youngest students (Dhuey et al., 2019; Elder, 2010; Hibel et al., 2010; Layton et al., 2018).

These findings have several implications for special education policy, particularly around referral and evaluation practices. First, policies like universal age-normed developmental screeners given to all students at kindergarten entry could reduce disparities in the likelihood of special education identification in kindergarten by age. Rather than relying solely on teachers to flag students who seem behind, universal screeners would provide an initial benchmark for teachers and parents to assess children's developmental progress (McIntyre et al., 2017). In this vein, many states have recently begun mandating the use of kindergarten readiness assessments to identify students who may be at risk of falling behind in literacy, math, and socioemotional development (Diffey, 2018). However, the purpose of these readiness assessments is not screening for special education eligibility and the kindergarten readiness assessments that states are currently rolling out are not age-normed. Adding age-normed cognitive, physical and

socioemotional measures to these kindergarten entry assessments would allow states to fit universal developmental screeners into established assessment programs.

Further, some states plan to use these kindergarten readiness assessments to better target the Response to Intervention (RtI) services in early grades that are often used as a precursor to special education identification (Johnson, 2019; Ohio Department of Education, 2020). Separating "readiness" for school from the developmental differences supported through special education is critical to ensuring that all students who can benefit from special education receive those supports. For example, there also been a move towards funding universal screeners for specific learning disabilities. For example, two states recently passed laws requiring universal screenings for dyslexia (Indiana S.217, 2018; South Carolina H.3414, 2017) to reduce the number of students who are undiagnosed or diagnosed long after first experiencing reading difficulties. Like the kindergarten readiness assessments, these policies have not be systematically evaluated. Further, although these disability specific screeners may reduce gaps in the likelihood of particular diagnoses, the use of universal screeners intended to identify specific learning disabilities like dyslexia are not likely to close the age-related identification gap alone given the diversity of developmental differences supported through special education.

Teacher professional development targeted at general education teachers could also help teachers better distinguish between typical developmental differences between children in early grades and signs of disability. For example, there is evidence that general educators may be more likely to perceive the same achievement and behaviors more negatively than do special educators, so that general educators refer students at higher rates than teachers with specialized training in teaching children with exceptionalities (Podell & Tournaki, 2007). Improved training for teachers in the early elementary grades could reduce the likelihood of disparities in referral

rates by age, particularly for general education teachers who may be the first to identify emergent needs and to recommend special education referral. The lack of heterogeneity in effects across school districts also suggests that implementation of universal developmental screeners and changes to teacher professional development around special education referral practices would be impactful for all school districts.

Finally, the finding that the students in kindergarten cohorts with wide age ranges are more likely to be placed in special education than their young peers in cohorts with narrow age ranges reveals an unintended spillover effect of parents delaying their child's school entry. Recently, policymakers in Michigan have considered changes to the compulsory attendance law so that kindergarten enrollment is mandatory at age five, which would reduce the ability of parents to choose to redshirt their children (Chambers, 2019). Further, a number of the developmental kindergarten programs allow children who are eligible to enroll in kindergarten to elect to delay entry in order to participate in a developmental kindergarten year. To reduce the age variability in traditional kindergarten classrooms, policy makers could consider restricting the program to children who are still preschool age.

These findings also have implications for future research. First, the effect of being young for grade on special education identification has often been interpreted as representing an overplacement in special education or a misdiagnosis of ADHD of the youngest students (Dhuey & Lipscomb, 2010; Elder, 2010; Ma et al., 2012). However, these differences in identification rates could actually indicate an *underplacement* of the oldest students (Dhuey et al., 2019) or an appropriate allocation of special education services to narrow the developmental gaps between students who are a year apart in age (Bedard & Dhuey, 2006; Elder & Lubotsky, 2006; McEwan & Shapiro, 2008). Evidence of whether the higher likelihood of identification for the youngest

students represents a misallocation of resources, and if so in which direction, is critical for designing policy solutions to address the age-related imbalance in special education identification rates.

More importantly, the impact of this age related disproportionality on the academic and socio-emotional outcomes of children is understudied. Receiving special education services in early grades can be beneficial for students, particularly those with speech-sound or language delays that predict weaker literacy skills in later elementary school (Bird, Bishop, & Freeman, 1995; Bishop & Adams, 1990; Nathan, Stackhouse, Goulandris, & Snowling, 2004; Peterson, Pennington, Shriberg, & Boada, 2009; Sices, Taylor, Freebairn, Hansen, & Lewis, 2007; Skebo et al., 2013). Therefore, the younger students who are induced into special education for speech or language delays because of their age may benefit from these higher identification rates. Similarly, if older students go undiagnosed because their absolute age premium obscures developmental delays, the lower identification rates for the oldest students may have negative effects on their future academic outcomes (Guaralnick, 1998; Odom et al., 2004). On the other hand, special education identification may have negative impacts on students related to stigma, lowered expectations, and placements in restrictive environments apart from typically developing peers (Dowling, 1985; Kauffman & Badar, 2013; Lalvani, 2015; McLeskey, Landers, Williamson, & Hoppey, 2012; Shifrer, 2013).

The present study is limited in a number of ways. First, the regression discontinuity design estimates the effect of school starting age right at the cutoff, which means that the estimated difference is between the students at the two extremes of the age eligibility range. Thus, these findings may not be generalizable to students who are relatively old or young (i.e., in the bottom or top quartile of age) for their grade but not the youngest or the oldest. Second,

although the overall attrition rates in the sample are low, there is some evidence that students who exit from Michigan public schools after kindergarten are more likely to be Black and low-income which suggests differential attrition that could bias the results. For example, if the youngest students are more likely to be placed in special education which increases their likelihood of exiting the public schools, this would bias the follow-up year results toward zero. Finally, the present study does not include measures of special education referral separate from identification which I hope to include in the future. Whether a greater share of the referrals for the youngest students result in eligibility determinations than those for the oldest students or vice versa will provide valuable insight into which aspects of special education identification favor the youngest students.

Special education programs provide individualized instruction and supports to students with eligible disabilities and can be a powerful tool to improve academic outcomes for children with developmental differences. However, a fundamental challenge is correctly identifying those students who will be best served by being placed in special education programs. Longstanding descriptive evidence of disparities in identification rates by sociodemographic characteristics has raised important questions about the equity in special education placement. I find causal evidence that children who are young for their grade are more likely to be placed in special education and that these effects last through eighth grade. Future work evaluating reforms to the special education referral and evaluation process, and the impact of higher and lower identification rates on students' long-term academic outcomes is needed.

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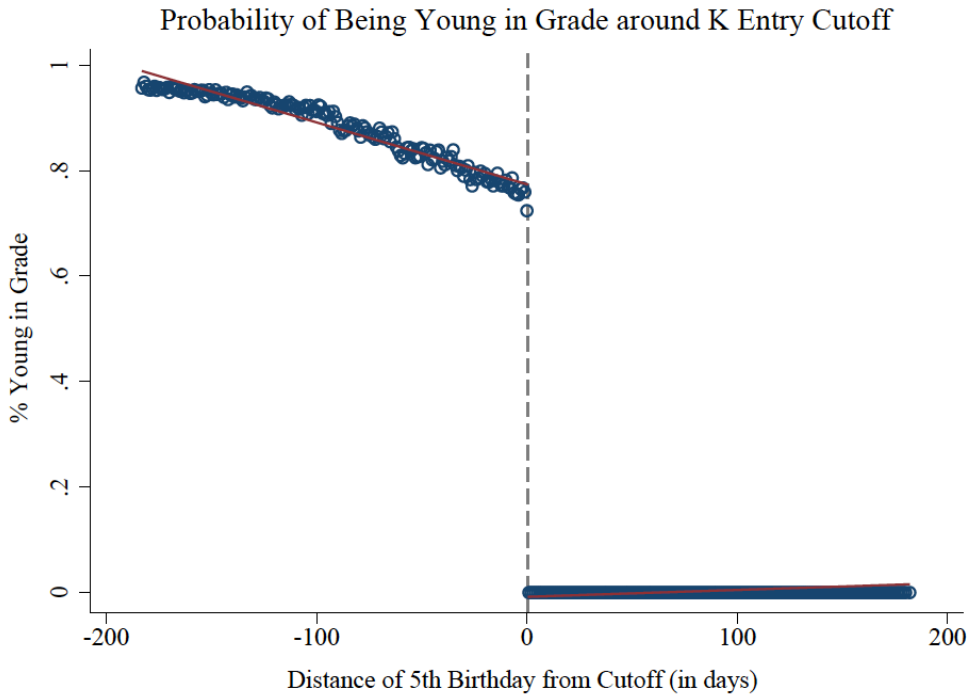
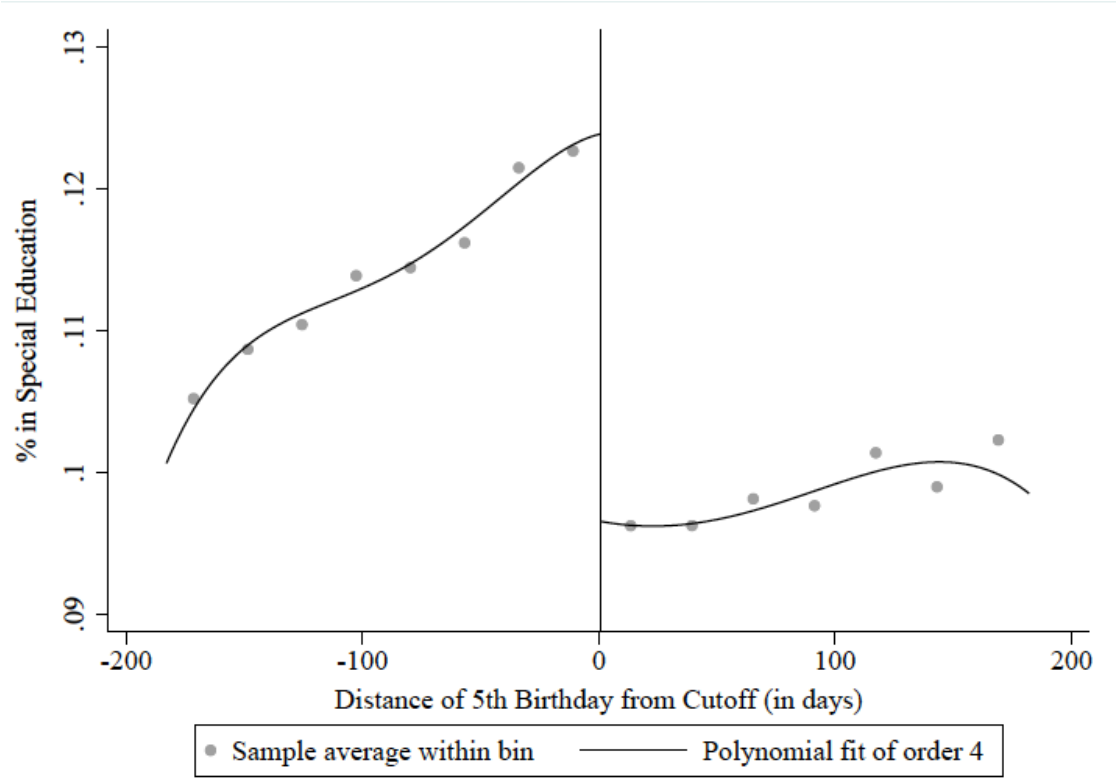
Tables and Figures

Figure 1.1: Probability of being in the youngest half of the kindergarten age eligibility age range around the kindergarten cutoff



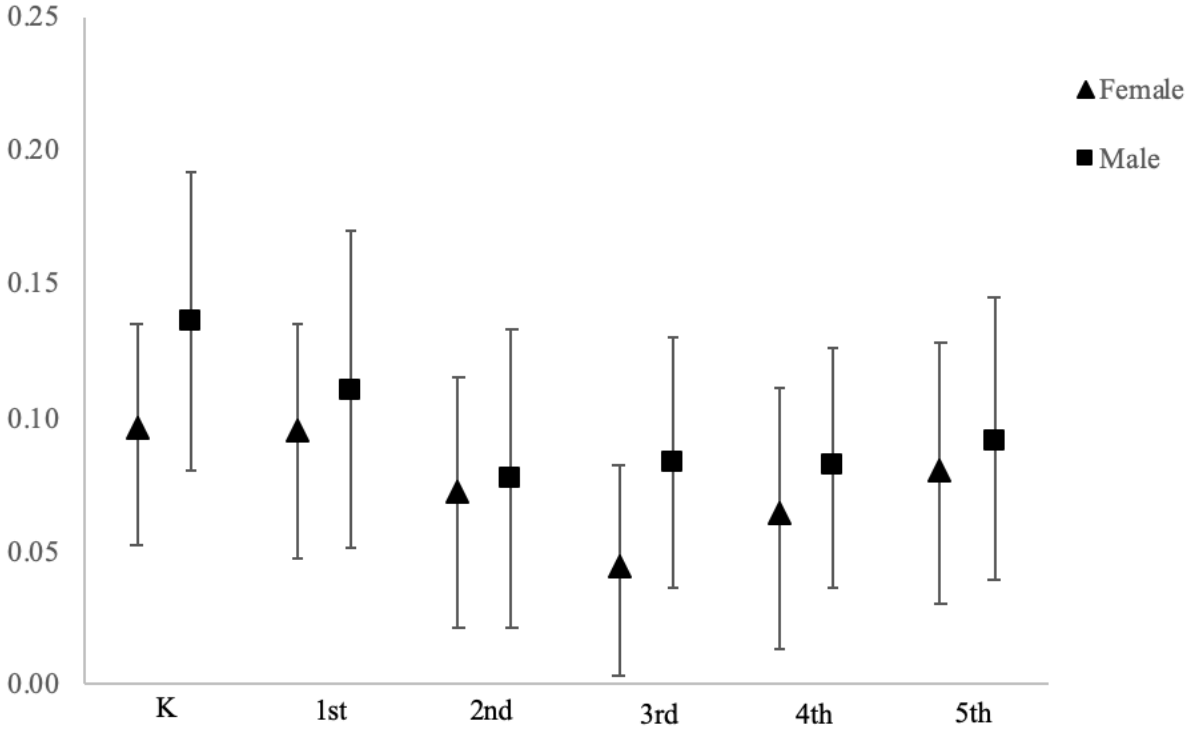
Note: The above figure plots the percent of students born on each day along the running variable who enrolled in kindergarten in the bottom half of the age-eligible distribution on each side of the kindergarten cutoff.

Figure 1.2. Relationship between a child's birthday and likelihood of receiving special education services in kindergarten.



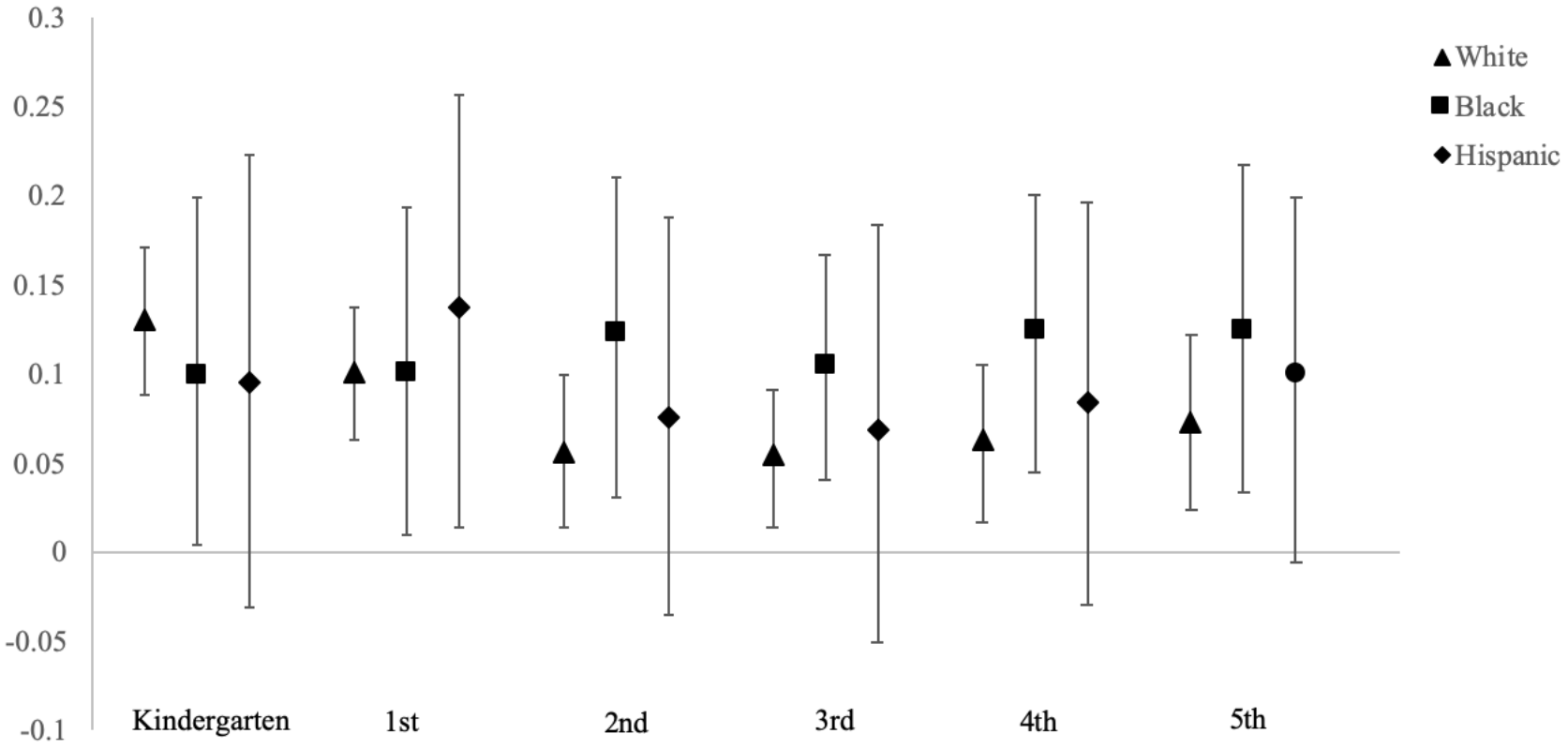
Note: The above figure plots the likelihood of having an IEP in a students' kindergarten eligible year on either side of the cutoff along the running variable for the full sample of students (*N*= 1,285,165). The plot uses integrated mean squared error optimal choice with evenly-spaced bins to mimic the underlying variation in the special education rate along the running variable and a 4th degree global polynomial for visual purpose only. The primary specification for the analyses uses a linear functional form.

Figure 1.3. Effect of being the youngest in grade on special education identification in kindergarten through fifth grade by gender in standard deviations



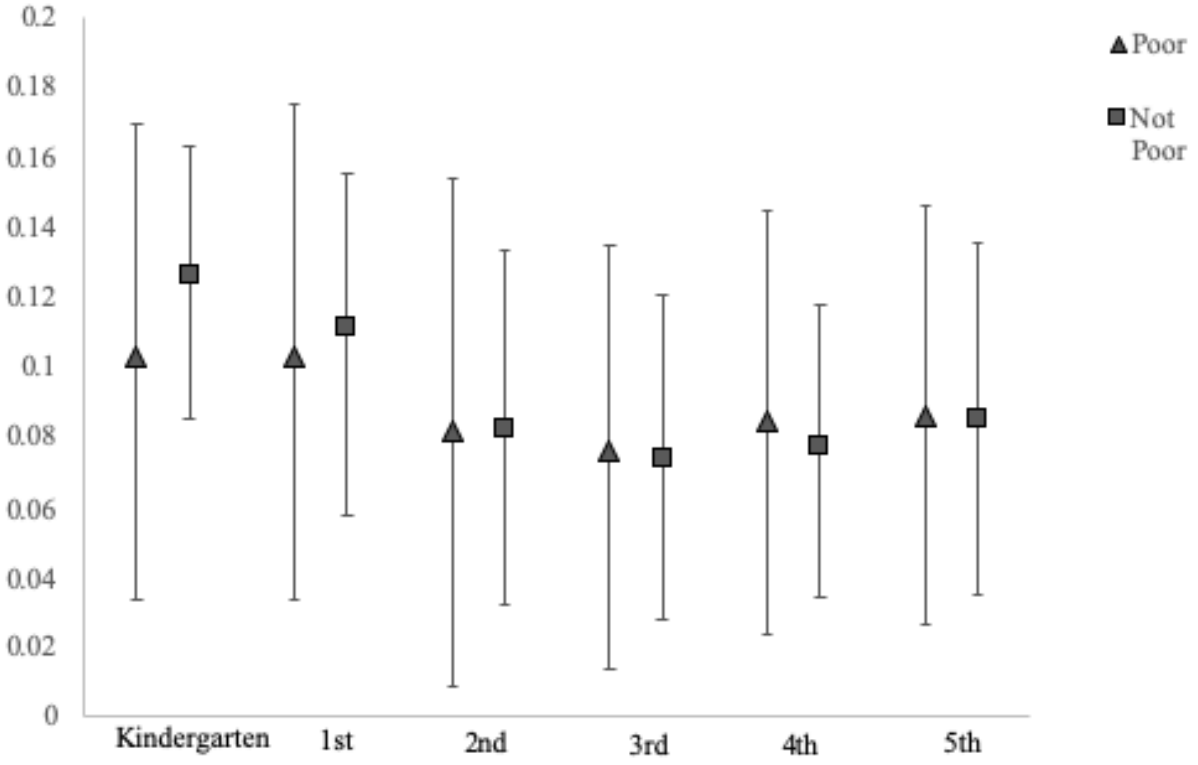
Note: Treatment effects were estimated separately for girls and boys using the primary specification (MSE-optimal bandwidth, polynomial order 1, triangular kernel, covariates, and clustered standard errors at the district-level). Percentage point differences were transformed into effect sizes by dividing the difference and associated confidence interval by the standard deviation of the control group mean within the appropriate MSE-optimal bandwidth.

Figure 1.4. Effect of being the youngest in grade on special education identification in kindergarten through fifth grade by race and ethnicity



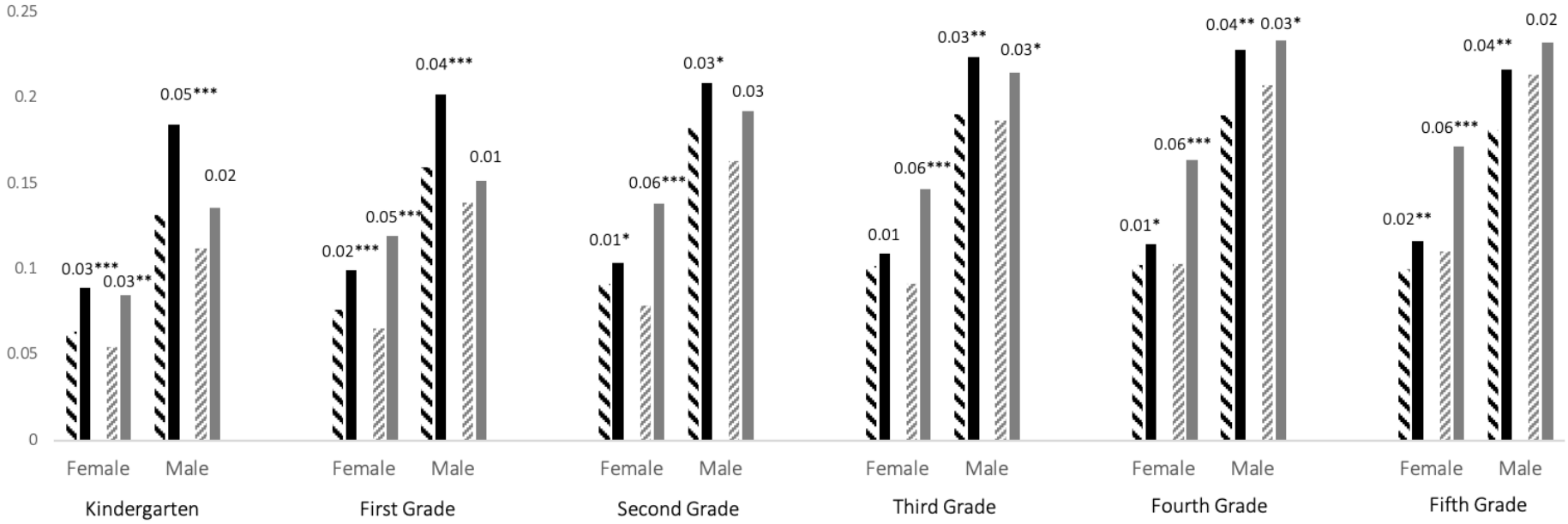
Note: All treatment effects were estimated using the primary specification (MSE-optimal bandwidth, polynomial order 1, triangular kernel, covariates, and clustered standard errors at the district-level). Percentage point differences were transformed into effect sizes by dividing the difference and associated confidence interval by the standard deviation of the control group mean within the appropriate MSE-optimal bandwidth.

Figure 1.5. Effect of being the youngest in grade on special education identification in kindergarten through fifth grade by free/reduced price lunch receipt



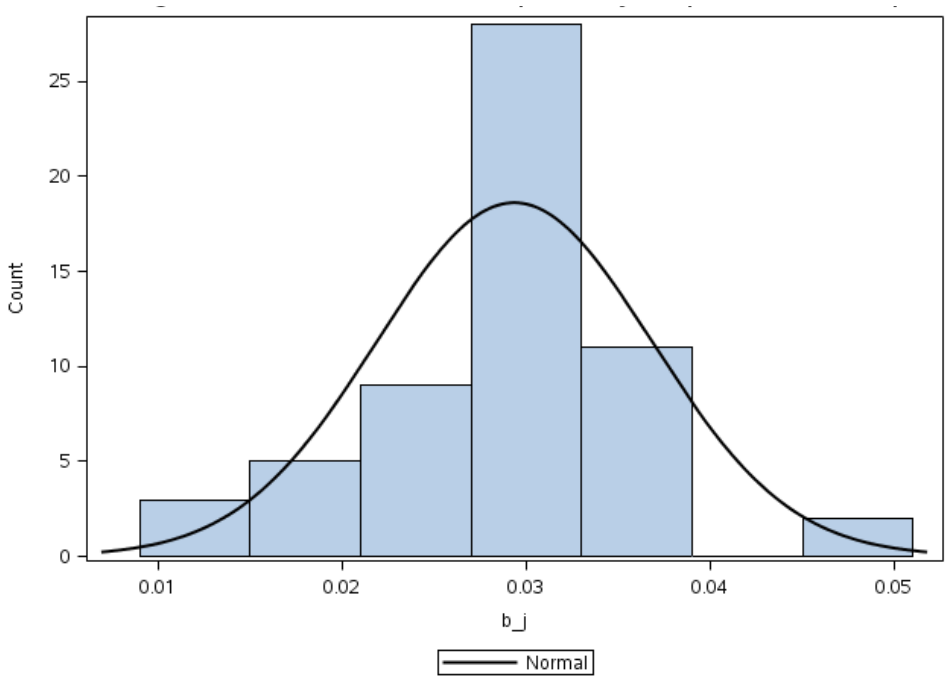
Note: All treatment effects were estimated using the primary specification (MSE-optimal bandwidth, polynomial order 1, triangular kernel, covariates and clustered standard errors at the district-level). Control group means were estimated using observations in the MSE optimal bandwidth for each outcome variable and treatment group means were estimated by adding the control mean and estimated treatment effect.

Figure 1.6. Effect of being the youngest in grade on special education identification in kindergarten through fifth grade for White and Black student by gender.



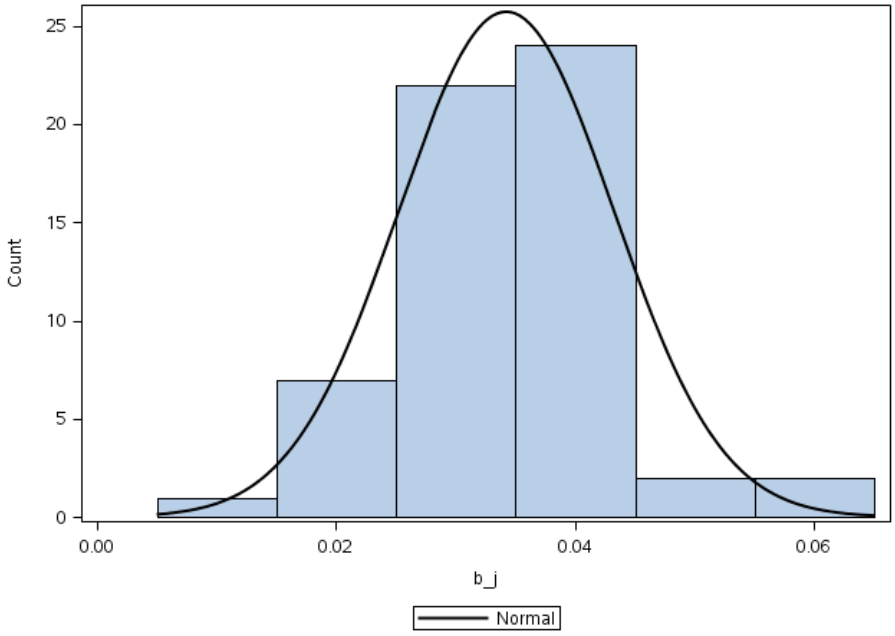
Note: * p<0.05, ** p<0.01, *** p<0.001. ■ White treatment group ▨ White control group ■ Black treatment group ▨ Black control group. All treatment effects were estimated using the primary specification (MSE-optimal bandwidth, polynomial order 1, triangular kernel, covariates and clustered standard errors at the district-level). Control group means were estimated using observations in the MSE optimal bandwidth for each outcome variable and treatment group means were estimated by adding the control mean and estimated treatment effect.

Figure 1.7. Histogram of ISD-level constrained empirical-Bayes impact estimates on kindergarten special education identification.



Estimated grand mean difference= 0.029, p= <0.0001
Estimated tau= <0.0001, p on Q-statistic= <0.0372

Figure 1.8. Histogram of ISD-level constrained empirical-Bayes impact estimates on ever being placed in special education.



Estimated grand mean difference= 0.034, p= <0.0001
Estimated tau= <0.0001, p on Q-statistic= 0.0113

Table 1.1. Effect of being eligible to be the youngest in a grade cohort on the likelihood of special education service receipt in kindergarten through 5th grade

	Sped in K	Sped in 1st	Sped in 2nd	Sped in 3rd	Sped in 4th	Sped in 5th
Eligible for K	2.8***	2.6***	1.7***	1.9***	2.1***	2.3***
Robust SE	0.5	0.4	0.4	0.4	0.4	0.4
Robust CI	[1.9, 3.8]	[1.7, 3.6]	[0.9, 2.7]	[1.0, 2.7]	[1.3, 3.0]	[1.5, 3.2]
BW N	93	75	84	83	79	73
Covariates	Y	Y	Y	Y	Y	Y
Cluster Var	District	District	District	District	District	District
Control mean	10.9	12.4	14.0	15.4	16.1	16.1
Effect Size	0.09	0.08	0.05	0.05	0.06	0.06

Note: * p<0.05, ** p<0.01, *** p<0.001. Covariates are female, Black, Hispanic, Asian, FRPL, Migrant, Early On (indicates prior access to early intervention but not receiving services), and fixed effects for eligible year 03-04 and 11-12. The primary specification has a linear functional form and uses a mean squared error optimal bandwidth selector and a triangular kernel. Standard errors are clustered at the district-level (district most enrolled in child's first kindergarten year- i.e., year 0).

Table 1.2. Effect of enrolling as the youngest in a kindergarten grade cohort on the likelihood of special education service receipt in kindergarten through 5th grade.

	Sped in K	Sped in 1st	Sped in 2nd	Sped in 3rd	Sped in 4th	Sped in 5th
First Stage	0.85***	0.82***	0.82***	0.83***	0.83***	0.80***
First Stage CI	[0.84, 0.86]	[0.81, 0.84]	[0.81, 0.83]	[0.82, 0.85]	[0.82, 0.84]	[0.79, 0.82]
Enroll as youngest in grade	3.3***	3.1***	2.3***	2.3***	2.5***	2.7***
Robust SE	0.6	0.6	0.6	0.6	0.5	0.6
Robust CI	[2.1 , 4.5]	[2.0 , 4.4]	[1.0 , 3.6]	[1.1 , 3.5]	[1.5 , 3.7]	[1.5 , 3.9]
BW N	50	40	39	43	43	37
Control mean	8.8	10.8	12.8	13.9	14.2	14.0
Effect Size	0.12	0.10	0.07	0.07	0.07	0.08

Note: * p<0.05, ** p<0.01, *** p<0.001. Covariates are female, Black, Hispanic, Asian, FRPL, Migrant, Early On (indicates prior access to early intervention but not receiving services), and fixed effects for eligible year 03-04 and 11-12. The primary specification has a linear functional form and uses a mean squared error optimal bandwidth selector and a triangular kernel. Standard errors are clustered at the district-level (district most enrolled in child's first kindergarten year- i.e., year 0).

Table 1.3. Effect of enrolling as the youngest in a kindergarten grade cohort on special education service duration and special education exit in kindergarten through 5th grade.

	Total Years in Special Ed	Percent Years in Sped	Ever in Special Ed	Ever Exited Special Ed	Ever Reentered
First Stage	0.84***	0.84***	0.83***	0.85***	0.87***
	[0.83, 0.85]	[0.83, 0.85]	[0.82, 0.85]	[0.83, 0.86]	[0.85, 0.88]
Enroll	0.22***	2.4***	4.3***	2.2***	0.5***
Robust SE	0.04	0.01	0.7	0.5	0.1
Robust CI	[0.1 , 0.3]	[0.02 , 0.03]	[2.9 , 5.6]	[1.1 , 3.3]	[0.3 , 0.7]
BW N	45	46	43	51	64
Control mean	0.97	12.3	20.3	7.2	0.9
Effect Size	0.10	0.44	0.11	0.09	0.05

Note: * p<0.05, ** p<0.01, *** p<0.001. Covariates are female, Black, Hispanic, Asian, FRPL, Migrant, Early On (indicates prior access to early intervention but not receiving services), and fixed effects for eligible year 03-04 through 11-12. The primary specification has a linear functional form and uses a mean squared error optimal bandwidth selector and a triangular kernel. Standard errors are clustered at the district-level (district most enrolled in child's first kindergarten year- i.e., year 0).

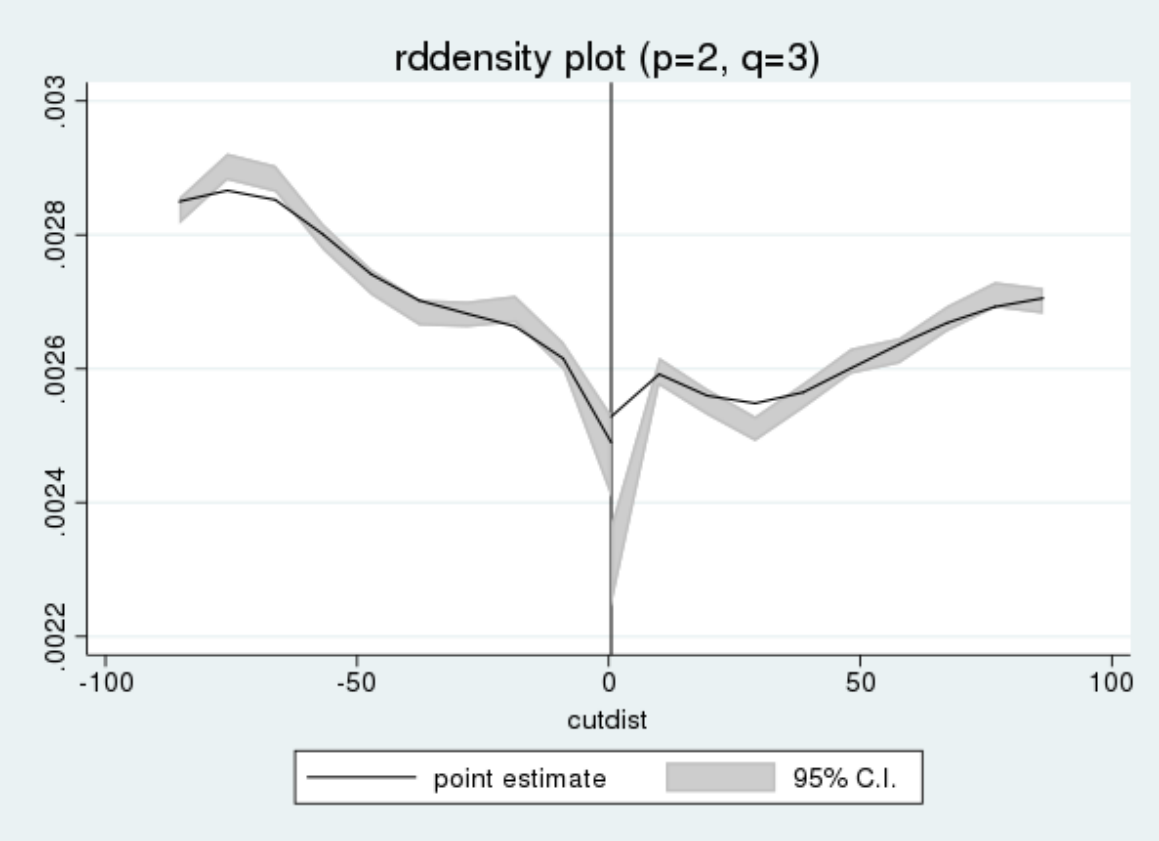
Table 1.4. Effect of being the youngest in grade on special education identification for students in high and low variance classrooms.

	Identified in Year 0		Ever Special Education	
	High Variance	Low Variance	High Variance	Low Variance
First Stage	0.75***	0.91***	0.72***	0.90***
First Stage CI	[0.71, 0.77]	[0.89, 0.92]	[0.69, 0.75]	[0.88, 0.91]
Enroll - Young	10.69***	0.21	9.12***	1.78
Robust SE	1.46	0.56	1.60	0.93
Robust CI	[7.52, 14.15]	[-0.96 , 1.34]	[5.95, 12.39]	[-0.12 , 3.61]
Bandwidth N	52	60	42	53
Control Mean	12.03	8.19	24.23	18.84
Effect size	0.32	0.01	0.21	0.05

Note: * p<0.05, ** p<0.01, *** p<0.001. Covariates are female, Black, Hispanic, Asian, FRPL, Migrant, Early On (indicates prior access to early intervention but not receiving services), and fixed effects for eligible year 03-04 through 11-12. Standard errors are clustered at the district-level (district most enrolled in child's first kindergarten year- i.e., year 0). P=1, BW= mserd, VCE= NN, Kernel= Tri

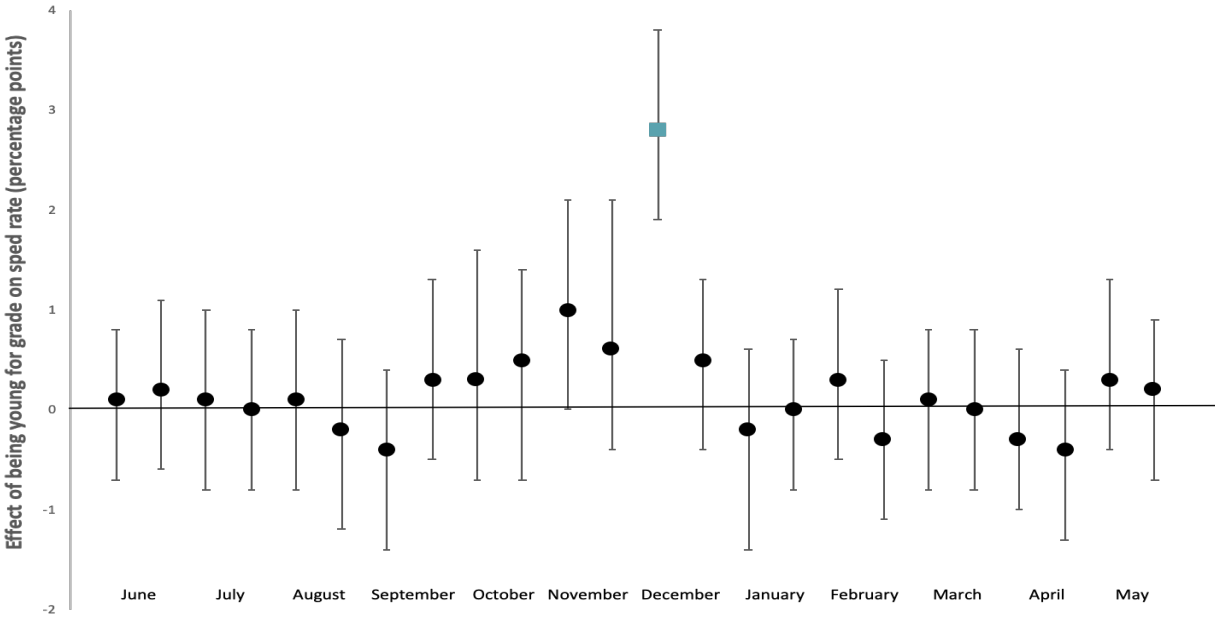
Appendix A

Figure A.1: Density of the running variable through the cutoff



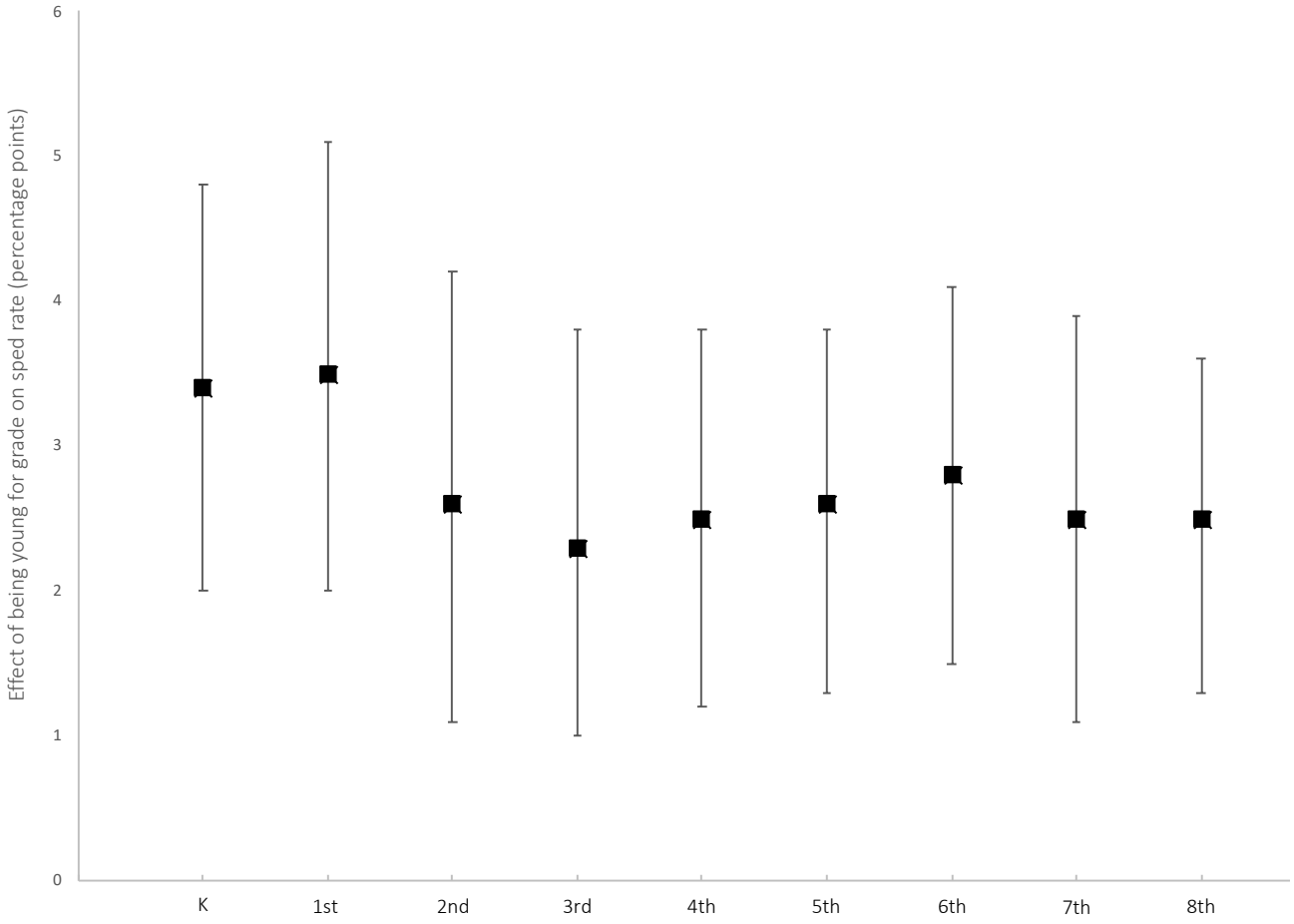
T= 1.4709 (p< 0.1413)

Figure A.2: Discontinuities in the outcome variable at points other than the cutoff compared with at the cutoff along the running variable



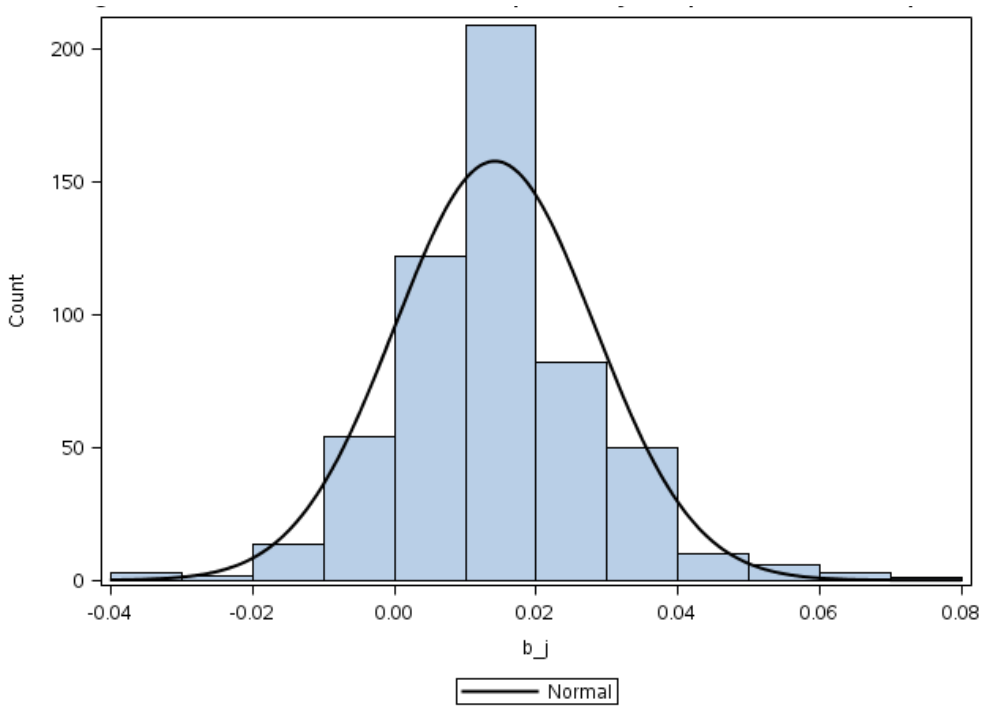
Note: Two pseudo-cutoffs were selected for each month of the year using a random date selector. Differences at each cut point were estimated using local polynomial estimation, with a polynomial order of 1 and a triangular kernel. Bandwidths were selected using one common MSE-optimal bandwidth for each discontinuity estimation.

Figure A.3. Effect of school starting age on being placed in special education in kindergarten through 8th grade for the 8th grade cohort



Note: All treatment effects were estimated using the primary specification (MSE-optimal bandwidth, polynomial order 1, triangular kernel, covariates and clustered standard errors at the district-level) for kindergarten eligible cohorts from 02-03 to 09-10.

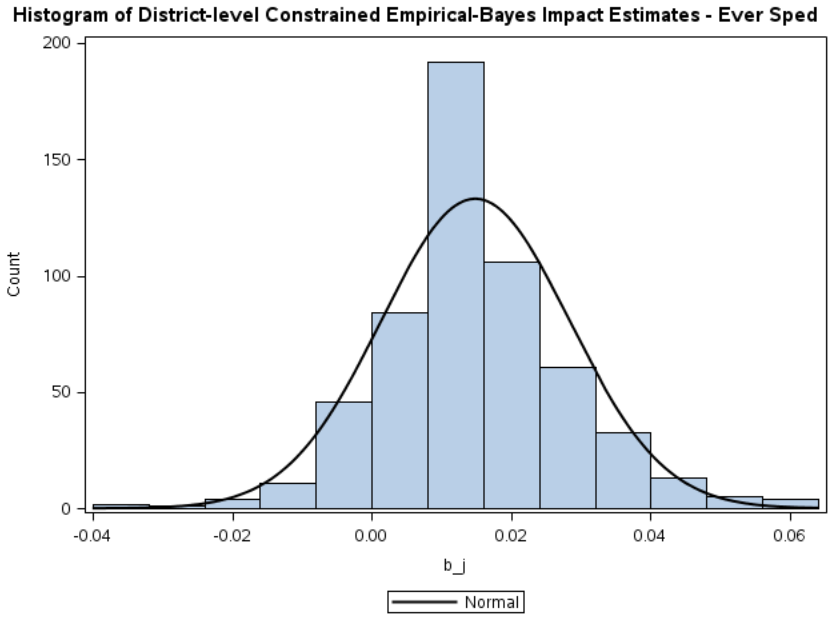
Figure A.4. Histogram of district-level constrained empirical-Bayes impact estimates on kindergarten special education identification



Estimated grand mean difference= 0.014, p= <0.0001
Estimated tau= <0.0001, p on Q-statistic= <0.0002

Note: The grand mean effect is smaller for the district-level analysis than for the ISD-level analysis due to an analytic decision to exclude the charter school sites from the cross-district analysis. I chose to exclude the charter school sites from these analyses is because there are very few kindergarten students in a given cohort whose birthdays fall within the analytic bandwidth, making those site-specific estimates particularly imprecise. All results presented in the main text are robust to the exclusion of charter schools (results available upon request).

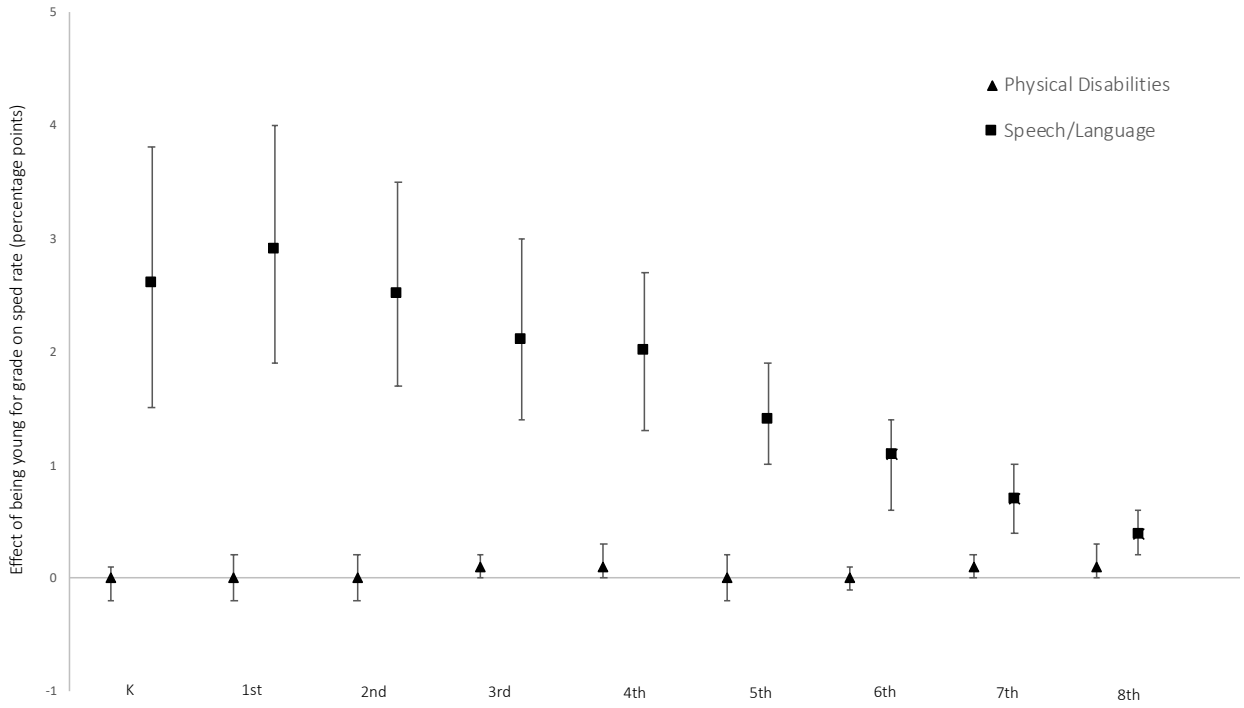
Figure A.5. Histogram of district-level constrained empirical-Bayes impact estimates on ever being placed in special education



Estimated grand mean difference= 0.015, p= <0.0001
Estimated tau= <0.0001, p on Q-statistic= <0.0001

Note: The grand mean effect is smaller for the district-level analysis than for the ISD-level analysis due to an analytic decision to exclude the charter school sites from the cross-district analysis. I chose to exclude the charter school sites is because there are very few kindergarten students in a given cohort whose birthdays fall within the analytic bandwidth, making those site-specific estimates particularly imprecise. All results presented in the main text are robust to the exclusion of charter schools (results available upon request).

Figure A.6: The effect of being young for grade on the likelihood of receiving services for speech/language impairment and for physical/severe disabilities in kindergarten through 8th grade



Note: Physical/severe disabilities include all primary disability classifications of orthopedic impairment, hearing/visual impairments, deaf-blindness, traumatic brain injuries, and severe multiple impairments. I also estimate the effects on physical disabilities alone (orthopedic, hearing/visual and deaf-blindness) as a sensitivity check and found similar effects (results available upon request). All treatment effects were estimated using the primary specification (MSE-optimal bandwidth, polynomial order 1, triangular kernel, covariates, and district-level clustered standard errors).

Figure A.7. Effect of being the youngest in grade on special education identification in kindergarten for students in high and low variance classrooms

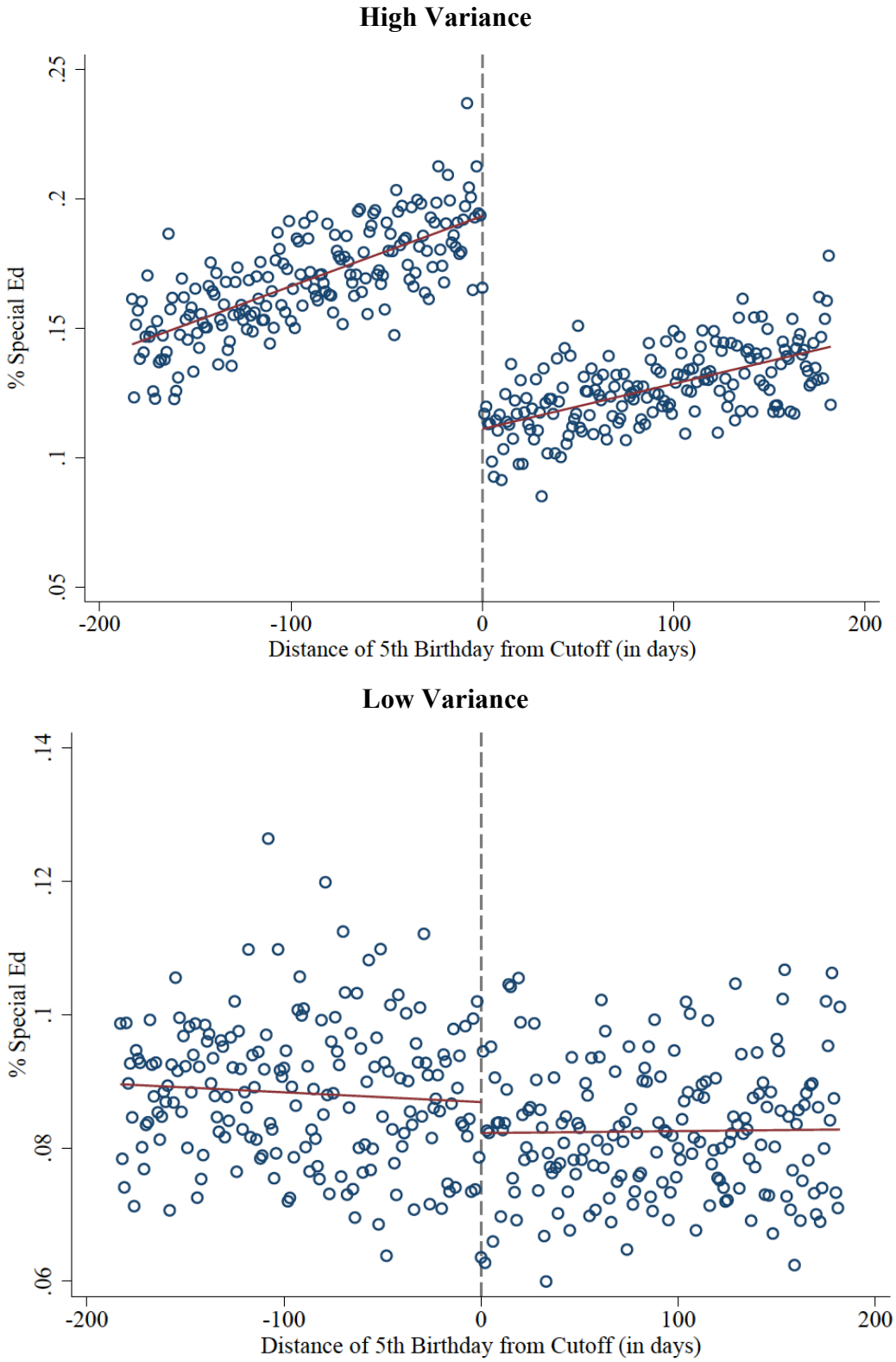


Table A.1. Variation in pretreatment or time-invariant characteristics through the cut point

	Estimated Difference in percentage points	Robust SE	Robust CI	Control Mean
Female	0.9**	0.3	[0.3 , 1.8]	48.77
Race/Ethnicity				
White	0.7	0.4	[0.0, 1.8]	67.99
Black	-0.1	0.4	[-1.0, 0.5]	20.77
Hispanic	-0.3	0.2	[-0.6 , 0.2]	6.91
Asian	-0.3*	0.1	[-0.6 , 0.0]	3.12
Poor	0.3	0.4	[-0.8 , 1.1]	43.17
Migrant	0.1	0.1	[0.0 , 0.2]	0.28
Early On- IEP	-0.1	0.1	[-0.3 , 0.1]	1.50

Note: * p<0.05, ** p<0.01, *** p<0.001. Differences in covariates at the cut-point 0 were estimated using local polynomial estimation, with a polynomial order of 1 and a triangular kernel. Bandwidths were selected using one common MSE-optimal bandwidth, with bandwidth sizes as follows: Female +/- 60.2, White +/- 39.5, Black +/- 38.4, Hispanic +/- 69.2, Asian +/- 52.1, Poor +/- 47.3, Migrant +/- 37.5, EO +/- 76.4. All estimates have been converted to percentages and percentage point differences by dividing the estimate by 100.

Table A.2: LATE impacts of being young in grade on special education service receipt in K-8

	K	1st	2nd	3rd	4th	5th	6th	7th	8th
First Stage	0.81***	0.78***	0.79***	0.81***	0.82***	0.82***	0.82***	0.80***	0.84***
Robust CI	[0.80-0.83]	[0.76-0.80]	[0.78-0.81]	[0.69-0.83]	[0.80-0.83]	[0.81-0.84]	[0.80-0.83]	[0.78-0.81]	[0.83-0.86]
Enroll - Young	3.4***	3.5***	2.6***	2.3***	2.5***	2.6***	2.8***	2.5***	2.5***
Robust SE	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.6
Robust CI	[2.0 , 4.8]	[2.0 , 5.1]	[1.1 , 4.2]	[1.0 , 3.8]	[1.2 , 3.8]	[1.3 , 3.8]	[1.5 , 4.1]	[1.1 , 3.9]	[1.3 , 3.6]
BW N	37	29	32	36	38	39	37	35	46

Note: * p<0.05, ** p<0.01, *** p<0.001. Covariates are female, Black, Hispanic, Asian, FRPL, Migrant, Early On (indicates prior access to early intervention but not receiving services), and fixed effects for eligible year 03-04 through 11-12. The primary specification has a linear functional form and uses a mean squared error optimal bandwidth selector and a triangular kernel. Standard errors are clustered at the district-level (district most enrolled in child's first kindergarten year- i.e., year 0).

Table A.3: LATE impacts of being young in grade on special education service receipt in K-5 for sex, race/ethnicity, and socioeconomic subgroups

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Sex						
Male	4.4***	3.9***	2.9**	3.2***	3.2***	3.5***
	[2.6 , 6.2]	[1.8 , 6.0]	[0.8 , 5.0]	[1.5 , 5.0]	[1.6 , 4.9]	[1.4 , 5.5]
	11.86	14.66	16.98	18.12	18.54	18.17
Female	2.2***	2.4***	2.0**	1.3*	1.9**	2.4***
	[1.3 , 3.2]	[1.4 , 3.6]	[0.8 , 3.4]	[0.2 , 2.5]	[0.5 , 3.4]	[1.0 , 3.9]
	5.59	6.84	8.40	9.41	9.88	9.85
Race/Ethnicity						
White	3.8***	3.2***	1.9**	1.9**	2.2**	2.5**
	[2.6 , 5.0]	[2.0 , 4.4]	[0.4 , 3.3]	[0.6 , 3.3]	[0.7 , 3.8]	[0.8 , 4.2]
	9.43	11.48	13.44	14.29	14.34	13.76
Black	2.7*	3.0*	4.0**	3.6***	4.5***	4.5**
	[0.0 , 5.3]	[0.2 , 5.7]	[1.2 , 7.0]	[1.5 , 5.8]	[1.8 , 7.4]	[1.2 , 7.8]
	8.00	9.89	11.78	13.35	15.24	15.92
Hispanic	2.5	4.0*	2.4	2.3	0.029	3.5*
	[-0.8 , 5.8]	[0.5 , 7.6]	[-1.2 , .5.9]	[-2.0 , 6.3]	[-0.9 , 6.8]	[0.1 , 7.2]
	7.33	9.43	11.47	12.68	13.49	13.99
Poverty						
FRPL	3.1**	3.4**	2.9*	2.8**	3.2**	3.3**
	[1.1 , 5.2]	[1.0 , 5.7]	[0.3 , 5.5]	[0.6 , 5.1]	[0.9 , 5.5]	[1.0 , 5.6]
	10.04	12.48	14.96	16.41	17.47	17.85
Not FRPL	3.4***	3.3***	2.6**	2.4**	2.5***	2.7***
	[2.4 , 4.5]	[2.0 , 4.7]	[1.0 , 4.2]	[0.9 , 3.9]	[1.2 , 3.9]	[1.1 , 4.4]
	7.87	9.69	11.21	11.93	11.81	11.34

Note: * p<0.05, ** p<0.01, *** p<0.001. Fixed effects for eligible year 03-04 through 11-12. The primary specification has a linear functional form and uses a mean squared error optimal bandwidth selector and a triangular kernel. Standard errors are clustered at the district-level (district most enrolled in child's first kindergarten year- i.e., year 0). Robust confidence intervals are in brackets.

Table A.4. Treatment effect sensitivity to data-driven bandwidth selectors

	Sped in K	Sped in K	Sped in K	Sped in K
First Stage	0.85***	0.82***	0.80***	0.77***
First Stage CI	[0.84, 0.86]	[0.79, 0.83]	[0.78, 0.83]	[0.73, 0.79]
Enroll - Young	3.3***	3.3***	3.5***	3.5***
Robust SE	0.6	0.6	0.7	0.7
Robust CI	[2.1 , 4.5]	[2.2 , 4.6]	[2.2 , 4.8]	[2.2 , 4.9]
BW Select	mserd	msetwo	cerrd	certwo
BW L	50	92	34	63
BW R	50	39	34	27
Covariates	Y	Y	Y	Y
Cluster Var	District	District	District	District

Note: * p<0.05, ** p<0.01, *** p<0.001. Covariates are female, Black, Hispanic, Asian, FRPL, Migrant, Early On (indicates prior access to early intervention but not receiving services), and fixed effects for eligible year 03-04 through 11-12. Standard errors are clustered at the district-level (district most enrolled in child's first kindergarten year- i.e., year 0). MSERD= One common mean squared error optimal bandwidth. MSETWO= Two different mean squared error optimal bandwidths on each side of the cutoff. CERRD= One common coverage error rate optimal bandwidth. CERTWO= Two different coverage error rate optimal bandwidths on each side of the cutoff.

Table A.5. Estimates of the mean and standard deviation of the distribution of ISD-average treatment effects - Ever Special Ed

		Mean (Beta)			Standard Deviation (tau)	
Bandwidth	Control Mean	Est.	(SE)	p-value	Est	p-value
+/- 50	19.05	2.19	0.27	<.0001	0.001	0.0036
+/-34	19.02	2.02	0.32	<.0001	0.001	0.0075
+/- 30	19.08	2.04	0.41	<.0001	0.001	0.0637
+/- 15	18.95	1.95	0.58	0.0007	0.003	0.0545

Note: Covariates included were the running variable, gender (female=1), race (Black, Hispanic, Asian, migrant, early on no services, and binary indicators of kindergarten eligible cohort year. For intent-to-treat estimates, the ISD value was imputed for students who did not enroll in their kindergarten eligible year by using the ISD value of their first enrollment year (year 1).

Table A.6. Overall and differential sample attrition for on special education outcomes in follow-up years 1-5 for the full 5th grade sample (cohorts 02-03 through 12-13)

	Year 1	Year 2	Year 3	Year 4	Year 5
Overall Attrition- Eligible					
Control Intercept	3.83	6.20	7.84	9.24	17.50
Treatment Intercept	3.47	6.76	8.87	10.22	11.84
Difference	-0.28**	0.54**	0.89***	0.86***	-5.79***
SE	(0.11)	(0.17)	(0.18)	(0.23)	(0.52)
Differential Attrition					
Female	2.91*	3.26*	3.47**	1.89	-2.11
	[0.06]	[0.07]	[0.07]	[0.04]	[-0.04]
White	-5.71***	-7.13***	**-12.25*** **	2.92*	6.85***
	[-0.12]	[-0.14]	**[-0.25]**	[0.06]	[0.14]
Black	6.32***	**10.50*** **	0.02	-0.53	-0.87
	[0.15]	**[0.25]**	[0.00]	[-0.01]	[-0.02]
Hispanic	1.26	-0.88	0.21	0.46	0.53
	[0.04]	[-0.03]	[0.01]	[0.01]	[0.02]
Asian	-1.83	1.90	2.39	2.27	-3.98
	[-0.07]	[0.07]	[0.09]	[0.09]	[-0.17]
Poor	-2.65**	-3.25***	-3.30***	-5.89***	0.25
	[-0.05]	[-0.07]	[-0.07]	[-0.12]	[0.00]
Early On	1.64*	1.65*	5.53**	1.74*	0.43
	[0.05]	[0.05]	[0.17]	[0.05]	[0.01]

Note: Differences in the likelihood of having missing data were estimated using the same mean squared error optimal bandwidth selector as the primary specification. For the covariate-level analysis, the differences in the likelihood of having a value of one for each covariate at the cutoff are displayed in percentage point and effect sizes in brackets (standardized on the standard deviation of the control group mean).

Chapter III

Characteristics of Special Education Placements for Students Receiving Services in Elementary School

Abstract

Students who are eligible to start school at a relatively young age are more likely to be placed in special education, as are students who are older than expected for grade due to delayed school entry and grade repetition. However, there is little empirical evidence that the disability classifications, service prescriptions, and classroom settings of students in special education differ by age in their placement grade. To fill this gap in the literature, I estimate the relationship between age in grade and special education services for students placed in special education in elementary school. I find that within grade of placement, the youngest students are the most likely to have speech language impairments and to exit from services, whereas the oldest students are more likely to have severe disability classifications, more likely to receive related services, and less likely to exit from special education. Students who are old-for-grade because of delayed school entry or grade repetition are particularly likely to have severe disability classifications and intensive placements, and are the least likely to exit from services. These findings reveal considerable differences in the types of placements students receive by age, suggesting that younger students with more mild impairments may be induced into special education because they are young-for-grade, whereas parents may choose to delay school entry for students with severe impairments, making them old-for-grade because of their disabilities.

These patterns motivate future research into the relationship between grade retention and special education and the effects of disparate placement rates by age on student outcomes.

Introduction

Nearly 7 million (14%) students enrolled in public schools received special education services in 2017-2018 (NCES, 2017). Underlying this national figure, there is considerable geographic- and student-level variation in which students receive services, particularly by race, gender, and socioeconomic status (e.g., Elder, Figlio, Imberman, & Persico, 2019; Hibel, Farkas, & Morgan, 2010; McManus et al., 2011; Morgan et al., 2015; Skiba et al., 2006). For example, racial disproportionality in special education placement rates is well-documented, although researchers disagree on whether these patterns indicate an over-placement or under-placement of minoritized students (Grindal, Schifter, Schwartz, & Hehir, 2019; Morgan et al., 2015). Further, within the population of students receiving special education services, demographic characteristics are also associated with differences in the disability classifications, service types, and educational settings of those students in special education. For example, there is evidence that Black students are more likely to be classified with more severe or subjective disability classifications such as intellectual impairments or emotional disturbances (Oswald, Coutinho, Best, & Singh, 1999; Skiba et al., 2006) and more likely to receive services in restrictive educational environments after identification (Hosp & Reschly, 2001) than are their White peers in special education. Similarly, low-income students are more likely to be identified for more subjective disabilities and placed in more restrictive environments than are their more economically advantaged peers in special education (Schifter, Grindal, Schwartz, & Hehir, 2019). The cause of these differences, how to interpret them, and the impact they may have on students and schools remain hotly contested.

Comparatively less attention has been paid to within-grade age differences in special education placement types, despite consistent evidence that the likelihood of special education

placement varies by age. For example, students who enroll in kindergarten at the youngest eligible age are more likely to be placed in special education than students who enroll at the oldest eligible age (Dhuey, Figlio, Karbownik, & Roth, 2019; Dhuey & Lipscomb, 2010; Independent Budget Office, 2020, Shapiro, 2020). In contrast, students who are older than expected in their grade, either through delaying school entry (i.e., "redshirting") or grade repetition, are also more likely to be receiving special education services (Elder & Lubotsky, 2006; Fortner & Jenkins, 2017). Given these competing placement patterns, students who are placed in special education at different ages in the same grade are likely to differ both in the types of the disabilities they are classified with and in the services they receive.

To address this gap in the literature, I use longitudinal administrative data on nearly 250,000 students who enrolled in a public school in Michigan for kindergarten from 2002-2012 and were placed in special education in elementary school to describe how age in grade is associated with the types of initial placements students receive. I estimate within-school and within-cohort differences in the disability types, services prescribed, educational settings, and likelihood of exiting special education by age, with age groups defined by students who are young-for-grade, around the average age, or old-for-grade in their year of placement. I also conduct these analyses for all students, just for students who are the expected age in their grade, and for students who are older than expected for grade to explore how enrollment choices and grade repetition interacts with special education variation.

This descriptive evidence makes several contributions to the literature. First, in prior work I found that the youngest kindergarten-eligible students in Michigan are 3.3 percentage points more likely to be placed in special education than oldest kindergarten-eligible students (Shapiro, 2020). In the present study, I extend this work by comparing the placements of these

younger students with their average age and old-for-grade peers who enrolled kindergarten when eligible. These findings are informative both interpreting the higher rates of placement for the youngest eligible students, and for motivating future work estimating the impact of identification on those who may have been induced into special education due to their age in grade. Second, my findings align with the prior evidence that special education placement is associated with both redshirting and grade retention and add evidence that students who are older than expected in grade have the most intensive special education placements. Third, I consider the policy implications of context-specific kindergarten enrollment policies and grade retention practices in Michigan that contribute to variation in age within grade, and the variation in early elementary special education provision approaches that may impact long-term student outcomes. Finally, I document differences in disability classifications, service prescriptions, and educational settings of students placed in special education that may have long-term impacts on their experiences in special education and their academic outcomes, underscoring the importance of within-special education disparities.

Background

Students who are eligible to start kindergarten at a younger age are more likely to be diagnosed with a disability or placed in special education than their oldest eligible peers (Dhuey, Figlio, Karbownik, & Roth, 2019; Dhuey & Lipscomb, 2010; Elder, 2010; Evans, Morrill, & Parente, 2010; Hernandez-Diaz et al., 2012; Independent Budget Office, 2020; Krabbe, Thoutenhoofd, Conradi, Pijl, & Batstra, 2014; Layton, Barnett, Hicks, & Jena, 2018; Ma et al., 2012; Schwandt & Wuppermann, 2016; Chapter 1). The evidence that age in grade impacts special education placements primarily comes from natural experiments using kindergarten

entrance policies, where students whose birthdays fall just around the kindergarten cutoff are as good as randomly sorted into being young or old-for-grade (Murnane & Willett, 2010).

However, kindergarten cutoff policies are not the only factors that determine a student's age in grade. First, parents can select into their children being old-for-grade through "redshirting." Redshirting, or delaying school entry for a year, is a popular practice not only for advantaged families looking to give their children a developmental edge, but also for parents who are concerned about their child's developmental preparedness (Bassok & Reardon, 2013; Deming & Dynarski, 2008; Noel & Newman, 2003). Unsurprisingly then, students who redshirt are more likely to be placed in special education after school entry (Elder & Lubotsky, 2006; Fortner & Jenkins, 2017; Graue & DiPerna, 2000; Huang, 2015). Student age in grade can also change over time, with students becoming older than their peers because of grade repetition. There is a strong positive relationship between grade repetition and special education placement that goes in both directions; Students in special education are more likely to be retained in later grades, and students who are retained are more likely to then be placed in special education (Beebe-Frankenberger, Bocian, MacMillian, & Gresham, 2004; Silverstein, Guppy, Young, & Augustyn, 2009).

The U-shaped relationship between age in grade and special education placement signals that younger students may be more likely to be placed in special education because of their age in grade whereas students may also be older than expected for their grade because of their disability. In other words, students who are receiving special education services at different ages in the same grade are likely to differ in meaningful ways that are obscured when looking solely at overall placement rates. In particular, students may differ by disability classifications, service prescriptions, and educational settings, all of which can shed light on the nature of a student's

developmental difference, the accommodations students receive, and their access to inclusive educational settings (National Research Council, 1997). Although much of the evidence that disability classification, service prescription, and educational setting varies by age comes from across-grade comparison, exploring heterogeneity of special education placements within grades is critical to interpreting the relationship between age in grade and special education placement.

Variation in disability classifications by age

Students are considered eligible for special education services if they have one of 13 qualifying disabilities, which cover a wide range of physical, cognitive and behavioral differences, and if this disability impacts their ability to participate fully in public education without accommodations.[8](Individuals with Disabilities in Education Act, 2004). Disability classifications indicate the general nature of an individual student's developmental differences; For example, a student with speech or language impairment may have a language processing delay, whereas a student with emotional disturbance may struggle with behavioral difficulties. However, the specific criteria for each category are left to the discretion of states and many students may be eligible under multiple categories (National Research Council, 1997). Further, the percent of students classified under each of the 13 categories differs across states, likely due to state-specific guidelines for evaluation and classification (MacFarlane & Kanaya, 2009; NCES, 2017; United States Government Accountability Office, 2019). Nevertheless, within-school comparisons of disability classifications can suggest variation in the perception of development differences associated with age and other demographic characteristics.

[8] Autism Spectrum Disorder, deaf-blindness or deafness, developmental delay (through age 9), emotional disturbance, hearing impairment, intellectual disability, multiple disabilities, orthopedic impairment, other health impairment, specific learning disability, speech or language impairment, traumatic brain injury, or visual impairment

Disability classifications of students who are placed in special education in early grades differ from those placed later in schooling, suggesting that students receive special education for different types of disabilities based on their age. Students who receive special education services in early grades are more likely to be diagnosed with speech or language impairments or developmental delays than those placed in later grades, and are more likely to exit from services (Carlson et al., 2008; National Center for Education Statistics, 2007; Office of Special Education and Rehabilitative Services, 2019; Wagner & Blackorby, 2002; Woods, 2019). In contrast, many of the early recipients of special education services are also students with persistent or severe impairments who will continue to receive services throughout K-12 (Carlson et al., 2008).

Unlike students placed in the early grades, who may be placed in special education either to preempt academic challenges or because of severe disabilities that will require persistent accommodations, students placed in special education in the later grades are more typically classified with disabilities associated with academic functioning like specific learning disorders, emotional impairments, and other health impairments (which includes ADHD). In contrast, classifications of speech/language impairments decline in the later grades whereas classifications of physical or severe impairments stay constant (National Center for Education Statistics, 2017). Classifications can also change over time as students progress through school. For example, nearly 20% of students who are placed for speech or language impairments in the early grades are reclassified as having a learning disability or other health impairment in later grades (Marder, 2009). Just as disability classifications differ by grade, students who are placed at different ages in the same grade may differ as well.

Variation in service prescription by age

Variation in the types of services students receive by age at placement may suggest differences in the cognitive, physical, or behavioral domains in which students receive additional support. After eligibility determination and disability classification, students receive an Individualized Education Plan (IEP), which describes the instructional and related services like speech language pathology or physical therapy that a student will receive, and their primary educational environment (Dragoo, 2017). Unlike disability classification, however, differences in service allocation across grades are less commonly studied.[9] However, in one study of students with Autism Spectrum Disorder, speech and behavior services were more common for younger students and social work and psychology services more common for secondary students (Morgan et al., 2016; Wei, Wagner, Christiano, Shattuck, & Yu, 2014). These differences suggest that students may need different types of academic supports depending on their age of placement within grade as well, either because age is correlated with disability type and severity or because the nature of student's developmental differences changes as students grow.

Variation in educational environment by age

Finally, primary education environment is an indicator of how much access a student has to general education. Students in more restrictive environments spend less time on average in classroom settings with their typically developing peers. Schools are required to provide services to students in the least restrictive environment (LRE) possible, so students in restrictive environments are likely to be those students that require more intensive supports that cannot be provided through supplements to general education alone (Carlson et al., 2008; Individuals with

[9] Unlike service setting, the Office of Civil Rights does not monitor schools on equity in service allocation which likely explains why services are less commonly reported by schools and therefore less likely to be studied.

Disabilities in Education Act, 2004; Michigan Department of Education, 2016; National Council on Disability, 2018).

Grade is associated with the educational settings of students receiving services, suggesting that how schools accommodate students with disabilities changes as students progress through school. Across the United States, the share of students receiving services in a general education environment for >80% of the day (the threshold considered to be "inclusion") has been growing for all students (McLeskey, Landers, Williamson, & Hoppey, 2012). However, 73% of students receiving services in kindergarten are in inclusive settings compared with around 60% of 14-18 year-olds nationwide. In contrast, older students are more than twice as likely to be general education for only 40-79% of the school day (11% of 6 year-olds versus 22% of 14-17 year-olds), particularly students with more severe disabilities like Autism Spectrum Disorders, intellectual disabilities and multiple impairments (Morningstar, Kurth, & Johnson, 2017; Office of Special Education and Rehabilitative Services, 2019). Within a particular school and disability classification, variation in LRE placements by student age in grade may suggest differences in educational approaches that not only signal differences in disability severity, but also impact student outcomes in the long-term (Hehir, 2012).

Present Study

Students who are young, average age, or old-for-grade when placed in special education may have different placements for two reasons. First, if being young-for-grade increases the likelihood of being placed in special education, then the disabilities with which students are placed and approaches to accommodation for those students may differ from those of their peers. Second, if a student's disability impacts their likelihood of being old-for-grade, students who are older than expected in grade may also differ in disability classifications, services, and

educational setting. By describing how special education placements vary by age, we can differentiate between the high special education placement rates at each end of the age in grade distribution, informing our interpretation of both. However, there has been little descriptive evidence that age in grade is associated the characteristics of students' special education placements in elementary school. Therefore, I ask the following research questions:

1. How do students who are placed in special education at different ages in the same grade in elementary school differ on observable characteristics?
2. How do students placed in special education in kindergarten who are younger than average, average age, or older than average differ in disability classification, setting type, service type, and likelihood of exiting or reentering services in future years?
3. What are the disability classifications, setting type, and service types for students who are younger than average, average age, or older than average in grade who are placed in special education for the first time in 1st-5th grade?

Method

Sample

The study sample is drawn from all first-time kindergarten entrants between school years 2002-2003 and 2012-2013 who enrolled in a public school in Michigan (*N*= 1,285,165).[10] I then restrict the sample to children who had an Individualized Education Plan (IEP) for the first time at any point during their first kindergarten enrolling year through fifth grade (*N*= 248,306, 19% of all kindergarten enrollees).[11] This sample restriction allows me to observe the first year that a student begins receiving services in elementary school. The kindergarten entry special education

[10] I exclude 17,822 students (1.4%) without available birthday information and 592 students whose birthdays were implausible (<0.01%) from the full population of students.
[11] I exclude the students who began receiving services in a prekindergarten setting because access to prekindergarten is not universal in Michigan.

sample includes 88% of the total population of students who enrolled in a Michigan public school in elementary school and received special education services.

The sample is generally representative of the full population elementary school students in special education during this period by gender, race and ethnicity, although the kindergarten enrolling sample is more likely to be White (2.2-4.8pp, $p<0.001$). The sample is also more likely to be low-income (5.0-5.6pp, $p<0.001$) (Appendix B., Table B.1). In addition, approximately seven percent of students who enrolled in a Michigan public school for kindergarten and received special education services in elementary school were no longer enrolled by fifth grade. Students who exit from the public schools before 5th grade are somewhat less likely to be White (2.4-3.0pp, $p<0.001$) and less likely to be low-income (2.6-7.7pp, $p<0.001$) than those student who do not attrit from the sample (Appendix B., Table B.2). The kindergarten entrance sample restrictions, therefore, may limit the generalizability of the results to students in special education who stay in the Michigan school system from kindergarten through fifth grade.

Context

The age of student in comparison to their same grade peers in Michigan is influenced both by statewide policy that introduces plausibly exogeneous variation in school starting age, and parental enrollment decisions and schooling outcomes that are endogenous to student characteristics related to special education placement. During the study years, a child who turned five years old on or before December 1st was eligible to enroll in kindergarten in the fall of that school year (1976 PA 451), whereas a child who turned five years old on or after December 2nd had to wait until the following school year to enroll. This kindergarten cutoff policy effectively sorts students born in the fall and winter months into being young-for-grade or old-for-grade respectively, whereas students born in the spring and summer start school at the average age. In

practice, however, some parents choose to hold their child back for a year (i.e., "redshirt"), making their children among the oldest in their grade when they start school.[12] Redshirting is particularly common among children born just before the kindergarten cutoff who would have been young-for-grade if they enrolled on time. During the study period, 6% of all students in Michigan with IEPs in kindergarten had been redshirted.

Age in grade can also change overtime as children progress through school. In Michigan, there are two ways in which a student might go from being young or average age to being old for their grade. The first is through participation in a two-year kindergarten program. There were two of these programs operating widely in Michigan during this period; developmental kindergarten or "Young Fives," and Early Childhood Developmental Delay programs (ECDD). The students who participate in either DK or ECDD are enrolled in kindergarten twice, so by their second year in the sequence they are amongst the oldest in their grade. Importantly, these programs are offered only by some local school districts, not all school districts with ECDD programs operate it as a two-year sequence, and the DK and ECDD programs are designed to serve different populations of students.[13] Around 7% of students with IEPs in kindergarten in the sample were recorded as having been enrolled in either developmental kindergarten (4%) or a two-year ECDD program (3%).

The second way a child's age position can change as they progress through elementary school is by being retained in grade. Students may be held back for a number of reasons and

[12] Alternatively, there was no formal way for the oldest eligible students to enroll in kindergarten a year early during this period. This is supported by the empirical evidence that very few students born just after the kindergarten cutoff date enrolled in kindergarten before they were eligible to do so (0.2%).

[13] Developmental kindergarten enrollment policies vary by offering district but tend limit enrollment to students who would be on the older side of their preschool cohort or the younger side of their kindergarten cohort. These programs are general education environments serving students with and without IEPs, and were primarily offered in more advantaged school districts serving higher income and fewer minority students. In contrast, two-year ECDD programs enroll students who are kindergarten age and have severe developmental delays (students meeting one half or less or expected development in one or more areas) (Michigan Department of Education, 2016).

there were no state retention policies during the study period in Michigan (Education Commission of the States, 2005). Nearly one third of students with IEPs in kindergarten in the sample repeated a grade at some point in elementary school, and 40% of those placed in later elementary grades were grade repeaters (including those in two-year kindergarten programs). For context, around 16% of the kindergarten entrants who are never placed in special education are retained in grade in elementary school, signaling disproportionately high rates of retention for students with disabilities during this period.

Outcomes

For each student, I generated measures of the disability category, setting, and services of students in the first year they were placed in special education from kindergarten through fifth grade. To measure first-time special education placement grade, I first constructed a binary indicator set to one if a child had an IEP at any point during the school year and then identified the first grade in which I observe the child receiving services from kindergarten through fifth grade. In each first-time placement grade, I also constructed binary indicator of primary disability category. Given the low-incidence of some disability categories, I used the following eight primary disability classifications: intellectual impairment, speech and language impairments, specific learning disability, developmental delay, autism spectrum disorder, emotional impairment, and physical/severe impairment.[14]

To measure the characteristics of students' special education experiences in their first placement year, I created binary measures of predominant service setting, program type, and service type in a student's first placement year. First, I combined 34 possible setting types to generate four service setting indicators that align with the federal categorizations of educational

[14] Physical impairment includes orthopedic, hearing/visual impairments, deaf-blindness, traumatic brain injuries, and severe multiple impairments.

environment: >80% in general education, 40-79% in general education, <40% in general education, and separate environment (i.e., 100% of the day in special education classroom or separate facility). To measure program type, I generated two binary indicators. The first is a measure of whether a child was enrolled in one or more of eleven special education programs[15], which have special requirements for student-teacher ratios and infrastructure and are typically sheltered or substantially separate environments. The second is an indicator of whether a child was receiving any services in a resource room, which is a separate "pull-out" classroom for students but not the student's primary educational setting. I also generated indicators for whether a child had an instructional aide, or received any of five related services (speech language pathology, social work, psychology, occupational therapy, or physical therapy) in their first placement year. Finally, I constructed a binary indicator of special education exit set to one to if a student had an IEP in a given year and no longer had an IEP in subsequent years, conditional on still being enrolled in a Michigan public school.

Dependent variables

Age tercile. To measure a student's age in grade in the school year they were placed in special education, I generated three binary indicators of whether a student was amongst the youngest student in their grade, around average age for their grade, or amongst the oldest in their grade. To do so, I sorted students by their age on September 1st of each school year within a given school and grade, and then split the distribution into terciles within each school*grade*year block. Importantly, I calculated these measures using the full population of students in Michigan (post kindergarten entrants, general education students etc.), not just the

[15] The 12 programs are three for mild, moderate, or severe cognitive impairment; emotional impairment, learning impairment, hearing or visual impairment, physical impairment, severe multiple impairment, early childhood developmental delay, severe speech impairment, or autism spectrum disorder.

study sample. This approach allowed me to measure a students' age in grade relative to all of their peers in the year and school in which they were placed in special education. For all students, I calculated their age tercile in grade for the year they were first placed in special education, regardless of whether they were retained in grade. For example, if student was retained in kindergarten and placed in special education in their second kindergarten year, their age tercile indicator was based on their age in grade in their second kindergarten year.

Covariates. To describe the differences between students who are placed in special education at different ages and in different grades, I used mutually exclusive binary indicators of gender, race and ethnicity (Asian, Black, Hispanic, White, and Other), and socioeconomic status as measured by eligibility for free or reduced price lunch. The race and ethnicity categories were defined by the Michigan Education Data Center. I also included a binary measure of receipt of early intervention services through Early On (Michigan's early intervention program). This measure can be considered an indicator of whether a student was ever evaluated for a delay or received early intervention services but did not have an IEP or IFSP prior to starting elementary school. Finally, I generated binary measures of a student's birth cohort and the school in which a student was enrolled in the year they were placed in special education. These covariates are included in the primary specification for estimating the differences in characteristics between age groups.

Enrollment measures. I also include a number of enrollment-related measures to describe the parental choices and enrollment decisions described in the context section. First, I include two measures that flag planned two-year kindergarten sequences. The first is a measure taken from the administrative data that indicates whether a student participated in a developmental kindergarten (DK) program. However, the state did not require that students

participating in DK be reported as such during the study period. This administrative flag is therefore likely to be an undercount of the full population of students enrolled in a two-year kindergarten sequence. Therefore, I also include a flag for "programmatic retention" that likely includes both unreported developmental kindergarten students and students placed in an two-year Early Childhood Developmental Delay (ECDD) classrooms. To create this measure, I identified students who were retained in kindergarten in a school and year with at least 16 kindergarten retentions (i.e., one full kindergarten classroom) as likely programmatic retentions. Finally, I included a binary indicator for "redshirting" to identify students who enrolled in kindergarten the year after they were eligible, and a binary measure of ever being retained in grade for students set to 1 if a child was retained in grade at any point in elementary school as measured by enrolling the same grade two years in a row.

Data analytic strategy

To answer the first research question — how do students who are placed in special education in each elementary school grade at different relative ages differ on observable characteristics? — I estimated a within-school and within-cohort difference in the mean observable demographic and enrollment characteristics of special education students who are in the bottom, middle, and upper tercile of their grade in the year they are first placed in special education. I fit equation 1 separately for each placement grade where *Y* is the demographic or enrollment characteristic of interest for child *i* in cohort *c* in school *s*, *middle* is a binary indicator for whether child *i* is in the middle tercile of the age distribution of their peers in their grade in cohort *c* in school *s*, *upper* is a binary indicator for being in the upper tercile, γ is a set of cohort fixed effects, σ is a set of school fixed effects, and ε_{ics} is the student-level error term.

$$Y_{ics} = \beta_{ics} + \alpha(middle)_{ics} + \alpha(upper)_{ics} + \gamma_c + \sigma_s + \varepsilon_{ics} \quad (1)$$

To answer the second and third research questions —how do students placed in special education who are young, average age, or old-for-grade cohort differ in special education placements in kindergarten through fifth grade — I estimated the differences in the special education disability, setting, and service types of students in the year they are placed in special education by age group. Equation 2 is my primary estimation approach, where all terms are the same as equation 1 with the exception that *Y* is now the special education outcome of interest for child *i* in cohort *c* in school *s,* and X` is a vector of time-invariant or pre-treatment student characteristics[16] for student *i* in cohort *c.*

$$Y_{ics} = \beta_{ics} + \alpha(middle)_{ics} + \alpha(upper)_{ics} + X'_{ic} + \gamma_c + \sigma_s + \varepsilon_{ics} \quad (2)$$

The inclusion of school and year fixed effects allows for a within school-year comparison of special education outcomes for students who are different ages. This will account for any fixed differences in approaches to special education placement and service provision across schools and fixed differences across birth cohorts. Inclusion of student-level covariates adjusts for variation in special education placements associated with observable demographic characteristics. For all outcomes, I also fit specifications without cohort year fixed effects, without school fixed effects, and without covariates as a sensitivity checks and find that the results are not sensitive to the inclusion or exclusion of these parameters (results available upon request).

Results

Demographic variation by age in placement grade (RQ1)

Within placement grade, I find that the oldest students are somewhat more likely to qualify for free and reduced price lunch than younger and average age students (1-3pp, $p<0.001$),

[16] Female, White, Black, Hispanic, Asian, receiving free/reduced price lunch, evaluated for early (B-3) intervention

but are similar by race and ethnicity. In contrast, I find that girls make up a higher share of the younger students across all placement grades, with differences between the youngest and oldest students ranging from 4 percentage points in kindergarten to 10 percentage points in the later grades (Table 1). I also find differences across grade of placement. First, the share of students in each age tercile changes. Among kindergarten placements (nearly 50% of all elementary school placements), 36% of students are in the lowest age tercile of their grade. However, by 4th and 5th grade around 25% of placements are in the lowest tercile and nearly 50% of placements are students in the upper age tercile. This shift appears to be driven by high rates of grade repetition (~40%) and delayed entry (8-25%) among those placed after kindergarten. I also find that White students and boys make up a larger share of those placed in kindergarten and first grade, and that Black, low-income, and female students make up a larger share of placements in the later grades (Appendix B., Table B.3).

Age in grade and special education experiences.

Kindergarten placements (RQ2). For students who are first identified for special education in kindergarten, I find that the youngest and average age students have more similar special education placements, whereas the oldest students are more likely to be placed with more intensive services and for more severe disabilities. The percent of younger and average age students found eligible for each disability is relatively similar, though younger students are slightly more likely to have a speech or language impairment (SLI) (+2.0pp)[17] (Figure 1, Panel 1). The oldest students are less likely to be placed for an SLI (-16.0pp) and conversely more likely to be placed for more severe disabilities like Autism Spectrum Disorder (+4.4pp),

[17] All reported differences are statistically significant at the $p<0.001$ level and in relation to the lower tercile mean unless stated otherwise

intellectual disability (+4.2pp), or developmental delay[18] (+3.3pp). The oldest students are the most likely to have been prescribed instructional aides (+2.1pp) and most related services (3.0pp - 8.2pp) (Figure 2, Panel 1). Finally, the oldest students are the least likely to exit from special education (38% of the oldest vs 48-50% of young and average age students) both overall and within each disability category (Figure 3, Panel 1). In contrast, I find that although the oldest students are *more likely* to receive their services in restrictive environments (<40% in general education) (+5.3pp) and resource rooms (+10.6pp) they are 7 percentage points *less likely* to receive services in the most restrictive environment (i.e., a separate classroom) (Figure 4, Panel 1). As discussed below, this seemingly contradictory pattern is likely contextually specific to Michigan.

To account for the high share (18%) of old-for-grade students who selected into delaying school entry, I also conducted these analyses excluding students who redshirted. Although I find much smaller differences between the oldest students and their younger and average peers in disability classification (Figure 1, Panel 2), service prescription (Figure 2, Panel 2), educational setting (Figure 3, Panel 2), and likelihood of special education exit (Figure 4, Panel 2), the pattern of younger students receiving fewer services for less severe disabilities holds. Nonetheless, the different results when excluding students who are older than expected for grade suggests that much of the age differences are driven by students who are old-for-grade because they selected into delaying entry.

To explore this further, I compared the demographic characteristics and special education placements of old-for-grade students who redshirted and old-for-grade students who were on time enrollees (Table 2). I find that the redshirted students were less likely to be White (-2.12pp)

[18] Developmental Delay is a relatively less common disability category in Michigan compared with other states, and is typically given to students with more severe developmental delays

and more likely to be poor (+9.26pp). These patterns diverge from prior findings that among all students (those with and without disabilities), White and higher-income students are more likely to have been redshirted (Bassok & Reardon, 2013).

Most importantly, 98% of redshirting students had engaged with state's early intervention service program prior to being placed in special education in kindergarten (+76pp). This supports the hypotheses from prior literature that students may delay school entry because of a concerns about developmental delay. The redshirted students are much less likely to have been placed for a speech/language impairment (-19.10pp) and more likely to have been placed for developmental delay (8.35pp), Autism (6.72pp), intellectual impairments (2.54pp) or other health impairments (2.87pp) (Table 3). Redshirted students are also less likely to be in both general education (-6.6pp) and separate placements (-4.2pp), but more likely to have resource room services (14.9pp) and other restrictive environment placements[19] (11.8pp). Finally, the redshirted students are the least likely to exit from special education (31%).

Placement in first through fifth grade. Finally, I compared students by age tercile in their placement year who were placed in 1st through 5th grade (RQ 3). I find that the youngest students who are placed in special education in first through grade are less likely to be placed for specific learning disabilities (+2.2-8.9pp) and more likely to be placed for speech or language impairments (+5.5 – 14.0pp) or emotional impairments (+1.1- 2.6pp) compared with the oldest students (Table 4, Columns A-C). As described above (Table 1) nearly 70% of students in the oldest age tercile in placements grades 1-5 are older than expected for grade which may be driving these differences. However, when I restrict the comparison to those students who are the expected age in grade (Table 4, Columns D-F), I find that the youngest students are still the most

[19] <40% in general education, 40-79% in general education, classroom program

likely to be placed for speech language impairments whereas the oldest students are more likely to be placed for specific learning disabilities. The oldest students are also less likely to receive services in inclusive settings, particularly those students placed in second and third grade, and more likely to receive services in a resource room.

Discussion

Across the country, students who are eligible to start kindergarten at relatively younger ages are more likely to be placed in special education, including in Michigan (Dhuey et al., 2019; Dhuey & Lipscomb, 2010; Chapter 1). Students who are older than expected for grade, either through delaying school entry or grade repetition, are also more likely to be receiving special educations services (Beebe-Frankenberger et al., 2004; Elder & Lubotsky, 2006; Fortner & Jenkins, 2017; Graue & DiPerna, 2000; Huang, 2015; Silverstein et al., 2009). In the present study, I add to the literature by describing how although young-for-grade students and students who are older than expected for grade both experience high rates of special education identification, the placements themselves differ substantially. I find that the students who are placed in special education in the youngest third of their schools' age distribution are more likely to have speech/language impairment classifications and to exit from special education services. In contrast, the students who are in the upper third of the age distribution in their grade have more severe disability classifications and more intensive special education service experiences, particularly those who are older than expected for grade because of delaying school entry or grade repetition.

These patterns support two hypotheses raised in the literature for why students of different ages may be more likely to be placed in special education at kindergarten entry, both of which have implications for how policies are designed to improve special education allocation.

First, many have hypothesized that the higher rates of placement for the youngest students in kindergarten occurs through the placement of students who are more likely to be on the margin of needing services (Dhuey et al., 2019; Dhuey & Lipscomb, 2010; Elder, 2010). My findings that a higher share of students who are young-for-grade are placed for milder disability classifications, and that these students are more likely to exit from special education lend support to this hypothesis. Importantly, the differences between the youngest students and average age students are small in magnitude, suggesting that special education profiles of these younger students are not substantially different from their average age peers.

These findings also suggest that older students who have more mild developmental delays may be overlooked for special education placement in the early grades. Even when students who are old-for-grade due to redshirting or grade retention are excluded, the oldest students are more likely to have severe disability classifications and less likely to exit from special education. Given these descriptive patterns, policy solutions to address disparities in the likelihood of special education placement by school starting age should focus not only on identifying sources of misidentification for the youngest students, but also on tools that may help teachers identify older students with more mild delays in the early grades who could benefit from special education supports.

Second, in the literature on delaying school entry, many have interpreted the high rates of special education placement for redshirted students as indicating that concerns about development drive some parents to delay their child's school enrollment. I find that nearly all of the students who redshirted had engaged with the early intervention program in Michigan prior to being placed in special education in kindergarten, and that these students were the most likely to have severe disability classifications and intensive placements. This suggests that these

redshirting students are not just perceived to have a developmental delay by parents, but have been evaluated for and received early intervention prior to formally receiving special education services, supporting this interpretation as well.

These findings also have implications for both early intervention policy and elementary school service provision. These patterns suggest that parents of children with developmental differences that are identified in the birth to five period may be being counseled by schools to delay school entry in Michigan. Given the lack of evidence that delaying school entry confers any educational or developmental benefit for typically developing students (Black, Devereux, & Salvanes, 2011; Deming & Dynarski, 2008), the effects of this redshirting behavior among children with disabilities should be evaluated. If policies promoting delayed school entry for children with disabilities are common at district levels and these policies do not benefit students, these local approaches may need to be revisited.

I also find a strong relationship between special education placement and grade retention in Michigan than has been found in other settings (Beebe-Frankenberger et al., 2004; Silverstein et al., 2009). Approximately 40% of all students placed in special education in elementary school in Michigan repeat a grade either through a two-year kindergarten sequence or grade retention. As a result, nearly 50% of all students placed in special education in first through fifth grade are in the oldest third of their grade age distribution. These students have the most intensive placements and are the most likely to be placed for a specific learning disability in the later grades, particularly those who are older than expected for grade. Further evidence of the effect of grade retention on student outcomes like learning disability diagnosis, and the effect of being placed in special education on future grade retention, is needed, particularly with the passage of the third grade retention law in Michigan that requires students who do not pass the third grade

reading assessment to be retained in grade (MCL 380.1280f). At the policy-level, more research into the local policies around grade retention for students with disabilities is needed to inform why students with disabilities are not progressing through elementary school at the same pace as their typically developing peers.

The findings also raise several questions about the educational settings of young children with disabilities in Michigan. Between 18-23% of kindergarten students with IEPs in Michigan are placed in sheltered classrooms, particularly the youngest (20%) and oldest (23%) students. Without knowing more about the differences between the sheltered classrooms for kindergarten students and the general education classrooms, it is difficult to hypothesize how these environments might differentially impact children with disabilities. However, there is a growing body of evidence that special education in inclusive environments benefits students with disabilities, including in the early years (Hanushek, Kain, & Rivkin, 2002; Hehir, 2012; Horn, Palmer, Butera, & Lieber, 2016; Kim, King, & Jennings, 2019; Rafferty, Piscitelli, & Boettcher, 2003; Weiland, 2016). Given these high rates of sheltered classroom placement for kindergarteners, more research is needed to understand how special education setting impacts the educational outcomes of young children with disabilities and how age in grade may impact the likelihood a child has access to inclusive settings. Policies designed to ensure that the youngest students in a grade are not over-placed in restrictive environments may also be needed, particularly if districts are unintentionally doing so.

The present study is limited in a number of ways. Although I am able to include all students who enrolled in Michigan public schools for kindergarten, the sample of first time placements for first through fifth grade is limited to students who also enrolled in a public school in kindergarten. Therefore, I am excluding students who are also first time placements in the

post-kindergarten elementary years but for whom I cannot observe their first year of placement. This study sample, as a result, may not be representative of the full population of Michigan students in elementary school receiving services. Second, without measures of cognitive, behavioral, or physical development at kindergarten entry, I cannot assess how the youngest, average age, and oldest students compare to their same age peers who are not placed in special education. These measures would allow not only for a comparison within the special education population, but also within age groupings across general and special education placements. Finally, these patterns may not generalize to other states outside of Michigan with different approaches to special education placement.

The present study findings underscore the challenge of interpreting special education placements rate for students by revealing how high rates of placement by age are likely driven by very different mechanisms on each end of the distribution. In light of the evidence that special education placement benefits students, particularly those on the margin of qualifying for services, (Ballis & Heath, 2019; Hanushek et al., 2002) and the push for early intervention services to mitigate the effects of long-term undiagnosed delays (Guaralnick, 1998; Odom et al., 2004), future studies that can disentangle the effects of age on the likelihood of placement from the effects of the special education services themselves are needed.

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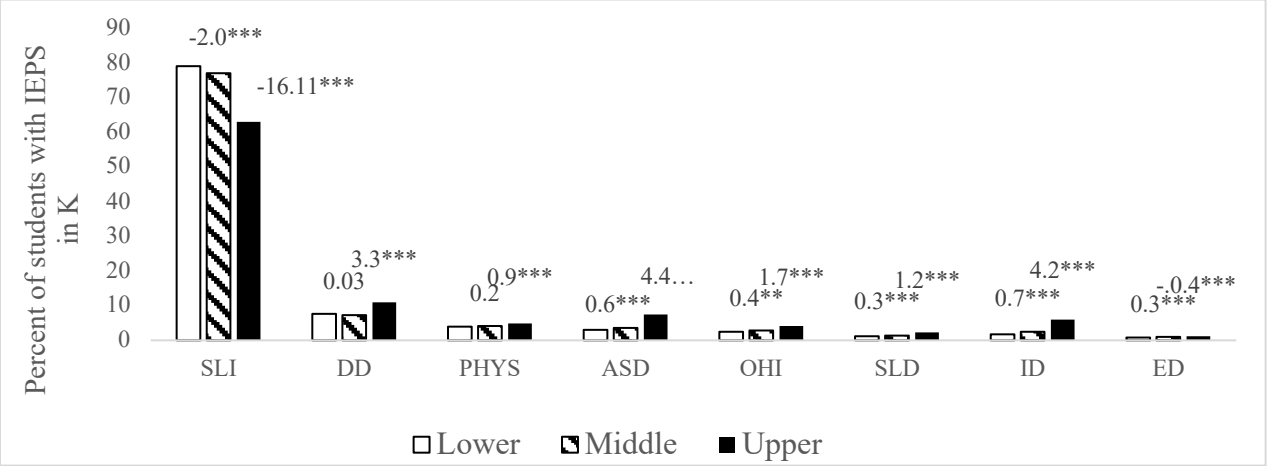
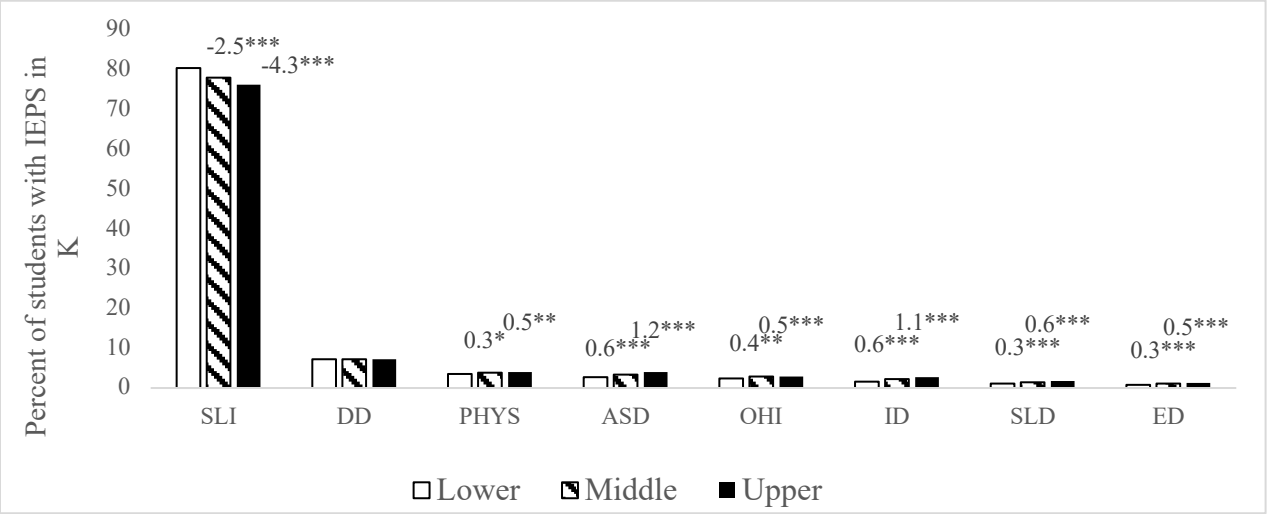
Tables & Figures

Figure 2.1: Likelihood of disability classification by age tercile for students placed in special education in kindergarten

All Students



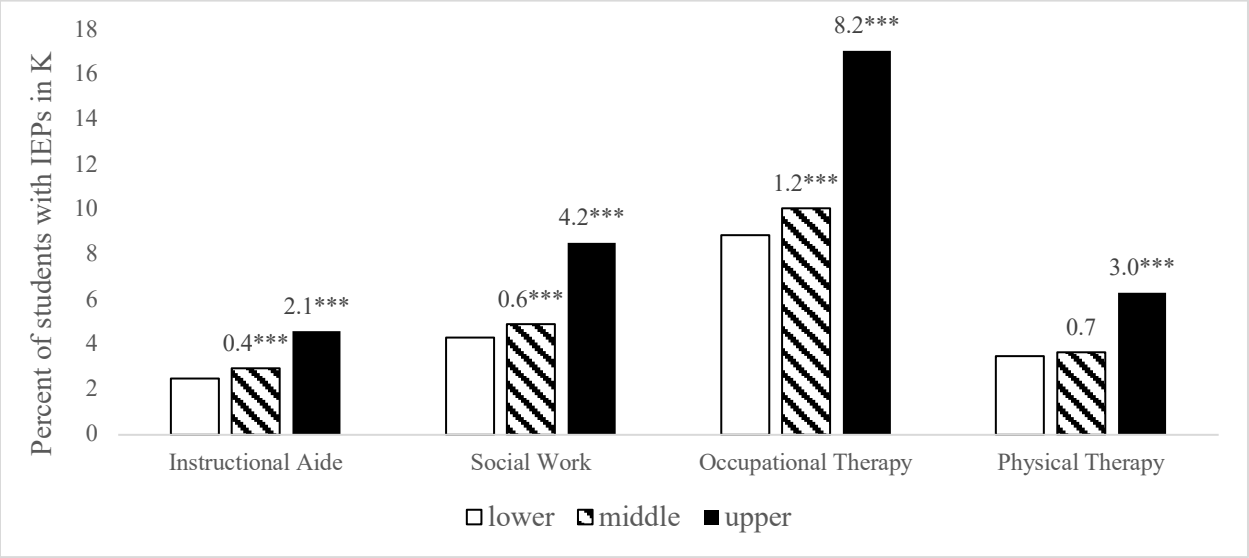
On-Time Only



Note: * p<0.05, **p<0.01, ***p<0.001. Lower tercile group means are unconditional. The differences between the lower tercile group mean and the middle and upper group means were estimated using a linear regression with cohort and kindergarten school fixed effects and student-level covariates. Middle and upper tercile group means were then calculated by subtracting the adjusted difference from the unconditional lower tercile group mean. SLI: Speech or language impairment, DD: developmental delay, PHYS: physical impairment, ASD: Autism Spectrum Disorder, OHI: Other health impairment, SLD: specific learning disability, ID: intellectual disability, ED: Emotional impairment

Figure 2.2: Differences in the likelihood of receiving specific special education services by age-in-grade for students placed in special education in kindergarten

All students



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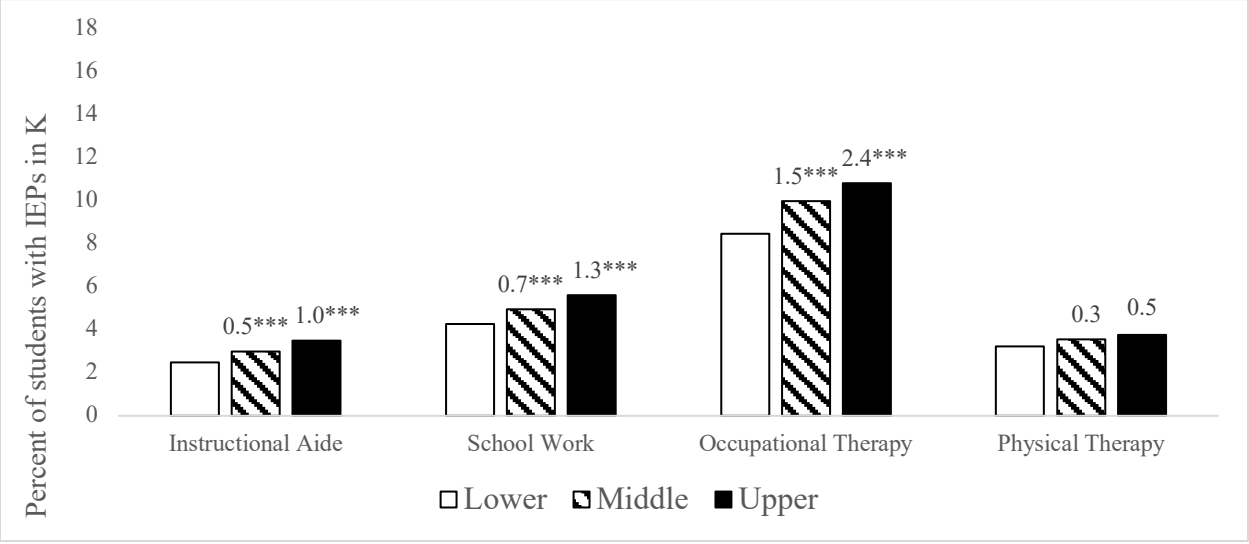
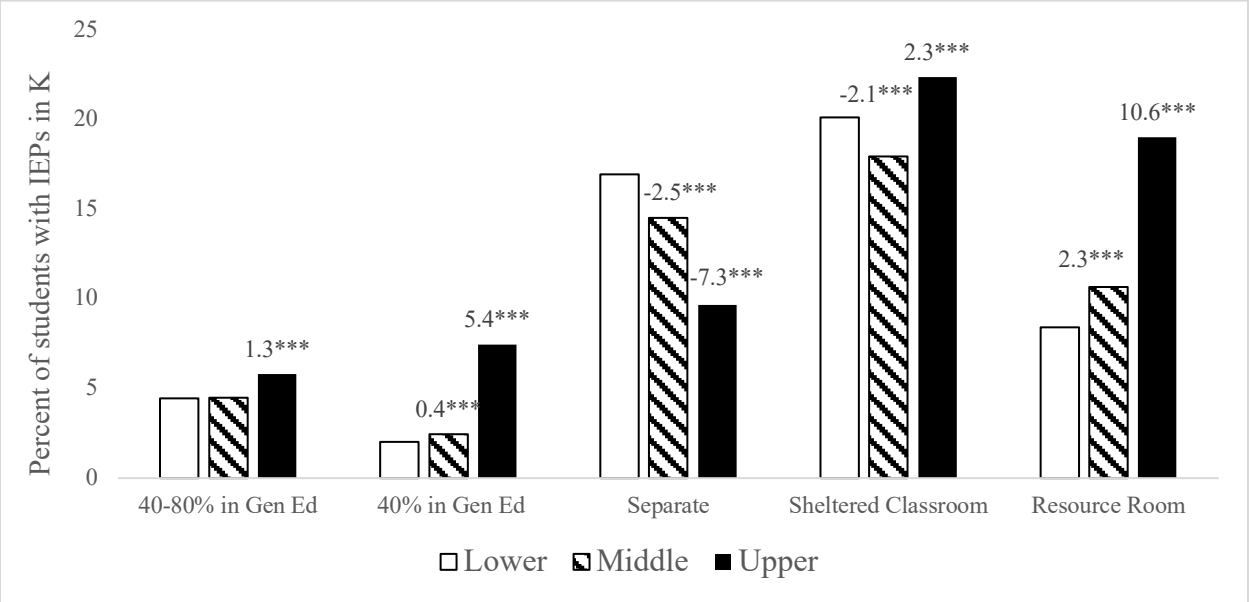


Note: * p<0.05, **p<0.01, ***p<0.001. Lower tercile group means are unconditional. The differences between the lower tercile group mean and the middle and upper group means were estimated using a linear regression with cohort and kindergarten school fixed effects and student-level covariates. Middle and upper tercile group means were then calculated by subtracting the adjusted difference from the unconditional lower tercile group mean.

Figure 2.3: Likelihood of receiving specific special education services in more restrictive educational environments for students placed in special education in kindergarten

All students



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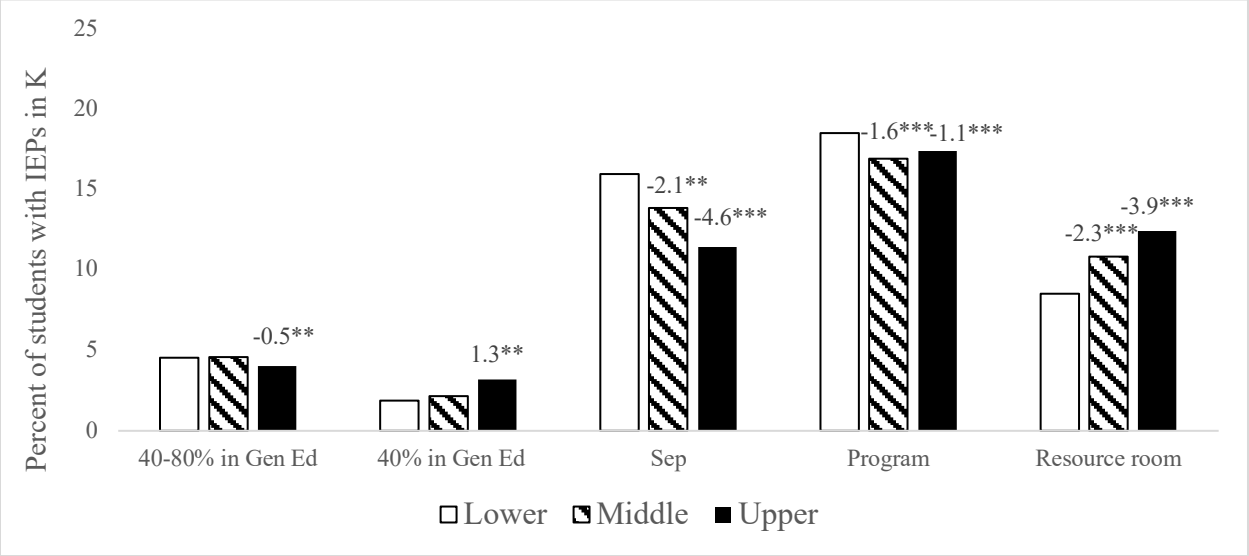
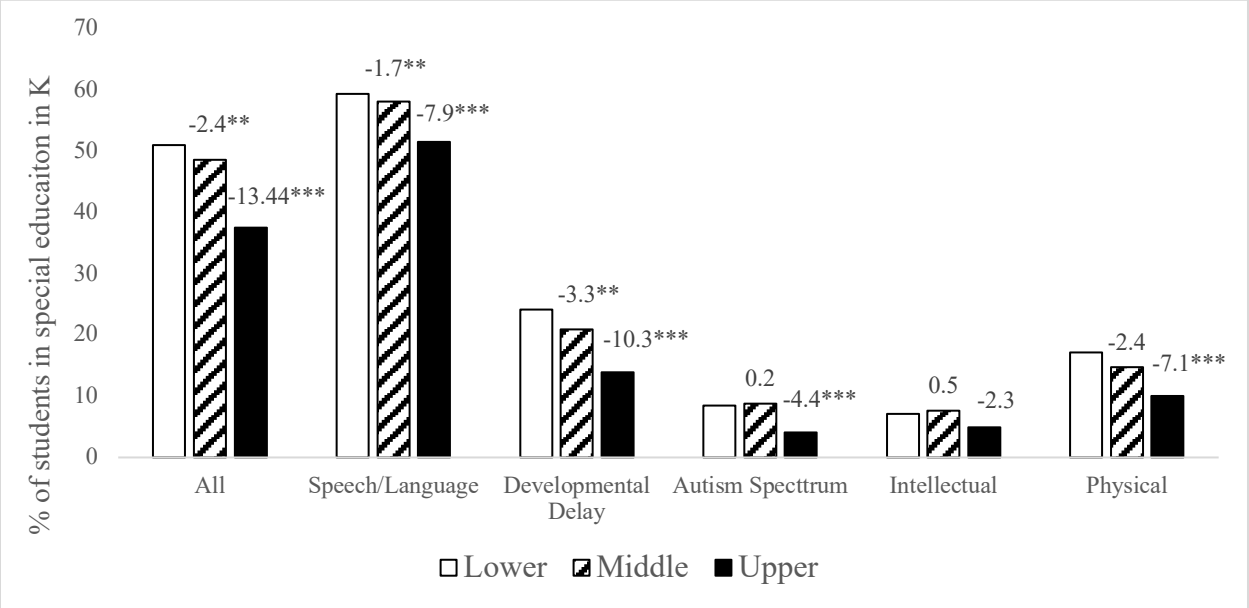


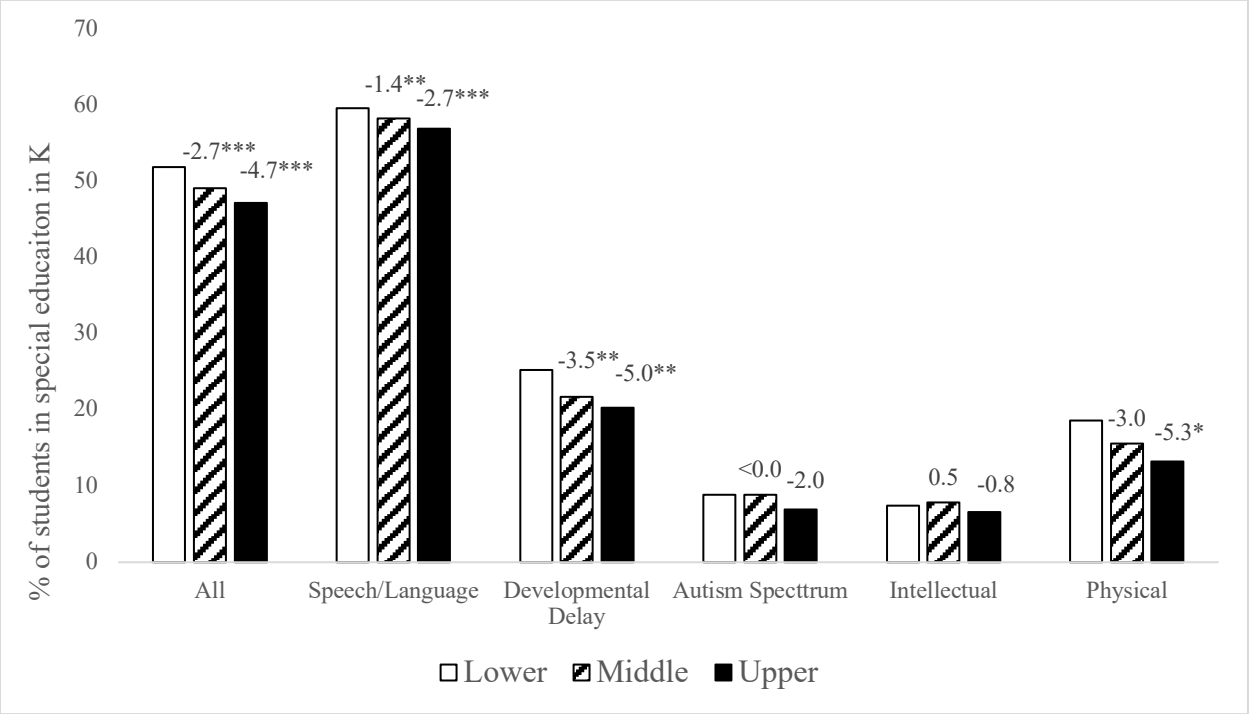
Note: * p<0.05, **p<0.01, ***p<0.001. Lower tercile group means are unconditional. The differences between the lower tercile group mean and the middle and upper group means were estimated using a linear regression with cohort and kindergarten school fixed effects and student-level covariates. Middle and upper tercile group means were then calculated by subtracting the adjusted difference from the unconditional lower tercile group mean.

Figure 2.4: Likelihood of exiting from special education services in elementary school for students placed in special education in kindergarten

All Students



Ontime



Note: * p<0.05, **p<0.01, ***p<0.001. Lower tercile group means are unconditional. The differences between the lower tercile group mean and the middle and upper group means were estimated using a linear regression with cohort and kindergarten school fixed effects and student-level covariates. Middle and upper tercile group means were then calculated by subtracting the adjusted difference from the unconditional lower tercile group mean**.**

Table 2.1: Demographic characteristics of students receiving special education services for the first time in first through fifth grade by grade cohort age tercile

	Female	White	Black	Hispanic	Asian	Poor	EarlyOn	Dev K	2yr K	Redshirt	Retained
Kindergarten (*n*=107,711)											
Lower (36%)	33.70	70.98	19.56	6.12	1.83	48.28	19.26	6.41	21.64	0.54	48.84
Middle (34%)	**31.51**	**72.52**	**18.7**	5.81	1.55	48.03	**21.61**	**3.5**	**11.41**	0.75	**28.83**
Upper (30%)	**29.54**	71.74	19.22	5.91	1.84	**51.19**	**30.59**	**2.33**	**6.47**	**17.98**	**17.18**
First grade (*n*=39,327)											
Lower (26%)	36.71	66.19	24.47	6.37	1.61	50.56	12.23	1.60	1.09	0.50	24.47
Middle (29%)	**33.36**	67.78	23.46	6.20	**1.06**	49.49	12.65	1.81	**2.39**	**1.91**	**18.39**
Upper (45%)	**29.56**	**68.67**	**21.90**	6.31	1.57	51.03	10.97	**6.29**	**26.76**	**25.24**	**47.91**
Second grade (*n*=34,119)											
Lower (28%)	40.91	66.88	23.88	6.16	1.49	48.82	12.43	1.13	1.10	0.26	12.89
Middle (31%)	**36.76**	**68.76**	22.64	5.86	1.33	**47.90**	12.45	1.77	**2.89**	0.96	12.26
Upper (41%)	**31.75**	67.85	22.64	6.85	1.15	**52.20**	11.30	**6.61**	**23.92**	**12.49**	**60.71**
Third grade (n= 31,206)											
Lower (25%)	44.82	66.86	24.45	5.94	1.48	48.52	11.98	1.20	0.88	0.30	8.43
Middle (28%)	**40.03**	66.79	24.17	5.88	1.65	47.53	12.77	1.69	**3.60**	1.31	**11.28**
Upper (45%)	**34.92**	67.27	23.05	7.00	1.30	**51.45**	10.76	**6.92**	**24.06**	**11.23**	**66.12**
Fourth grade (*n*= 21,978)											
Lower (24%)	46.70	61.82	28.19	6.86	1.67	51.82	12.92	0.79	0.94	0.44	8.19
Middle (26%)	**42.57**	64.07	26.65	6.54	1.37	53.23	13.01	1.85	**4.33**	1.41	**12.39**
Upper (48%)	**38.06**	**64.22**	**25.75**	7.69	1.06	**55.18**	11.57	**6.40**	**23.07**	**10.44**	**69.18**
Fifth grade (n= 14,055)											
Lower (24%)	48.55	61.09	29.35	6.92	1.48	56.80	14.09	1.02	1.11	0.35	6.86
Middle (26%)	**41.93**	62.37	28.39	6.75	1.11	55.49	14.46	1.84	**4.04**	1.12	**11.45**
Upper (47%)	**40.05**	60.92	28.80	8.01	1.03	59.29	13.67	**5.42**	**20.43**	**8.18**	**68.76**

Note: Lower tercile group means are unconditional. The differences between the lower tercile group mean and the middle and upper group means were estimated using a linear regression with cohort and kindergarten school fixed effects. Middle and upper tercile group means were then calculated by subtracting the adjusted difference from the unconditional lower tercile group mean. Bolded figures indicate differences between value and lower group mean that are statistically significant at the $p<0.001$ level. EarlyOn= B-3 developmental screening/intervention, Dev K= Developmental kindergarten, 2yr K= All two-year kindergarten programs.

Table 2.2. Demographic characteristics of Ontime and Redshirted students who were old for grade when placed in special education in K

	Ontime	Redshirt	Difference
Female	30.80	29.13	-1.67*
White	68.36	66.24	-2.12***
Black	22.63	22.93	0.30
Hispanic	6.01	7.33	1.32***
Asian	1.86	2.68	0.82***
Poor	50.21	59.46	9.26***
Early On	21.72	97.66	75.95***
	18,242	5,846	

Note: * p<0.05, **p<0.01, ***p<0.001. Ontime means are unconditional. The differences between on time and redshirted students were estimated using a linear regression with cohort and kindergarten school fixed effects and student-level covariates. Early On denotes students who received early intervention services but did not have an ECSE IEP

Table 2.3. Special education placements of on-time and redshirted students who were old for grade when placed in special education in K

	Ontime	Redshirt	Difference
Disability			
Intellectual Disability	2.62	5.16	2.54***
Speech/Language	76.20	57.10	-19.10***
Other Health	2.91	5.78	2.87***
Learning Disability	1.72	0.41	-1.31***
Developmental Delay	7.31	15.67	8.35***
Autism	4.01	10.74	6.72***
Emotional Impairment	1.29	0.93	-0.36***
Physical Impairment	3.94	4.08	0.15***
Exit	46.86	31.02	-15.85***
Exit & Reenter	6.68	4.00	-2.67***
Setting			
Classroom program	17.00	21.00	3.99***
Resource room	12.60	27.48	14.88***
General Ed	77.63	70.99	-6.64***
Separate	11.57	7.38	-4.19***
<40% in gen ed	3.82	6.90	3.08***
40-79% in gen ed	3.21	13.01	9.80***
Services			
Instructional Aide	3.67	2.75	-0.91*
Speech/Language	94.20	92.58	-1.62**
Social Work	5.99	5.59	-0.40
Psychology	--	--	--
Occupational Therapy	10.49	3.50	-6.98***
Physical Therapy	3.60	1.83	-1.77***
N	18,242	5,846	

Note: * p<0.05, **p<0.01, ***p<0.001. Ontime means are unconditional. The differences between on time and redshirted students were estimated using a linear regression with cohort and kindergarten school fixed effects and student-level covariates.

Table 2.4: Differences in the share of students classified with each primary disability by age tercile in placement grade for all students and just expected age in grade students

	All Students			Expected Age		
	Lower	Middle	Upper	Lower	Middle	Upper
Speech/language Disability						
First	70.26	**63.85**	**62.40**	71.13	**64.93**	**62.24**
Second	48.36	**43.49**	**38.82**	49.42	**44.88**	**44.19**
Third	41.63	**36.18**	**27.59**	42.72	**37.50**	**35.97**
Fourth	29.16	**25.95**	**21.01**	30.18	**26.41**	**24.94**
Fifth	17.22	15.96	**12.75**	17.60	15.85	15.82
Other Health Impairment						
First	5.74	5.73	6.06	5.80	5.36	5.33
Second	8.63	8.44	8.59	8.31	8.28	7.66
Third	10.71	9.50	8.72	10.58	**9.48**	**8.17**
Fourth	14.20	13.62	**11.55**	13.92	13.39	11.92
Fifth	18.24	18.75	**15.95**	18.57	19.39	16.62
Specific Learning Disability						
First	11.76	**18.11**	**14.22**	10.97	**17.64**	**19.79**
Second	32.97	**37.99**	**39.44**	32.62	**37.82**	**38.93**
Third	37.65	**44.67**	**53.60**	37.15	**43.78**	**46.60**
Fourth	44.81	**48.78**	**57.16**	44.69	**49.03**	**51.31**
Fifth	50.37	51.64	**59.23**	50.02	51.20	**56.19**
Emotional Disturbance						
First	4.72	4.44	**3.59**	5.01	4.44	4.42
Second	5.61	5.39	**4.79**	5.48	5.05	4.63
Third	6.16	**5.07**	**4.41**	6.05	**4.93**	5.03
Fourth	7.55	6.87	**4.93**	7.27	6.93	6.44
Fifth	9.25	9.35	**6.63**	9.11	9.17	**6.50**

Note: Across all placement grades and age terciles, fewer than 1% of newly placed students were placed for physical impairments and fewer than 2% for Autism Spectrum Disorders and Intellectual disabilities respectively. Bolded figures indicate a statistically significant differences at the $p<0.001$ level between the figure and its respective lower age tercile comparison group.

Appendix B

Table B.1: Difference in baseline characteristics between the total population of students receiving special education in 1st-5th grade and those who are in the study sample

	1st	2nd	3rd	4th	5th
Female	0.57	1.01*	1.04**	1.56***	1.78***
Race					
White	4.82***	4.11***	3.46***	2.65***	2.21***
Black	-3.08***	-1.94***	-0.63	0.64*	1.23***
Hispanic	-0.62*	-0.75**	-1.31***	-1.57***	-1.78***
Asian American	-1.00***	-1.34***	-1.39***	-1.34***	-1.38***
Poor	4.95***	5.73***	5.59***	5.26***	5.56***
% in study sample	93.72	92.3	90.95	89.46	88.64

Note: * $p<0.05$, ** $p<0.01$, *** $p<0.001$. Differences are unadjusted.

Table B.2: Difference in baseline characteristics between the full study sample and students who attrit from the study sample at each grade point

	1st	2nd	3rd	4th	5th
Female	-0.99	-1.32**	-1.49***	-1.24**	-1.13**
Race					
White	-2.44***	-2.63***	-2.61***	-2.64***	-2.98***
Black	-0.89	-0.76	-1.01**	-0.95**	-0.61*
Hispanic	1.91***	2.20***	2.33***	2.28***	2.38***
Asian American	1.22***	1.19***	1.29***	1.30***	1.26***
Poor	-7.71***	-5.87***	-4.96***	-4.59***	-2.62***
% in study sample	1.85	3.44	4.71	5.79	7.3

Note: * $p<0.05$, ** $p<0.01$, *** $p<0.001$. Differences are unadjusted.

Table B.3: Demographic characteristics of students receiving special education services for the first time in kindergarten through 5th grade

	K	1st	2nd	3rd	4th	5th
Age at Entry	5.37	5.42	5.34	5.31	5.30	5.29
Female	31.75	32.72	35.67	38.75	41.06	42.82
Race						
White	71.83	70.80	68.88	67.18	63.03	60.98
Black	18.77	19.96	21.88	23.32	26.92	28.87
Hispanic	6.22	6.27	6.37	6.68	7.34	7.65
Asian	1.79	1.49	1.31	1.35	1.23	1.22
Poor	49.29	48.46	50.11	51.27	55.11	58.16
Enrollment						
Early On	23.80	10.60	11.65	11.74	12.42	13.60
Developmental K	4.08	3.13	3.58	3.83	3.72	3.39
All 2-year K	12.82	10.64	10.90	12.51	12.78	11.89
Redshirt	5.90	19.59	8.61	8.33	8.40	7.02
Ever Retained	31.74	29.49	32.99	36.94	40.89	40.68
N	107,711	39,327	34,119	31,206	21,978	14,055

Note: Group means are unconditional. Sample includes all students who enrolled in kindergarten in Michigan and had at IEP at any point through 5th grade. First time special education placement is measured in the first grade in which a student has an IEP in a Michigan public school. Programmatic retention is a measure of kindergarten retention in a school and year with at least 16 retentions, suggesting participation in ECE special education program or unrecorded developmental kindergarten.

Table B.4. Differences in the educational settings of students by age tercile in placement grade for all students and just expected age in grade students

	All Students			Expected Age		
	Lower	Middle	Upper	Lower	Middle	Upper
Resource Room						
First	24.46	**30.17**	**32.30**	23.78	**29.79**	**30.31**
Second	43.84	**49.04**	**55.52**	42.95	**48.12**	**48.53**
Third	50.84	**56.71**	**66.91**	50.33	**55.62**	**57.34**
Fourth	62.89	**65.98**	**74.03**	62.85	**66.03**	**67.94**
Fifth	71.86	72.96	**80.67**	72.25	72.15	75.08
General Education						
First	91.41	**90.29**	**86.85**	91.82	91.02	**90.07**
Second	88.82	**87.04**	**79.23**	89.34	**88.11**	**86.78**
Third	87.31	**84.92**	**78.42**	88.31	**86.20**	**85.32**
Fourth	85.83	84.59	**80.56**	87.34	86.08	**84.68**
Fifth	85.71	85.70	**81.31**	86.82	86.83	87.38
40-79% in general education						
First	4.55	**5.78**	**7.14**	4.37	**5.60**	**5.95**
Second	7.67	**9.12**	**14.98**	7.35	**8.42**	**9.47**
Third	9.22	**11.40**	**17.06**	8.67	**10.75**	**11.69**
Fourth	10.54	**12.08**	**15.73**	10.01	**11.41**	**12.80**
Fifth	10.04	11.33	**15.84**	9.73	10.92	10.99
<40% in general education						
First	2.90	3.18	**5.25**	2.80	2.85	**3.50**
Second	2.77	3.01	**5.13**	2.65	2.72	2.93
Third	2.80	3.06	**4.04**	2.39	2.55	2.50
Fourth	2.38	2.23	2.91	1.70	1.63	1.92
Fifth	3.26	**1.87**	**2.13**	2.48	**1.33**	**0.90**

Note: Across all placement grades and age terciles, fewer than 1% of newly placed students were placed in separate environments that were not classroom programs. There were no difference in classroom program placements across age terciles, with roughly 8% of first grade students in a program decreasing to 4% of fifth grade students. Bolded figures indicate a statistically significant differences at the $p<0.001$ level between the figure and its respective lower age tercile comparison group.