A REAL CHOICE? EXAMINING THE EFFECTIVENESS OF CHARTER SCHOOL ALTERNATIVES TO TRADITIONAL PUBLIC SCHOOLS AMONG ECONOMICALLY DISADVANTAGED ELEMENTARY SCHOOL STUDENTS IN OHIO

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ABSTRACT

Since the creation of charter schools in the early 1990s, charter school attendance in the United States has been on the rise. Previous research examining charter school effectiveness tends to show that charter school attendance is positively associated with academic achievement. While previous studies have primarily been conducted at the student level, the present study uses school-level data from the state of Ohio to analyze the effectiveness of charter schools as an alternative to traditional public schools for economically disadvantaged elementary school students. Using data from the most recent academic year, 2015–2016, I find that charter school attendance among low-income students is unrelated to reading proficiency in the elementary grades, but is negatively associated with math proficiency in fourth and fifth grades. I further find that charter schools with larger populations of black students perform worse relative to traditional public schools than do charter schools with smaller populations of black students.

I would like to express my gratitude to Adam Thomas for his thoughtful guidance and support throughout this process, and to my mother, Diane Parham, for a lifetime of guidance and feedback on my writing.

Many thanks,
Katharine Parham

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INTRODUCTION

Over the past quarter century, the number of primary and secondary students attending educational institutions other than traditional public schools in the United States has gradually increased. In the 2013–14 academic year, public charter schools in the U.S. accounted for 6.6 percent of the approximately 98,000 public schools nationwide, enrolling more than 2.5 million students (Kena et al. 2016). The market for charter schools—publicly funded but privately run institutions—emerged in response to what school choice advocates believe is social inequality embedded in the traditional public school system (Duncan 2014). Since their inception in 1991, charter schools have provided alternatives to the traditional public schools to which students are "zoned" based on their home address, thereby expanding educational options for many students residing in poor communities who may otherwise attend underfunded or underperforming traditional public schools (Reardon 2016).

As the share of nontraditional public schools continues to grow in the 42 states (plus the District of Columbia) that allow charter schools, it is increasingly important that researchers assess their effectiveness at educating economically disadvantaged populations. This topic is even more salient given that, among students attending high-poverty schools in the U.S., more of them attend charter schools than traditional public schools (Kena et al. 2014, 2015, 2016).[1] Over the past two decades, researchers have assessed the effectiveness of charter schools by comparing them to traditional public school performance at the school level nationwide (Clark et al. 2011; CREDO 2009; CREDO 2013; Hoxby 2004; Berends 2006; Carnoy et al. 2005; Betts and Tang 2011; Gleason et al. 2010), by examining the

[1] "High-poverty" schools are defined by the U.S. Department of Education as schools in which at least 75 percent of students qualify for free or reduced-price lunch under the National School Lunch Program (U.S. Department of Education 2010).
[2] The "achievement gap" refers to observable disparities in educational outcomes for students from differing racial or socioeconomic backgrounds.
[3] "Economically disadvantaged" students are defined in this paper and by the Ohio Department of Education

academic outcomes of low-income and minority students enrolled at charter schools compared to similar peers at traditional public schools (CREDO 2009; CREDO 2013), and by assessing whether charters are effectively closing achievement gaps between students from differing racial or socioeconomic backgrounds (Hoxby 2009; Abdulkadiroglu et al. 2009).[2]

This paper compares charter schools to traditional public schools in terms of academic outcomes among economically disadvantaged elementary school (third through fifth grade) students in Ohio.[3] Elementary school is a critical time in students' educational careers. During these primary years, students are taught the foundational skills the rest of their education will rely upon. Research shows the most essential literacy skills for children should be learned by the third grade, and those children who have not mastered key concepts are more likely to fall behind and remain behind their peers for the remainder of their academic careers (Center for Public Education 2015). Attendance rates in fourth grade have been shown to be predictive of students' likelihood of dropping out of high school in later years (Roderick 1993). And, academic success in both reading and math in fifth grade is associated with success in future grades (Balfanz 2007). If charter schools are more effective than traditional public schools at generating proficient academic outcomes among elementary school students—particularly for students from low-income backgrounds—these schools could have a significant impact in terms of closing the achievement gap between low- and high-income students.

Ohio was one of the earliest states to allow for the creation of charter alternatives—beginning in 1997—and over the past 20 years, charter growth in Ohio has increased steadily

[2] The "achievement gap" refers to observable disparities in educational outcomes for students from differing racial or socioeconomic backgrounds.

[3] "Economically disadvantaged" students are defined in this paper and by the Ohio Department of Education according to federal guidelines as those who are eligible for free or reduced-price meals under the National School Lunch and Child Nutrition Programs. In 2015-2016, the income threshold was a family income less than or equal to 185% of federal income poverty guidelines (Federal Register 2016).

as a result of the state's charter school authorization policies (NASCA 2016).[4] At present, just over 10 percent of public schools in Ohio are charter schools, and two of the state's school districts—Dayton City School District and Cleveland Municipal School District—rank among the top ten districts nationwide in terms of the percentage of public school students enrolled in charter schools (NAPCS 2015). Using school-level data from the Ohio Department of Education, this paper examines the differences in academic outcomes in both reading and math among economically disadvantaged elementary school students attending charter schools and traditional public schools in Ohio during the 2015–16 academic year.

BACKGROUND

History of Charter Schools in the U.S.

Public charter schools are defined by the U.S Department of Education as publicly funded educational institutions run by "a group or organization under a legislative contract (or charter) with the state or jurisdiction" (U.S. Department of Education 2016). Charter contracts exempt charter schools from some state regulations traditionally governing public school operations, such as decisions about curriculum and school-day structure. Charter school advocates have argued that this autonomy presents an opportunity for innovation (Gross 2011). Rather than being held accountable to the standards of a local school district or school board, charter schools set their own standards for performance and evaluation—writing them into their charters—and are instead held accountable by the institution granting their authorization (these authorizing institutions vary state to state) (Boast et al. 2016). Similar to traditional public schools, charters receive state funding based on a per-pupil enrollment

[4] Minnesota was the first state to allow for the creation of charter schools, in 1991 (Gleason et al. 2010).

formula, though many rely heavily on external donations for additional support (Rebarber and Consoletti Zgainer 2014).

Since the first charter schools were created in Minnesota in 1991, charter laws have passed in 42 states and the District of Columbia (U.S. Department of Education 2016). The growth of charter schools has primarily taken place in urban school districts (U.S. Department of Education 2016). This expansion has been attributed to a desire to create market-style competition within U.S. public education by providing higher-quality school alternatives for students and families who would otherwise not have access to such schools (Reardon 2016; Lubienski 2003). In addition, compared to vouchers, charters have proven a welcome alternative among school choice proponents in many states, as charter schools ensure that public funds are used to keep students in public schools rather than paying for transitions to private institutions (Jones 2000).

Alternatives to traditional public schools are of particular interest to low-income families, as the standardized test scores of economically disadvantaged students have historically been much lower than the test scores of their higher-income peers (Reardon 2011; De Luca 2016). As recently as 2013, students eligible for free or reduced-price lunch scored 24 percentage points lower than their higher-income peers on the National Assessment of Educational Progress (NAEP) across charter and traditional schools (U.S. Department of Education 2013). Additionally, survey results indicate significant public support for charter schools. A nationwide survey conducted by the National Alliance for Public Charter Schools in April 2016 indicated that 88 percent of low-income parents would support a charter school opening in their community (NAPCS Press Release 2016).[5]

[5] According to the same survey, a slightly smaller proportion of all parents of school-age children—78 percent—would support the opening of a charter school in their neighborhood.

However, as researchers have investigated the role of charters in the education market over the past two decades, they have failed to reach a consensus regarding the effectiveness of charter schools (Zimmer et al. 2009; CREDO 2009). This disparity in the literature is likely attributable to the wide variation in state laws governing the operation of charter schools, as well as differences in methods used to measure their impacts (Zimmer et al. 2009; De Luca 2016; Nicotera et al. 2009).

Ohio Charter Schools

The foundation of charter schools in Ohio began with the passage of a 1997 law authorizing a pilot project in Lucas County to create two charter schools that were sponsored by the University of Toledo (Ohio Council of Community Schools 2016). The first two "community schools" opened officially in 1998 with bipartisan support.[6] As of the 2015–16 academic year, more than 300 charter schools were operating in Ohio, representing just over 10 percent of all the state's public schools (NASCA 2016). These schools enrolled more than 120,000 students, or around 7 percent of all public school students statewide (NASCA 2016).

Compared to other states, Ohio has followed an unorthodox path in its charter school growth, particularly with regard to the state's laws governing charter authorization. In many states, new charters (i.e., the contracts allowing for an opening of a new community school) can be authorized, or granted, only by school districts (Boast et al. 2016). Ohio, however, allows any of the following entities to become charter authorizers: 1) the board of education in the district where the school is to be located, 2) the governing board of any educational service center, 3) a sponsoring authority designated by the board of trustees of any of the

[6] In Ohio, charter schools are referred to as "community schools," but they will be described as "charter schools" throughout this paper for ease of exposition.

thirteen state universities, 4) any qualified education nonprofit, or 5) the Ohio Department of Education ("Measuring Up," NAPCS 2016).[7] In total, Ohio allows 64 different entities to open and oversee operations of new or existing charter schools ("Ohio Authorizers," NASCA 2016). By way of comparison, Indiana and Maryland have only 8 and 6 total authorizers statewide, respectively.[8]

The large number of entities authorized to create charter schools in Ohio has created an environment that allows for "shopping around"—enabling lower-performing schools to seek authorizers with lower performance and accountability standards (Boast et al. 2016). Data show that the majority of charters that are opened in the state of Ohio do not close, regardless of school performance, and charter authorizers face no penalty for continuing to authorize underperforming schools (NASCA 2016). However, new accountability measures for charter authorizers were passed by the Ohio State Legislature in November 2015 and are currently in the process of being implemented (Turner 2015). In light of these developments, the question of charter schools' effectiveness in Ohio is of particular policy importance.

LITERATURE REVIEW

Since the creation of charter schools in the early 1990s, researchers have examined their effectiveness in terms of student achievement. Few studies have focused exclusively on charter schools in the state of Ohio (Gray 2012; De Luca et al. 2016). Most research has instead assessed charter effectiveness in other states or cities (Nicotera et al. 2009; Booker et

[7] Ohio also refers to authorizers as "sponsors," but they will be referred to as "authorizers" throughout this paper for ease of exposition.
[8] According to the National Association of Charter School Authorizers, Indiana allows entities including higher education institutions, local education agencies, and independent chartering boards to sponsor charter schools ("Indiana Authorizers," NACSA 2017). Maryland only allows for authorizing by local education agencies ("Maryland Authorizers," NACSA 2017).

al. 2004; Sass 2006; Mills 2013; Yongmei and Rorrer 2012; Hanushek et al. 2007; Chingos 2015; Dobbie and Fryer 2011), or in comparison to traditional public schools nationwide (Clark et al. 2011; CREDO 2009; CREDO 2013; Hoxby 2004; Berends 2006; Carnoy et al. 2005; Betts and Tang 2011; Gleason et al. 2010). This research has used three primary methodologies to assess charter performance—lottery-based studies, fixed effects, and matching techniques—and on the whole, research that relies on differing methodologies and that adopts differing geographic foci has arrived at differing conclusions.

Methodological Differences among Nationwide Studies

Lottery-based Studies

In some states, oversubscribed charter schools may use a lottery system to randomize the selection of students to fill available seats. There is wide variation in state laws regarding lottery usage. Lottery-based studies have been referred to as the "gold standard" of research on charter effectiveness, as they are the closest alternative to a randomized control trial (Hoxby et al. 2009). Researchers compare the performance of lottery students who applied and were admitted to charter schools with the performance of a control group of students who applied but were not admitted. Studies utilizing lottery admissions have overwhelmingly found positive relationships between charter school attendance and student achievement (Hoxby et al. 2009; Abdulkadiroglu et al. 2009; Angrist et al. 2012; Clark et al. 2011).

Further, a lottery-based study by Clark et al. (2011) found stronger relationships between attendance and performance among economically disadvantaged students than among their more advantaged peers. The external validity of these studies is limited, however, due to the relatively small number of charter schools employing lottery systems nationwide.

Fixed Effects

In fixed-effects studies, students' performance in charter schools is compared to their own previous performance. Fixed-effects estimates of charter school effectiveness therefore rely primarily on data provided by students who move between charter schools and traditional public schools over time. Studies of charter effectiveness in a variety of states nationwide have found competing results. Research from Arizona (Nicotera et al. 2009), Texas (Booker et al. 2004), and Florida (Sass 2006) found positive relationships between charter school attendance and academic performance in both reading and math. However, studies from Arkansas (Mills 2013) and Utah (Yongmei and Rorrer 2012) found negative relationships between charter attendance and school performance in the same core subjects. Another fixed-effects study from Texas (Hanushek et al. 2007) found no statistically significant difference in student performance in charters versus traditional public schools in terms of students' math and reading achievement.

Matching Techniques

In recent years, some researchers have used a newer statistical method, virtual control records, to examine charter school effectiveness. VCR is similar in some respects to propensity score matching, as it uses students' observable characteristics and their prior academic performance to create "synthetic" observations to use as control groups for charter school students (Davis and Raymond 2012). This method was used by the Center for Research on Education Outcomes (CREDO) at Stanford University in their widely cited nationwide assessment of charter schools (2013). The most recent CREDO study (2013), using cross-sectional data from 27 states in the U.S., found a strongly positive association between charter attendance and academic gains in reading and math, particularly among

minority and low-income students. However, CREDO's use of VCR in its 2013 study was criticized for the authors' inappropriate application of the technique (Hoxby 2009). A 2012 study by Davis and Raymond used both fixed effects and VCR analysis to compare charter school and traditional public school students in California and found comparable results with both methods. Using both methods, Davis and Raymond found significant variation in charter school quality nationwide, by both demographics and geography (Davis and Raymond 2012).

A study by Hoxby (2004) utilized a matching methodology to assess fourth graders' performance nationwide in 2002–03. Hoxby analyzed a sample of 99 percent of all elementary charter school students and matched these students to students who attended traditional public schools. Charter school students were matched to traditional public school students who attended the types of schools that the charter school students would likely otherwise have attended based on geography and demographic composition. The author found charter school students to be 3.2 percent more likely to be proficient in math and 5.2 percent more likely to be to be proficient in reading than their traditional public school counterparts. She further found charter school attendance to be associated with improved academic achievement among low-income and Hispanic students (Hoxby 2004).

In summary, though across all relevant literature charter researchers have come to conflicting conclusions with regard to charter effectiveness, the highest-quality studies—those utilizing lottery-based enrollment structures—show that charter school attendance improves academic outcomes (Hoxby et al. 2009; Abdulkadiroglu et al. 2009; Angrist et al. 2012; Clark et al. 2011). Many studies using other methods, such as fixed effects and VCR, have arrived at the same conclusion (Nicotera et al. 2009; Booker et al. 2004; Sass 2006; CREDO 2013; Davis and Raymond 2012; Hoxby 2004). A minority of research has found either the opposite

or no effect, but none of those studies utilize the "gold standard" of randomized lotteries (Mills 2013; Yongmei and Rorrer 2012; Hanushek et al. 2007). This review of the literature suggests that, on net, charter school attendance is associated with improved academic performance for attending students.

Previous Assessments of Ohio Charter School Effectiveness

There is also variation in the findings produced by studies that focus specifically on Ohio. On the whole, however, the available evidence suggests that Ohio's charter schools do not outpace traditional public schools to as great an extent as in some other states. Using fixed effects with longitudinal, student-level data, Zimmer et al. (2009) found that students in middle and high school charter schools in Ohio perform at levels comparable to students in neighboring traditional public schools. However, they also found greater variation in school performance among charter schools in Ohio as compared to charter schools in other states.

CREDO, in its 2009 assessment of 16 states, used longitudinal, student-level data and found a negative relationship in Ohio between charter school attendance and academic growth as compared to the trajectories of similar, "synthetic" students in traditional public schools. CREDO (2009) also found that, in states that allow for multiple charter authorizers (such as Ohio), performance among students in charter schools was lower than among charter school students in states with only one authorizer. These findings raise the question of whether the large number of authorizing bodies in Ohio has led to an environment in which the state's charter schools are less effective than charter schools in other states.

Gray (2012) exploited a change in Ohio state laws in 2003—which allowed for charter creation beyond the eight largest districts in the state where they were originally allowed—to

assess whether charter creation improved the performance of surrounding traditional public schools. Gray theorized that this source of competition would improve traditional school performance. He found a positive relationship between charter creation and traditional public school performance in the surrounding area. A similar study in North Carolina in 2003 reached comparable conclusions (Holmes 2003).[9]

Though the potential impact of charter school creation on the performance of neighboring traditional public schools is a critical question, this study will instead assess charter performance compared to that of traditional public schools using Ohio data for the most recent year, 2015–16. This snapshot will allow for the assessment of current charter performance in Ohio, providing an important framework for discussions of the necessary direction of future charter school policy statewide.

The Present Study

The present study contributes to the existing literature in several ways. First, few analyses of charter schools are conducted at the school level, despite the fact that this is the level at which decisions and policies are often made. Second, the present study uses the most current data available on Ohio public schools—from the 2015–16 academic year—and focuses on academic outcomes for third through fifth grade, which constitute a critical time period in students' academic trajectories (Center for Public Education 2015; Balfanz 2007; Roderick 1993). Third, and finally, as the number of charter schools in Ohio increases annually due to the state's liberal charter-authorization policies (Boast et al. 2016), this study

[9] It is also possible, given the demographics of an average charter school student indicate they are more likely to be low-income, minority, and lower performing academically, that the removal of these students from traditional public schools and into charter schools is what is positively impacting traditional public school performance—not market-based competition.

provides a timely new data point to inform the debate over the effectiveness of the state's charter schools and the environment in which they are created.

CONCEPTUAL FRAMEWORK

Given the findings detailed in literature review, I hypothesize that charter school attendance will have a small but positive correlation with student achievement for economically disadvantaged elementary school students in both reading and math. This hypothesis is consistent with studies that examined charter school effectiveness for elementary students specifically (Betts and Tang 2011; Hoxby 2004). It is further supported by research that found a positive association between charter school attendance and improved student performance specifically among low-income students (Hoxby 2004). I also predict that there will be greater variation in student achievement among charter schools than among traditional public schools in my sample. This hypothesis is consistent with findings from Zimmer et al. (2009), who focused specifically on charter schools in the state of Ohio.

Given that my analysis is conducted at the school level, the model will account for a number of school-level conditions, including the demographics of each school's student population and school characteristics, as well as district-level spending. These factors are diagrammed in Figure 1 below and are discussed in more detail in subsequent sections.

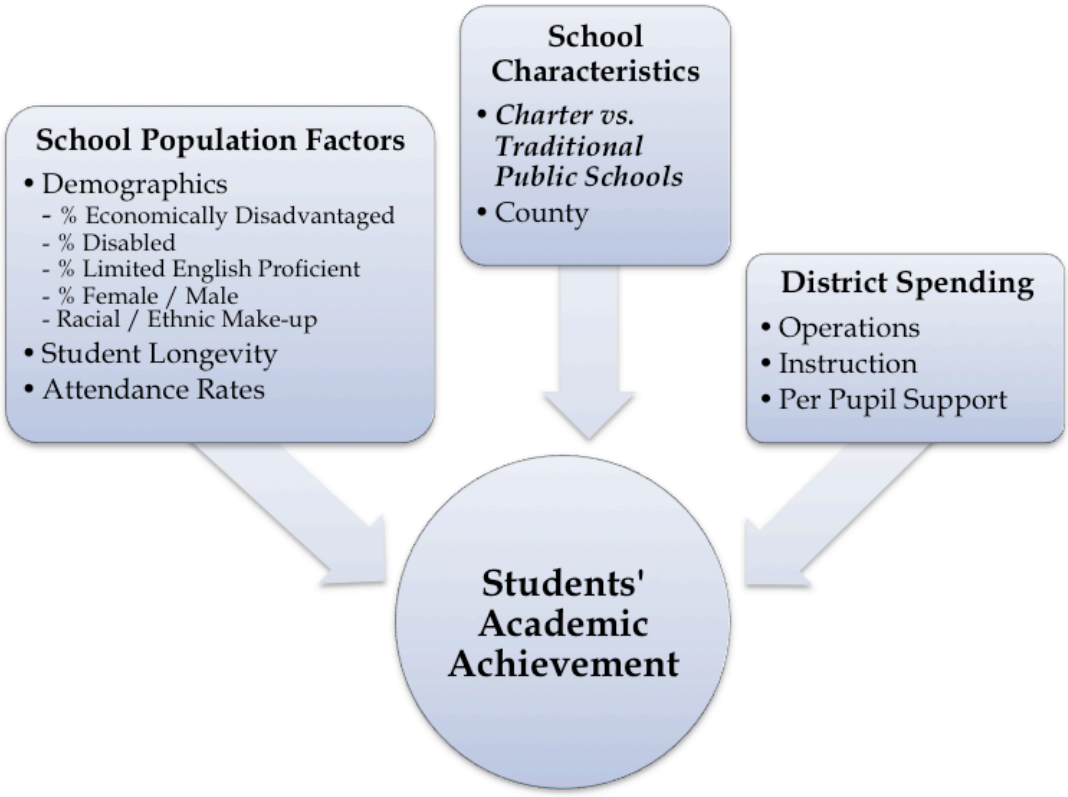

Figure 1. School-Level Influences on Student Achievement

School Population Factors

- *Demographics:* Economically disadvantaged students are the sub-population of focus in this study, and thus the percentage of students considered economically disadvantaged within a school population is relevant to this analysis. I also control for a variety of other demographic factors that have been included in related studies, including the percentage of students with disabilities, the percentage of students who are Limited English Proficient, the percentage of students who are male versus female, and the racial/ethnic breakdown of the student population (CREDO 2009; Sass 2006; De Luca and Wood 2016; Angrist et al. 2012).
- *Student Longevity*: Studies suggest there may be a relationship between the length of time a student attends a given school and his or her academic performance,

particularly in the primary grades (Jones 2006). This study will control for the distribution of the number of academic years that a school's elementary school students have attended the same school prior to the year of analysis.

- *Attendance Rates*: Studies of public school student performance suggest that there is a strong relationship between student attendance and academic performance (Jones 2006; Stanca 2006). Therefore, the present study will control for the average annual rates of attendance of economically disadvantaged students at each school within the sample.

School Characteristics

- *County*: My model will capture factors such as median household income by controlling for county fixed effects. In Ohio, students are at liberty to attend schools outside the district in which their families reside, and research suggests that school choice options vary significantly in terms of both quantity and quality between rural and urban areas (Rembert et al. 2016). Further, average household income is strongly correlated with the quality of nearby traditional public schools (Reardon 2016). This relationship would plausibly have an effect on the likelihood that charter schools will open and operate successfully in a given area. The geographic factor controlled for in this model—the county in which each school is located—is therefore plausibly correlated with differences in the academic outcomes of students attending charter and traditional public schools.

District Spending

Research by De Luca and Wood (2016) in Ohio suggests that there is an association between elementary school spending and academic achievement. Moreover, Hoxby (2004) finds that charter school students have higher rates of proficiency when school-level funding is at minimum 40 percent of the per-pupil funding given to comparable traditional public schools.[10] School-level spending data were unavailable for this study, but district-level spending data for the state's approximately 1,000 school districts will be used as a proxy. I therefore control for three categories of district-level spending in this study: operations, instruction, and per-pupil spending.

DATA AND METHODS

To analyze the relationship between student achievement and charter school attendance, I estimate an ordinary least squares (OLS) regression model with individual schools as the unit of analysis and the percentage of economically disadvantaged third, fourth, or fifth grade students scoring proficient or above on standardized assessments as the dependent variable. I estimate separate models to analyze differences in school performance with respect to reading proficiency and math proficiency as the dependent variable for each of the three elementary grades. My regression model is as follows:

[10] Like traditional public schools, charter schools are primarily funded through allocations of public, government funding based on a per pupil formula determined by the state. However, many charter schools also receive funding from private sources (e.g., foundations, philanthropic organizations) to supplement their public funding. The amount of this private funding needed to operate often depends on a given state's laws governing charter school funding. In some states, charter schools receive less public money than traditional public schools for school operations, and in others, charter schools are not allocated any public money for building operations at all (Shen and Berger 2011).

$$Proficient_{grade,\ subj} = B_0 + B_1 Charter + B_2 EconDisadvantaged + B_3 Disabled + B_4 LEP + B_5 Race + B_6 Gender + B_7 Longevity + B_8 Attendance + B_9 OperationsSpending + B_{10} InstructionalSpending + B_{11} PerPupilSpending + \alpha_k County_k + \varepsilon$$

The empirical analysis uses school-level data for all public schools in operation in the state of Ohio during the 2015–16 academic year. All variables included in my analysis were drawn from the Ohio Department of Education's online database.[11] My dataset includes student achievement information on standardized state-level examinations for a total of 3,740 public schools for the year of analysis.[12] Among these public schools, 381 are charter schools. The dependent variable reflects the percentage of students scoring proficient or above on standardized assessments in reading or math.[13] My analysis focuses specifically on the student achievement outcomes of economically disadvantaged students.[14] Table 1 provides definitions for all variables included in the model.

[11] Ohio Department of Education, Ohio School Report Cards, http://reportcard.education.ohio.gov/Pages/Download-Data.aspx.

[12] Single imputation was used to account for missing values within this dataset for the following explanatory variables: economically disadvantaged enrollment, percentage of students with disabilities, percentage of students Limited English Proficient, percentage of students of a given race or ethnicity (white, African-American, Asian, Hispanic, or multi-racial, percentage of students male or female, the longevity of student attendance within each of three possible categories (students attending school zero previous years, 1-2 years, or 3 or more years), the attendance rate of economically disadvantaged students, and all three spending variables (operations, instruction, and per pupil spending). For each set of imputations, the same variables were used as the "independent variables," with the exception of the variable being imputed. A total of 12,937 observations were imputed. A series of t-tests suggest there were no notable differences in school population characteristics between observations for which missing data were imputed and observations for which data were not imputed.

[13] Students in all Ohio public schools take standardized assessments in the four key subject areas of math, reading, science, and social studies from third through eighth grade (Ohio Department of Education 2016).

[14] In this dataset, any value greater than 95 was capped at that value, and should therefore be interpreted as "greater than or equal to 95."

Table 1. Definitions of Variables

Variable	Definition
Dependent Variable	
Proficient	A continuous variable measuring the percentage of economically disadvantaged elementary school students scoring proficient or above on state standardized assessments in reading and math.
Key Independent Variable	
Charter	A dichotomous variable indicating whether or not a public school in Ohio was a charter school in 2015–16. Charter schools = 1, all other schools = 0.
School Population Factors	
Economically Disadvantaged	A continuous variable indicating the percentage of students in a school's population who are economically disadvantaged.
Disabled	A continuous variable indicating the percentage of students in a school's population who have disabilities.[15]
Limited English Proficient (LEP)	A continuous variable indicating the percentage of students in a school's population who are Limited English Proficient.[16]
Race	A series of continuous variables indicating the percentage of students in a school's population of a given race or ethnicity (e.g., white, African-American, Asian, American Indian/Alaskan Native, Hispanic, or multi-racial).
Male	A continuous variable indicating the percentage of male versus female students in a school's population.
Longevity	A series of dummy variables indicating the length of time (in academic years) that elementary school students attended the same school prior to taking their standardized assessments in 2015–16. These dummies correspond to three different categories: students who attended the same school for zero previous years, 1–2 years, or 3 or more years.
Attendance	A continuous variable indicating the average annual attendance rate of economically disadvantaged students at a school.[17]
School Characteristics	
County	A series of discrete variables indicating the county in which a given school is located.

[15] The Ohio Department of Education defines students as having disabilities for the purpose of this dataset if they qualify for an Individualized Education Plan (IEP) under federal law—the Individuals with Disabilities Act (IDEA) of 1975—and if they received specialized accommodations or modifications on state standardized assessments ("Ohio Operating Standards for the Education of Children with Disabilities," 2014).

[16] The Ohio Department of Education defines students as Limited English Proficient for the purpose of this dataset if a student's primary or home language is a language other than English, the student scores below a certain threshold on an assessment of English proficiency, and the student received LEP accommodations or modifications on state standardized assessments ("Guidelines for the Identification and Assessment of Limited English Proficient Students/English Language Learners," 2012).

[17] Ohio administrative code defines "student attendance rate" as "a ratio of the number of enrolled students actually in attendance over the course of a school year to the number of enrolled students that year" (Ohio Administrative Code 2014). The attendance variable in this data set represents the student attendance rate for the subset of students defined as economically disadvantaged.

Table 1. (cont.)

Variable	Definition
District Spending	
Operations	A continuous variable indicating a district's operational expenditures in FY16.
Instruction	A continuous variable indicating a district's instructional expenditures in FY16.
Per Pupil Spending	A continuous variable indicating a district's per pupil expenditures in FY16.

DESCRIPTIVE STATISTICS

Tables 2 through 4 provide descriptive statistics for my dependent variables, key independent variable, and control variables, broken down by grade level. Among the 3,740 Ohio schools in my sample (of which 381 are charter schools), proficiency levels for economically disadvantaged students in all three grades are higher for math than for reading (55.1 percent versus 44.0 percent for third grade; 57.4 percent versus 45.2 percent for fourth grade; and 47.7 percent versus 46.3 percent for fifth grade). Also across all three grades in both subject areas, proficiency levels range from 0 percent (indicating that no economically disadvantaged students in a given school population were proficient in reading or math in 2015–16) to 95 percent or above (indicating that almost 100 percent of economically disadvantaged students in a school population were proficient or above). On average, over half (approximately 62 percent) of schools' populations were composed of economically disadvantaged students. However, some public schools had almost no economically disadvantaged students in 2015–16, while other schools catered almost exclusively to students from a lower-income background. Attendance rates among schools in the sample were quite high, at approximately 94 percent.

Table 2. Descriptive Statistics for Third Grade Dependent, Key Independent, and Control Variables

	Mean	SD	Min	Max
Dependent Variables				
% Economically Disadvantaged Third Grade Students Proficient in Reading	44.0	18.71	0	95
% Economically Disadvantaged Third Grade Students Proficient in Math	55.1	21.0	0	95
Key Independent Variable				
Charter School	0.11	0.31	0	1
School Population Factors				
Attendance rate (economically disadvantaged students)	94.0	1.88	71.6	95
% Economically Disadvantaged	61.9	27.4	4.2	95
% Disabled	15.2	7.69	0	95
% Limited English Proficient	9.54	10.48	0	95
% White	62.4	33.3	0	95
% African-American	29.8	27.8	0	95
% Asian students	4.44	7.48	0	95
% Hispanic	9.12	9.01	0	84.3
% Multiracial	6.79	3.48	0	24.5
% Female	48.66	4.12	25.8	95
% Attending school 1–2 previous years	51.3	13.3	10.8	95
% Attending school 3+ previous years	41.1	14.2	4.7	86.9
District Spending ($ millions)				
Operations	126.4	200.8	0.784	704.4
Instruction	68.4	104.6	0.17	360.5
Pupil Support	8.66	15.3	0	64.4

There are 1,557 non-missing observations for which the above descriptives are reported—those for which data are available for either the dependent variable for reading, the dependent variable for math, or both.

Table 3. Descriptive Statistics for Fourth Grade Dependent, Key Independent, and Control Variables

	Mean	SD	Min	Max
Dependent Variables				
% Economically Disadvantaged Fourth Grade Students Proficient in Reading	45.2	18.1	0	95
% Economically Disadvantaged Fourth Grade Students Proficient in Math	57.4	22.7	0	95

Table 3. (cont.)

	Mean	SD	Min	Max
Key Independent Variable				
Charter School	0.10	0.30	0	1
School Population Factors				
Attendance rate (economically disadvantaged students)	94.1	1.80	71.6	95
% Economically Disadvantaged	61.8	27.6	4.2	95
% Disabled	15.2	7.57	1.38	95
% Limited English Proficient	9.53	10.6	0	95
% White	62.7	33.3	0	95
% African-American	29.5	27.7	0	95
% Asian students	4.37	7.51	0	95
% Hispanic	9.26	9.20	0	84.2
% Multiracial	6.70	3.45	0	24.5
% Female	48.7	4.16	24.3	95
% Attending school 1–2 previous years	49.0	14.1	7.9	95
% Attending school 3+ previous years	43.7	15.3	0	86.9
District Spending ($ millions)				
Operations	127.4	200.9	0.913	704.4
Instruction	68.9	104.7	0.171	360.5
Pupil Support	8.73	15.35	0	64.4

There are 1,534 non-missing observations for which the above descriptives are reported—those for which data are available for either the dependent variable for reading, the dependent variable for math, or both.

Table 4. Descriptive Statistics for Fifth Grade Dependent, Key Independent, and Control Variables

	Mean	SD	Min	Max
Dependent Variables				
% Economically Disadvantaged Fifth Grade Students Proficient in Reading	46.3	18.0	0	95
% Economically Disadvantaged Third Grade Students Proficient in Math	47.7	22.8	0	95
Key Independent Variable				
Charter School	0.11	0.31	0	1
School Population Factors				
Attendance rate (economically disadvantaged students)	93.9	3.1	0	95
% Economically Disadvantaged	62.9	27.7	4.5	95
% Disabled	15.6	7.64	1.37	95
% Limited English Proficient	9.13	10.8	0	95
% White	61.9	33.8	0	95

Table 4. (cont.)

	Mean	SD	Min	Max
School Population Factors				
% African-American	30.03	28.3	0	95
% Asian students	3.95	6.90	0	95
% Hispanic	9.19	9.25	0	84.2
% Multiracial	6.61	3.41	0	24.5
% Female	48.7	4.27	25.8	95
% Attending school 1–2 previous years	44.6	16.4	4.8	95
% Attending school 3+ previous years	48.5	18.2	0	94.3
District Spending ($ millions)				
Operations	131.9	206.9	0.784	704.4
Instruction	71.05	107.7	0.171	360.5
Pupil Support	9.09	15.8	0	64.4

There are 1,416 non-missing observations for which the above descriptives are reported—those for which data are available for either the dependent variable for reading, the dependent variable for math, or both.

Table 5 disaggregates descriptive statistics for charter versus traditional public schools. For both reading and math across all three grades, economically disadvantaged students at traditional public schools perform better than economically disadvantaged students at charter schools. However, the student populations of charter schools are substantially more disadvantaged overall than populations at traditional public schools. For example, charter school students are significantly more likely to be economically disadvantaged, to have disabilities, to be English language learners, and to be racial minorities. There is also substantially higher turnover in charter schools, as evidenced by the fact that a much smaller share of students were attending charter schools for three years or more. Moreover, spending levels are much lower at charter schools across all three types of spending—operations, instruction, and pupil support. My multivariate regression analyses will control for these differences between charter and traditional public schools.

Table 5. Key Characteristics Disaggregated by School Type

	Charter	TPS	Difference	SE
Dependent Variables				
% Economically Disadvantaged Third Grade Students Proficient in Reading	29.43	45.62	-16.19***	1.43
% Economically Disadvantaged Third Grade Students Proficient in Math	38.02	57.19	-19.17***	1.68
% Economically Disadvantaged Fourth Grade Students Proficient in Reading	31.92	46.72	-14.79***	1.45
% Economically Disadvantaged Fourth Grade Students Proficient in Math	35.98	59.82	-23.84***	1.83
% Economically Disadvantaged Fifth Grade Students Proficient in Reading	32.19	47.98	-15.79***	1.42
% Economically Disadvantaged Fifth Grade Students Proficient in Math	28.01	50.1	-22.09***	1.69
School Population Factors				
% Economically Disadvantaged	85.34	50.50	34.84***	0.80
Attendance rate (economically disadvantaged students)	91.91	93.61	-1.70***	0.27
% Disabled	20.55	14.94	5.61***	0.83
% Limited English Proficient	18.03	6.86	11.17***	0.76
% White	28.94	73.67	-44.73***	1.17
% Black	61.07	21.66	39.41***	1.27
% Asian	6.02	3.51	2.51***	0.71
% Hispanic	13.26	7.46	5.80***	0.52
% Multiracial	8.20	5.91	2.29***	0.28
% Female	48.88	48.56	0.317	0.29
% Attended school 1–2 previous years	70.79	37.05	33.74***	0.63
% Attending school 3+ previous years	22.02	57.47	-35.45***	0.58
School Characteristics				
County	34.24	42.59	-8.35***	1.36
District Spending ($ millions)				
Operations	47.01	94.86	-47.85***	6.69
Instruction	25.29	52.01	-26.72***	3.58
Pupil Support	2.78	6.43	-3.65***	0.39

*** p<0.01, ** p<0.05, * p<0.1

The sample size is 3,740 with 381 observations for charter schools and 3,359 observations for traditional public schools.

RESULTS

My regression results are summarized in Tables 6 through 11. Tables 6 and 7 present results for third grade reading and math, respectively. Tables 8 and 9 report the same for fourth graders, and tables 10 and 11 report results for fifth graders. In all tables, the dependent variable reflects the percentage of economically disadvantaged students within a school's population who scored proficient or higher on a given state standardized assessment.

In each table, model (1) summarizes the results of a bivariate ordinary least squares regression of my dependent variable on my key independent variable without any additional controls. Model (2) adds school population factors, controlling for the demographics of schools in the sample. Model (3) adds county fixed effects. Model (4) adds district-level spending information. Models (5) through (7) each include controls for school population factors, county fixed effects, and district level spending, but also include interactions between my charter schools dummy and a series of dichotomous variables. Model (5) includes an interaction between my charter schools dummy and a dummy reflecting whether a school is above the median in share of students who are economically disadvantaged. Model (6) includes an interaction between my charter schools dummy and a dummy reflecting whether a school is above the median in the share of students who have special needs. And, model (7) includes an interaction between my charter schools dummy and a dummy reflecting whether a school is above the median in the share of students who are black. Models (5) through (7) also report results from F-tests assessing the joint significance of the charter schools dummy and each of these three interactions. Robust standard errors are reported for all coefficients.

Charter Schools and Third Grade Proficiency

Tables 6 and 7 report results from regressions with the percent of economically disadvantaged students scoring proficient or above on third grade reading and math assessments as the dependent variables. Model (1) in both tables shows that, in an OLS regression with no additional covariates, there is a negative, statistically significant difference between the percent of economically disadvantaged, proficient third graders at charter schools and the percent of economically disadvantaged, proficient third graders at traditional public schools for both reading and math. The magnitudes of these differences are quite large, indicating that the share of economically disadvantaged students who are proficient in third grade reading is 16.2 percentage points lower at charter schools than traditional public schools and is 19.17 percentage points lower at charter schools for third grade math. These estimates likely suffer from omitted variable bias, however, due to the number of omitted factors that are plausibly associated with both charter school attendance and standardized test scores.

The addition of covariates in models (2) through (7) does, in fact, decrease the magnitude of my key coefficient for both reading and math. These estimates are also statistically insignificant in all other models. This suggests that, after controlling for the demographic makeup of schools, their geographic location, and the district-level spending, charter schools are not statistically significantly different from traditional public schools in terms of student proficiency in either third grade reading or third grade math among economically disadvantaged students. Models (5) through (7) include interaction terms between my charter schools dummy and dichotomous variables reflecting whether a school is above the median in the share of students who are economically disadvantaged, who have special needs, or who are black, respectively, to assess the difference between charter schools

and traditional public schools for these subpopulations. For both subjects in third grade, there is no statistically significant difference between charter schools and traditional public schools for any of these subgroups.

Table 6. Regression Results for Third Grade Reading

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Key Independent Variable							
Charter	-16.20***	-1.123	-0.422	-1.133	1.776	-0.662	2.091
	(1.429)	(1.635)	(1.661)	(2.008)	(5.627)	(2.251)	(3.062)
School Population Factors							
Attendance		1.679***	1.694***	1.916***	1.906***	1.895***	1.935***
		(0.367)	(0.344)	(0.364)	(0.366)	(0.368)	(0.359)
% Econ. Disadvantaged		-0.0515**	-0.077***	-0.088***	-0.087***	-0.090***	-0.085***
		(0.0245)	(0.0265)	(0.0271)	(0.0273)	(0.0272)	(0.0272)
% Special Education		-0.151**	-0.166***	-0.155**	-0.154**	-0.145**	-0.171***
		(0.0621)	(0.0624)	(0.0619)	(0.0620)	(0.0646)	(0.0618)
% Limited English Proficient		0.144**	0.142*	0.126*	0.125*	0.127*	0.127*
		(0.0661)	(0.0731)	(0.0733)	(0.0735)	(0.0734)	(0.0734)
% Black		-0.236***	-0.249***	-0.267***	-0.265***	-0.267***	-0.258***
		(0.0212)	(0.0234)	(0.0252)	(0.0251)	(0.0252)	(0.0260)
% Asian		-0.0320	-0.0172	0.0141	0.0168	0.0109	0.0166
		(0.0591)	(0.0676)	(0.0665)	(0.0670)	(0.0669)	(0.0667)
% Hispanic		-0.436***	-0.434***	-0.417***	-0.416***	-0.416***	-0.434***
		(0.0611)	(0.0689)	(0.0711)	(0.0713)	(0.710)	(0.0729)
% Multiracial		-0.306**	-0.204	-0.179	-0.185	-0.176	-0.182
		(0.134)	(0.150)	(0.148)	(0.148)	(0.149)	(0.148)
% Female		0.118	0.100	0.104	0.103	0.104	0.0974
		(0.106)	(0.104)	(0.103)	(0.103)	(0.102)	(0.103)
% Attending 1-2 Previous Years		0.236***	0.154*	0.150	0.154	0.148	0.161*
		(0.0867)	(0.0918)	(0.0931)	(0.0942)	(0.0934)	(0.0946)
% Attending 3+ Previous Years		0.264***	0.163*	0.151*	0.155*	0.150	0.160*
		(0.0838)	(0.0891)	(0.0912)	(0.0920)	(0.0914)	(0.0924)
District Spending ($ millions)							
Operations				0.253***	0.252***	0.251***	0.248***
				(0.0754)	(0.0750)	(0.0756)	(0.0750)

Table 6. (cont.)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
District Spending ($ millions)							
Instruction				-0.462***	-0.461***	-0.459***	-0.452***
				(0.127)	(0.126)	(0.127)	(0.126)
Pupil Support				-0.177	-0.177	-0.173	-0.181
				(0.167)	(0.167)	(0.167)	(0.167)
Interactions							
Charter * EconDisadv					-3.244		
					(5.887)		
Charter * SPED						-1.454	
						(2.664)	
Charter * Black							-4.457
							(3.360)
F-Statistics and P-Values for Joint Hypotheses							
					0.31	0.34	0.99
					(0.7367)	(0.7114)	(0.3700)
County Fixed Effects?	N	N	Y	Y	Y	Y	Y
Constant	45.62***	-125.1***	-102.6***	-120.7***	-120.3***	-118.7***	-123.2***
	(0.483)	(33.81)	(32.85)	(34.24)	(34.34)	(34.72)	(33.62)
Observations	1,579	1,579	1,579	1,579	1,579	1,579	1,579
R-squared	0.070	0.383	0.440	0.447	0.447	0.447	0.448

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7. Regression Results for Third Grade Math

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Key Independent Variable							
Charter	-19.17***	-1.180	-0.296	0.189	-5.589	0.298	-1.144
	(1.677)	(1.847)	(1.937)	(2.382)	(6.268)	(2.597)	(3.845)
School Population Factors							
Attendance		2.077***	2.019***	2.313***	2.331***	2.308***	2.305***
		(0.405)	(0.363)	(0.384)	(0.384)	(0.389)	(0.386)
% Econ. Disadvantaged		-0.0207	-0.0437	-0.0640**	-0.0676**	-0.0643**	-0.0655**
		(0.0253)	(0.0268)	(0.0281)	(0.0282)	(0.0282)	(0.0282)
% Special Education		-0.298***	-0.333***	-0.323***	-0.326***	-0.321***	-0.317***
		(0.0682)	(0.0692)	(0.0684)	(0.0687)	(0.0708)	(0.0673)
% Limited English Proficient		0.115*	0.139*	0.137*	0.140*	0.137*	0.137*
		(0.0676)	(0.0741)	(0.0752)	(0.0753)	(0.0753)	(0.0753)

Table 7. (cont.)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
School Population Factors							
% Black		-0.285***	-0.287***	-0.312***	-0.315***	-0.312***	-0.316***
		(0.0245)	(0.0267)	(0.0292)	(0.0290)	(0.0292)	(0.0300)
% Asian		-0.0323	-0.0101	0.00184	-0.00347	0.00111	0.000960
		(0.0558)	(0.0602)	(0.0607)	(0.0610)	(0.0614)	(0.0607)
% Hispanic		-0.415***	-0.426***	-0.432***	-0.435***	-0.432***	-0.424***
		(0.0750)	(0.0784)	(0.0818)	(0.0817)	(0.0819)	(0.0853)
% Multiracial		-0.441***	-0.249	-0.197	-0.185	-0.196	-0.197
		(0.143)	(0.156)	(0.155)	(0.156)	(0.156)	(0.156)
% Female		0.0985	0.0796	0.0824	0.0846	0.0824	0.0851
		(0.112)	(0.118)	(0.118)	(0.118)	(0.118)	(0.118)
% Attending 1-2 Previous Years		0.279***	0.113	0.0991	0.0900	0.0986	0.0939
		(0.0938)	(0.0936)	(0.0947)	(0.0935)	(0.0947)	(0.0944)
% Attending 3+ Previous Years		0.337***	0.152*	0.120	0.112	0.119	0.116
		(0.0911)	(0.0914)	(0.0932)	(0.0922)	(0.0932)	(0.0929)
District Spending ($ millions)							
Operations				0.258***	0.259***	0.257***	0.260***
				(0.0838)	(0.0841)	(0.0842)	(0.0840)
Instruction				-0.450***	-0.453***	-0.449***	-0.454***
				(0.141)	(0.142)	(0.142)	(0.142)
Pupil Support				-0.267	-0.266	-0.266	-0.265
				(0.186)	(0.187)	(0.187)	(0.187)
Interactions							
Charter * EconDisadv					6.445		
					(6.512)		
Charter * SPED						-0.338	
						(3.637)	
Charter * Black							1.830
							(4.132)
F-Statistics and P-Values for Joint Hypotheses							
					0.49	0.01	0.10
					(0.6114)	(0.9922)	(0.9034)
County Fixed Effects?	N	N	Y	Y	Y	Y	Y
Constant	57.19***	-152.8***	-114.8***	-137.5***	-138.3***	-137.1***	-136.5***
	(0.539)	(37.69)	(34.61)	(36.06)	(36.00)	(36.54)	(36.34)
Observations	1,558	1,558	1,558	1,558	1,558	1,558	1,558
R-squared	0.079	0.412	0.487	0.493	0.493	0.493	0.493

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Charter Schools and Fourth Grade Proficiency

Tables 8 and 9 report results from regressions with the percent of economically disadvantaged students scoring proficient or above on fourth grade reading and math assessments as the respective dependent variables. Model (1) in both tables shows that, in an OLS regression with no additional covariates, charter schools have smaller proportions of their student populations that are proficient in both reading and math compared to traditional public schools. Similar to the results from third grade, the magnitude of each of these coefficients is quite large, at -14.8 percentage points for fourth grade reading and -23.84 percentage points for fourth grade math, suggesting that charter schools have much smaller percentages of economically disadvantaged students performing at proficient levels in each subject area than traditional public schools in the state.

However, when additional controls are added in models (2) through (7), my results change dramatically. For fourth grade reading, there are no statistically significant coefficients for charter schools in any model other than model (1), suggesting no significant difference between charter schools and traditional public schools in terms of economically disadvantaged students proficiency in fourth grade reading. For fourth grade math, model (7) shows a statistically significant and negative coefficient for charter schools of -6.275. This coefficient indicates that among schools with comparatively small populations of black students, charter schools have six percentage points fewer proficient students than traditional public schools.

Table 8. Regression Results for Fourth Grade Reading

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Key Independent Variable							
Charter	-14.80***	0.206	1.145	2.130	0.964	2.470	-0.207
	(1.445)	(1.580)	(1.606)	(1.895)	(6.979)	(2.225)	(3.351)
School Population Factors							
Attendance		1.670***	1.596***	1.708***	1.713***	1.693***	1.691***
		(0.339)	(0.324)	(0.375)	(0.375)	(0.375)	(0.380)
% Econ. Disadvantaged		-0.0419*	-0.075***	-0.093***	-0.094***	-0.094***	-0.096***
		(0.0235)	(0.0259)	(0.0261)	(0.0262)	(0.0264)	(0.0261)
% Special Education		-0.206***	-0.182***	-0.170***	-0.170***	-0.164***	-0.160***
		(0.0519)	(0.0492)	(0.0474)	(0.0473)	(0.0488)	(0.0493)
% Limited English Proficient		0.168***	0.142**	0.133**	0.133**	0.133**	0.132**
		(0.0594)	(0.0640)	(0.0624)	(0.0625)	(0.0624)	(0.0624)
% Black		-0.275***	-0.266***	-0.261***	-0.261***	-0.261***	-0.267***
		(0.0201)	(0.0222)	(0.0236)	(0.0234)	(0.0236)	(0.0239)
% Asian		-0.126***	-0.103***	-0.0973**	-0.0985**	-0.0997**	-0.0994**
		(0.0403)	(0.0389)	(0.0401)	(0.0410)	(0.0415)	(0.0401)
% Hispanic		-0.432***	-0.393***	-0.355***	-0.356***	-0.354***	-0.342***
		(0.0565)	(0.0639)	(0.0650)	(0.0650)	(0.0646)	(0.0667)
% Multiracial		-0.262**	-0.334**	-0.323**	-0.320**	-0.321**	-0.321**
		(0.116)	(0.133)	(0.133)	(0.132)	(0.134)	(0.133)
% Female		0.271***	0.282***	0.286***	0.287***	0.287***	0.292***
		(0.0954)	(0.0967)	(0.0966)	(0.0966)	(0.0965)	(0.0958)
% Attending 1-2 Previous Years		0.296***	0.170**	0.156**	0.153**	0.154**	0.146*
		(0.0719)	(0.0749)	(0.0754)	(0.0762)	(0.0755)	(0.0756)
% Attending 3+ Previous Years		0.278***	0.140*	0.127*	0.125*	0.126*	0.120
		(0.0690)	(0.0728)	(0.0734)	(0.0742)	(0.0735)	(0.0735)
District Spending ($ millions)							
Operations				-0.0316	-0.0312	-0.0329	-0.0272
				(0.0672)	(0.0669)	(0.0673)	(0.0669)
Instruction				0.0124	0.0118	0.0145	0.00398
				(0.113)	(0.113)	(0.113)	(0.112)
Pupil Support				0.388***	0.388***	0.390***	0.390***
				(0.150)	(0.150)	(0.150)	(0.151)
Interactions							
Charter * EconDisadv					1.308		
					(7.264)		

Table 8. (cont.)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interactions							
Charter * SPED						-1.065 (2.675)	
Charter * Black							3.237 (3.742)
F-Statistics and P-Values for Joint Hypotheses							
					0.69 (0.5017)	0.65 (0.5223)	1.06 (0.3452)
County Fixed Effects?	N	N	Y	Y	Y	Y	Y
Constant	46.72*** (0.476)	-133.1*** (33.25)	-110.4*** (32.77)	-119.0*** (37.05)	-119.2*** (37.01)	-117.5*** (37.14)	-116.8*** (37.55)
Observations	1,536	1,536	1,536	1,536	1,536	1,536	1,536
R-squared	0.060	0.448	0.507	0.512	0.512	0.512	0.512

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9. Regression Results for Fourth Grade Math

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Key Independent Variable							
Charter	-23.84*** (1.832)	-2.993 (1.856)	-1.670 (1.857)	-2.614 (2.336)	-5.600 (6.168)	-1.412 (2.635)	-6.275* (3.754)
School Population Factors							
Attendance		2.501*** (0.392)	2.358*** (0.359)	2.382*** (0.382)	2.393*** (0.383)	2.326*** (0.384)	2.355*** (0.386)
% Econ. Disadvantaged		-0.0589** (0.0261)	-0.097*** (0.0280)	-0.096*** (0.0294)	-0.098*** (0.0294)	-0.099*** (0.0294)	-0.101*** (0.0295)
% Special Education		-0.229*** (0.0556)	-0.223*** (0.0541)	-0.217*** (0.0541)	-0.218*** (0.0541)	-0.195*** (0.0553)	-0.201*** (0.0568)
% Limited English Proficient		0.0827 (0.0711)	0.0738 (0.0763)	0.0598 (0.0769)	0.0610 (0.0769)	0.0599 (0.0770)	0.0582 (0.0769)
% Black		-0.334*** (0.0235)	-0.311*** (0.0255)	-0.311*** (0.0275)	-0.313*** (0.0275)	-0.312*** (0.0274)	-0.321*** (0.0282)
% Asian		-0.191*** (0.0590)	-0.142*** (0.0489)	-0.121** (0.0502)	-0.124** (0.0509)	-0.129** (0.0513)	-0.124** (0.0500)
% Hispanic		-0.408*** (0.0738)	-0.333*** (0.0820)	-0.310*** (0.0853)	-0.311*** (0.0852)	-0.307*** (0.0847)	-0.289*** (0.0869)

Table 9. (cont.)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
School Population Factors							
% Multiracial		-0.422***	-0.370**	-0.377**	-0.370**	-0.370**	-0.375**
		(0.145)	(0.155)	(0.156)	(0.156)	(0.156)	(0.156)
% Female		0.190*	0.170	0.175	0.177	0.178	0.185
		(0.104)	(0.116)	(0.117)	(0.117)	(0.118)	(0.118)
% Attending 1-2 Previous Years		0.493***	0.292***	0.296***	0.291***	0.290***	0.282***
		(0.0852)	(0.0856)	(0.0860)	(0.0854)	(0.0856)	(0.0852)
% Attending 3+ Previous Years		0.490***	0.278***	0.283***	0.278***	0.278***	0.271***
		(0.0822)	(0.0824)	(0.0835)	(0.0830)	(0.0830)	(0.0826)
District Spending ($ millions)							
Operations				0.0646	0.0656	0.0602	0.0716
				(0.0804)	(0.0804)	(0.0803)	(0.0804)
Instruction				-0.135	-0.137	-0.128	-0.149
				(0.135)	(0.135)	(0.135)	(0.135)
Pupil Support				0.0491	0.0492	0.0566	0.0520
				(0.184)	(0.185)	(0.184)	(0.185)
Interactions							
Charter * EconDisadv					3.352		
					(6.455)		
Charter * SPED						-3.772	
						(3.411)	
Charter * Black							5.069
							(4.183)
F-Statistics and P-Values for Joint Hypotheses							
					0.78	1.35	1.41
					(0.4592)	(0.2592)	(0.2437)
County Fixed Effects?	N	N	Y	Y	Y	Y	Y
Constant	59.82***	-208.6***	-177.2***	-179.8***	-180.2***	-174.3***	-176.3***
	(0.579)	(36.86)	(34.47)	(35.99)	(35.98)	(36.24)	(36.53)
Observations	1,534	1,534	1,534	1,534	1,534	1,534	1,534
R-squared	0.101	0.528	0.589	0.590	0.590	0.590	0.590

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Charter Schools and Fifth Grade Proficiency

Tables 10 and 11 report results from regressions with the percent of students scoring proficient or above on fifth grade reading and math assessments as the respective dependent variables. Similar to the results seen for both third grade and fourth grade reading and math, model (1) in both tables shows that, in an OLS regression with no additional covariates, there is a negative and statistically significant difference between charter schools and traditional public schools for in terms of proficiency levels in both subjects in fifth grade. Again, the magnitude of these coefficients is quite large, at -15.8 percentage points for fifth grade reading and -22.1 percentage points for fifth grade math, suggesting that much smaller percentages of economically disadvantaged charter school students are performing at proficient levels for both subjects in fifth grade than their economically disadvantaged counterparts at traditional public schools.

This finding once again changes dramatically when additional covariates are added, as seen in models (2) through (7). For fifth grade reading, once controls are added to the original model, the statistical significance of the charter coefficient disappears, suggesting no significant difference between charter schools and traditional public schools in terms of economically disadvantaged student proficiency for fifth grade reading. For fifth grade math, however, I find statistically significant and negative coefficients for charter schools in models (4) and (7). The charter school dummy in model (4), which is fully specified, is significant at the 10 percent level. In model (7), I find that among schools with comparatively small black populations, charter schools have 9.6 percentage points fewer students proficient in fifth grade math than traditional public schools. Students at charter schools with comparatively large black populations also tend to perform less well in fifth grade math than students at traditional

public schools, although the gap is much smaller at approximately 2.2 percentage points fewer proficient students at those charter schools. The difference between charter schools and traditional public schools in terms of economically disadvantaged proficiency levels for fifth grade math is statistically significant for both charter schools with comparatively large and comparatively small black populations.

Table 10. Regression Results for Fifth Grade Reading

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Key Independent Variable							
Charter	-15.79***	-1.085	-1.238	-1.685	-1.752	-1.940	-3.316
	(1.420)	(1.539)	(1.643)	(1.974)	(6.232)	(2.403)	(3.057)
School Population Factors							
Attendance		0.604*	0.580*	0.572*	0.572*	0.577*	0.576*
		(0.320)	(0.311)	(0.312)	(0.313)	(0.315)	(0.309)
% Econ. Disadvantaged		-0.083***	-0.095***	-0.095***	-0.095***	-0.095***	-0.098***
		(0.0247)	(0.0275)	(0.0281)	(0.0281)	(0.0283)	(0.0282)
% Special Education		-0.213***	-0.222***	-0.213***	-0.213***	-0.218***	-0.204***
		(0.0539)	(0.0559)	(0.0558)	(0.0558)	(0.0581)	(0.0579)
% Limited English Proficient		0.117*	0.102	0.0940	0.0940	0.0941	0.0916
		(0.0607)	(0.0671)	(0.0674)	(0.0674)	(0.0675)	(0.0676)
% Black		-0.264***	-0.249***	-0.238***	-0.238***	-0.237***	-0.243***
		(0.0201)	(0.0222)	(0.0240)	(0.0240)	(0.0241)	(0.0252)
% Asian		-0.0189	-0.0119	-0.00394	-0.00400	-0.00206	-0.00478
		(0.0777)	(0.0859)	(0.0893)	(0.0895)	(0.0901)	(0.0895)
% Hispanic		-0.408***	-0.411***	-0.382***	-0.382***	-0.383***	-0.371***
		(0.0553)	(0.0642)	(0.0651)	(0.0651)	(0.0652)	(0.0683)
% Multiracial		0.0459	0.0146	0.000403	0.000540	-0.00127	0.000584
		(0.130)	(0.143)	(0.145)	(0.144)	(0.145)	(0.145)
% Female		0.324***	0.294***	0.298***	0.298***	0.298***	0.304***
		(0.0895)	(0.0883)	(0.0867)	(0.0867)	(0.0869)	(0.0874)
% Attending 1-2 Previous Years		0.264***	0.289***	0.285***	0.285***	0.286***	0.275***
		(0.0856)	(0.101)	(0.102)	(0.104)	(0.103)	(0.105)
% Attending 3+ Previous Years		0.281***	0.291***	0.293***	0.293***	0.295***	0.283***
		(0.0798)	(0.0951)	(0.0955)	(0.0978)	(0.0963)	(0.0984)

Table 10. (cont.)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
District Spending ($ millions)							
Operations				-0.0519	-0.0519	-0.0515	-0.0479
				(0.0733)	(0.0731)	(0.0734)	(0.0727)
Instruction				0.0581	0.0580	0.0574	0.0506
				(0.125)	(0.124)	(0.125)	(0.124)
Pupil Support				0.273*	0.273*	0.272*	0.274*
				(0.154)	(0.155)	(0.155)	(0.155)
Interactions							
Charter * EconDisadv					0.0746		
					(6.501)		
Charter * SPED						0.705	
						(2.671)	
Charter * Black							2.304
							(3.500)
F-Statistics and P-Values for Joint Hypotheses							
					0.37	0.36	0.62
					(0.6938)	(0.6944)	(0.5357)
County Fixed Effects?	N	N	Y	Y	Y	Y	Y
Constant	47.98***	-32.52	-29.06	-28.79	-28.79	-29.36	-28.39
	(0.493)	(29.84)	(30.72)	(30.24)	(30.26)	(30.53)	(30.09)
Observations	1,420	1,420	1,420	1,420	1,420	1,420	1,420
R-squared	0.074	0.453	0.503	0.505	0.505	0.505	0.505

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 11. Regression Results for Fifth Grade Math

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Key Independent Variable							
Charter	-22.09***	-2.347	-2.249	-4.375*	-3.548	-3.161	-9.648***
	(1.693)	(1.876)	(1.892)	(2.338)	(6.962)	(2.729)	(3.733)
School Population Factors							
Attendance		0.872**	0.757**	0.692**	0.690**	0.667**	0.704**
		(0.386)	(0.365)	(0.330)	(0.330)	(0.329)	(0.319)
% Econ. Disadvantaged		-0.0573**	-0.103***	-0.0762**	-0.0755**	-0.0798**	-0.0845**
		(0.0290)	(0.0320)	(0.0330)	(0.0330)	(0.0332)	(0.0332)
% Special Education		-0.187***	-0.173**	-0.165**	-0.165**	-0.141**	-0.134*
		(0.0686)	(0.0694)	(0.0702)	(0.0702)	(0.0716)	(0.0711)

Table 11. (cont.)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
School Population Factors							
% Limited English Proficient		0.0730 (0.0654)	0.0850 (0.0700)	0.0729 (0.0707)	0.0727 (0.0707)	0.0729 (0.0706)	0.0658 (0.0708)
% Black		-0.314*** (0.0241)	-0.279*** (0.0272)	-0.260*** (0.0289)	-0.260*** (0.0288)	-0.262*** (0.0289)	-0.276*** (0.0293)
% Asian		-0.106 (0.0699)	-0.0546 (0.0695)	-0.0415 (0.0751)	-0.0407 (0.0758)	-0.0506 (0.0763)	-0.0442 (0.0771)
% Hispanic		-0.426*** (0.0658)	-0.384*** (0.0760)	-0.362*** (0.0789)	-0.362*** (0.0789)	-0.359*** (0.0792)	-0.328*** (0.0815)
% Multiracial		-0.383** (0.161)	-0.249 (0.178)	-0.309* (0.179)	-0.310* (0.178)	-0.301* (0.178)	-0.308* (0.178)
% Female		0.180 (0.131)	0.204 (0.141)	0.203 (0.142)	0.203 (0.142)	0.204 (0.142)	0.221 (0.140)
% Attending 1-2 Previous Years		0.543*** (0.107)	0.410*** (0.112)	0.429*** (0.112)	0.431*** (0.113)	0.424*** (0.112)	0.400*** (0.111)
% Attending 3+ Previous Years		0.602*** (0.0996)	0.433*** (0.105)	0.462*** (0.105)	0.464*** (0.106)	0.456*** (0.105)	0.433*** (0.104)
District Spending ($ millions)							
Operations				-0.0933 (0.0862)	-0.0936 (0.0857)	-0.0953 (0.0858)	-0.0803 (0.0856)
Instruction				0.144 (0.147)	0.144 (0.147)	0.148 (0.147)	0.120 (0.146)
Pupil Support				0.150 (0.182)	0.149 (0.183)	0.154 (0.181)	0.156 (0.184)
Interactions							
Charter * EconDisadv					-0.933 (7.245)		
Charter * SPED						-3.351 (3.797)	
Charter * Black							7.442* (4.181)
F-Statistics and P-Values for Joint Hypotheses							
					1.77 (0.1705)	2.24 (0.1074)	3.43 (0.0326)
County Fixed Effects?	N	N	Y	Y	Y	Y	Y

Table 11. (cont.)

F-Statistics and P-Values for Joint Hypotheses							
Constant	50.10***	-73.93**	-48.25	-46.81	-46.89	-44.21	-45.80
	(0.619)	(36.32)	(35.96)	(32.43)	(32.37)	(32.50)	(31.61)
Observations	1,418	1,418	1,418	1,418	1,418	1,418	1,418
R-squared	0.091	0.450	0.526	0.528	0.528	0.528	0.528

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Summary of Results

My findings suggest several conclusions. First, there appears to be no significant difference between charter schools and traditional public schools in terms of elementary school reading performance among economically disadvantaged students for any of the three grade levels included in my analysis. The inclusion of school population factors, county fixed effects, and district level spending for reading models in all three grades dramatically reduces the extent of omitted variable bias in my resulting estimates, which in turn decreases the magnitude of the coefficients on the charter school dummy and removes their significance. However, there does appear to be a statistically significant difference between charter schools and traditional public schools in terms of elementary math performance for economically disadvantaged fourth and fifth grade students. Results suggest that economically disadvantaged fourth and fifth grade students in Ohio perform at lower levels of proficiency at charter schools than at traditional public schools. This relationship is seen and sustained across several different model specifications.

Finally, findings from models with interaction terms suggest that for fourth and fifth grade math, economically disadvantaged students at charter schools with comparatively large black populations are less likely to be proficient or above than are economically disadvantaged students at traditional public schools with comparatively large black

populations. I also find there is a smaller gap in proficiency levels of charter school students relative to traditional public school students for fifth grade math among schools with comparatively small black populations. I find no other significant differences between charter schools and traditional public schools in any other subgroup analyses.

DISCUSSION

This paper explores the relationship between charter school attendance and academic proficiency in reading and math among economically disadvantaged elementary school students in Ohio. Given the increasing interest in alternatives to traditional public schools in the U.S., research on the effectiveness of charter schools at educating traditionally underserved populations is particularly timely. The results of this study can help to inform leaders in the education policy field as they assess the array of alternatives to traditional public schools and craft new policies to govern the increasing number of charter schools in this country.

My results suggest that, among public school students in Ohio, economically disadvantaged students attending charter schools perform no better or worse than low-income traditional public school students on statewide reading assessments in elementary school. However, my results also suggest that low-income students in fourth and fifth grade perform worse on statewide math assessments at charter schools than they do at traditional public schools in Ohio. Further, I find that the difference between the performance of charter school students and traditional public school students varies according to the share of the student body that is black. For schools with large black populations, traditional public schools far

outperform charter schools, whereas, for schools with small black populations, the gap between charter schools and traditional public schools is much smaller.

These findings are at odds with a majority of charter school studies, which often find that charter school attendance is positively associated with student achievement in both reading and math among economically disadvantaged elementary school students (Nicotera et al. 2009; Booker et al. 2004; Sass 2006; CREDO 2013; Hoxby 2004; Hoxby et al. 2009; Abdulkadiroglu et al. 2009; Angrist et al. 2012; Clark et al. 2011). My results instead suggest that there is no significant relationship between charter school attendance and reading proficiency, and that there is a negative relationship between charter school attendance and math proficiency in the fourth and fifth grades. Methodological differences may be driving this discrepancy. The "gold standards" of charter effectiveness studies are those that employ natural experiments created by a lottery enrollment system. However, as Ohio does not have a lottery-based enrollment system for its charter schools, this approach was not a possibility for this study.

Another possible explanation for this discrepancy is the unique context of Ohio's charter school landscape relative to other states analyzed in nationwide studies. CREDO, in its 2009 nationwide assessment of charter school effectiveness, found a negative relationship between the number of charter school authorizers in a state and the performance of charter school students (CREDO 2009). CREDO's finding is relevant for Ohio, which has a particularly high number of charter authorizers relative to other states nationwide, and further suggests that the environment in which charter schools operate matters significantly for their effectiveness. The findings from the present study, which makes use of the most recent student data available, at a minimum support the CREDO finding that, in a state with a high

number of authorizers, there is either no relationship or a negative relationship between charter school attendance and low-income student performance. However, more research is needed to assess the effects of the charter authorizer landscape on student proficiency levels at charter schools.

This study suffers from several other, related limitations. First, my analyses are likely limited by my inability to control for the quality of charter school authorizers. It is possible that charter schools with high-quality authorizers perform better relative to traditional public schools than do charter schools with lower-quality authorizers, and this finding would be consistent with existing literature on charter authorizers (Boast et al. 2016). This literature suggests that an understanding of the relationship between authorizer quality and charter school performance is missing in the current analysis and that future studies should consider distinguishing between charters authorized by high-quality and low-quality authorizers when assessing the difference between charter schools and traditional public schools.

Similarly, I was unable to control for the number of years that a charter school had been in operation prior to the year of analysis. A number of studies, including several showing a negative relationship between charter attendance and academic achievement, note that charter schools often improve in performance each year following their initial year of operation (Zimmer et al. 2009; Yongmei and Rorrer 2012; Booker et al. 2004; Carruthers 2012). This suggests that, as I was not able to disaggregate schools by those in existence for a long period of time versus a short period of time, my results are also somewhat obscured in this regard in the current analysis. Future research should also consider exploring variation in the difference between charters and traditional public schools according to the length of time schools have been in existence.

Finally, evidence suggests that there is a positive association between school-level spending and academic achievement (De Luca and Wood 2016; Hoxby 2004). School-level spending data were unavailable for this study, and district-level spending data were used as a proxy across three categories: operations, instruction, and per-pupil spending. Among these variables, only per-pupil spending was significantly related to student proficiency, and only for some grade levels and model specifications. Charter schools are likely to receive less per-pupil funding than traditional public schools (Hoxby 2004). Thus, the omission of the level of school funding from my analysis is likely generating downward pressure on my key coefficients. Given these limitations, future analyses would ideally include a level of school spending data in order to produce the most credible possible estimates.

Overall, my findings suggest that, at present, charter schools in Ohio may not be helping to close the achievement gap between students from low- and high-income families nor between black and white students. It is plausible that the state's lax charter authorization policies contribute to this dynamic, as the increasing number of authorizing bodies has arguably decreased accountability among the schools that they authorize. State legislation passed in November 2015 included a new series of accountability measures for charter authorizers in Ohio, and more research is required to assess the impact of this legislation on charter student outcomes following its implementation.

The results of this study may contribute to education policy debates on school choice, despite the study's limitations. As most education policy stems from the local level, findings from this study are difficult to generalize beyond Ohio. However, for Ohio, these results suggest that charter schools are not meeting the academic needs of economically disadvantaged students in elementary school and that steps should be taken to ensure that

schools with higher populations of low-income and black students make adjustments to better meet those students' needs. Education policy researchers should continue to explore any factors that may strengthen both charter and traditional public schools in Ohio.

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