Impact of the Indiana Choice Scholarship Program: Achievement Effects for Students in Upper Elementary and Middle School*

R. Joseph Waddington
Assistant Professor
131 Taylor Education Building
University of Kentucky
Lexington, KY 40506
rjwaddington@uky.edu

Mark Berends
Professor of Sociology
1017 Flanner Hall
University of Notre Dame
Notre Dame, IN 46556
mberends@nd.edu

This paper is embargoed until Monday, June 26, at 9 a.m. Eastern Time.

Abstract

As one of the largest voucher programs in the U.S., the Indiana Choice Scholarship Program has over 34,000 students participating to date. This paper examines the impact of the voucher program for students in upper elementary and middle school who use a voucher to transfer from a public to a private school during the 2011-12 through 2014-15 school years—the first four years of the program. We analyze longitudinal data for students (grades 3-8) and use multiple approaches to estimate impacts of the voucher program due to the uniqueness of Indiana public and private schools taking the same standardized assessment over time. Overall, students who receive a voucher experience an average annual loss of 0.10 standard deviations in mathematics after attending a private school compared with matched public school students. The largest math losses occur during the first and second year that voucher students attend a private school. Voucher students remaining in private schools improve in math in later years. In English Language Arts (ELA), we find no statistically meaningful overall effects. However, special education voucher students experience an average annual loss of 0.13 standard deviations in ELA, while voucher students attending Catholic schools experience small annual gains in ELA. Across both subjects, voucher students who exit private schools and return to public schools experience modest-to-substantial achievement losses during their time in private schools. We situate these results in the context of Indiana's voucher program and recent voucher research, and we conclude the paper by suggesting some future research that may help explain our findings.

∗Author order was determined randomly; each contributed equally to this paper. This paper was supported by Notre Dame's Center for Research on Educational Opportunity (CREO), Institute of Educational Initiatives, the Spencer Foundation, and the Walton Family Foundation. We are grateful to the Indiana Department of Education for providing access to the state administrative records and for supporting independent analyses. We are also grateful for the substantial feedback we have received from numerous colleagues over several versions of this paper. All opinions expressed in this paper represent those of the authors and not necessarily the institutions with which they are affiliated. All errors in this paper are solely the responsibility of the authors. For more information, please visit the CREO website at http://creo.nd.edu/people/faculty/mark-berends.

Impact of the Indiana Choice Scholarship Program: Achievement Effects for Students in Upper Elementary and Middle School

Educational inequalities are increasing at a troublesome rate (Gamoran, 2015). Test score trends in the U.S. reveal educational disparity by socioeconomic origins has become worse in the last decade (Reardon, 2011; Reardon et al., 2015); students in poor families are more and more likely to be segregated in poor neighborhoods (Sharkey, 2013); students who are poor, African American, or Latino attend schools that have become more segregated over the past twenty-five years (Orfield & Frankenberg, 2014); and middle- and high-income families are raising their investment in their children's education-related activities at a faster rate than poor families (Kaushal, Magnuson, & Waldfogel, 2011). These increasing inequalities have disturbing implications for the schooling options available to students from different socioeconomic and racial/ethnic groups (Lareau & Goyette, 2014).

One controversial educational policy that seeks to address these problems is school choice—specifically, school vouchers (or scholarships) provided to families so they can send their children to the schools of their choice, whether public or private, religious or non-religious. If voucher programs are succeeding, we would expect that participating students are experiencing new opportunities to learn, increasing their achievement growth, and closing socioeconomic and racial/ethnic achievement gaps. In this paper, we assess those expectations by examining the impact of Indiana's Choice Scholarship Program (ICSP)—the largest voucher program of its type in the U.S.—on student math and English/Language Arts (ELA) achievement. Despite the program's large size, little is known about its effects on Indiana schools and students.

This study aims to address this gap in a context where vouchers have not been randomly assigned to families in Indiana. Instead, our analysis uses a rich set of longitudinal, student-level

records for public and private school students in grades 3-8. We use a variety of estimation strategies to examine the program's impact on students receiving a voucher and switching from a public to a private school during the first four years of the voucher program (2011-12 through 2014-15). This group of voucher students aligns with the initial eligibility requirements and intent of the Indiana voucher program. Our research questions are as follows:

- What is the impact of receiving a voucher and switching to a private school on student math and ELA achievement compared to peers remaining in public schools?
- What are the differences in voucher impacts over time since first receiving a voucher?
- What are the differences in voucher impacts across various subgroups of students (i.e., by sex, race/ethnicity, English proficiency, or special education status) or private schools (i.e., Catholic vs. Other Religious, or urban locale)?

Overall, we find that students who use a voucher to attend private schools experience modest average annual achievement losses in mathematics and no effects in ELA. The losses in mathematics are greatest for students in the first two years after receiving a voucher and dissipate for those who remain in the program and attend private schools for three or four years. However, these estimates are less precise because of the small number of students we can track for three or four years. We also find significant differences across some subgroups of students. Students who exit a private school after receiving a voucher and return to a public school experience the largest losses in both subjects. Catholic school voucher students experience small gains in ELA.

Our research contributes to the existing school voucher literature in three distinct ways. First, as stated above, Indiana's statewide school voucher program is the nation's most expansive

in terms of enrollment and providing scholarships to both low- and modest-income families.[1] Second, our study is one of only a handful that finds modest and statistically significant negative effects of school vouchers on student achievement outcomes. Third, we examined the effects of a voucher program that operates within a different context from other programs, whereby many private schools were participating in statewide accountability testing prior to the implementation of the voucher program. Finally, unlike other statewide studies that cover a shorter time frame (Abdulkdiroglu et al., 2015, Figlio & Karbownik, 2016; Mills & Wolf, in press), we can examine the impact for students who have received a voucher to attend private schools up to four years.

In what follows, we provide a brief background on the Indiana voucher program and the evidence about the effects of vouchers on student achievement based on prior rigorous research. We go on to describe the data and our approach to analyzing the effects of the first four years of the statewide program. We conclude with the results and a discussion of their implications.

THE INDIANA CHOICE SCHOLARSHIP PROGRAM

Currently, sixteen states have voucher programs, and 178,261 students are using them to attend private schools (EdChoice, 2017). In Indiana, which has the largest program, 34,299 students received a voucher during the 2016-2017 school year and 313 private schools participated (76 percent of private sector schools statewide) (Indiana Department of Education, 2017). Authorized in 2011, the Indiana Choice Scholarship Program (ICSP) provides state payments to qualifying Indiana families to help offset tuition at participating schools. When the program began, students qualified for vouchers based on their prior enrollment in a public school and their family's total household income. The scholarship's dollar amount is based on the

[1] The State of Ohio has more students enrolled in voucher programs across the state. However, these students are spread across five different programs, each with their own eligibility criteria and focus.

public school corporation in which students live, with an average in grades 1-8 of about $4,700 (Indiana Department of Education, 2017). The program made available 7,500 vouchers for the 2011-2012 school year and 15,000 in 2012-2013. Starting in 2013-2014, the state removed the cap on the number of eligible Indiana students who can receive a scholarship. It also expanded the criteria for eligibility to include kindergarten students, siblings of voucher students, special education students, and those located in the attendance zones of failing public schools.

Although researchers have studied the effects of various school voucher programs and policies over the past two decades (for reviews see Austin & Berends, in press; Epple, Romano, & Urquiola, 2015; Figlio, 2009; Shakeel, Anderson, & Wolf, 2016; Zimmer & Bettinger, 2015), the Indiana voucher program is unique.[2] Unlike other programs, the ICSP is aimed at both low- and modest-income families. Low-income families may obtain vouchers for up to 90 percent of tuition at a participating private school if their annual income is equal to or less than 100 percent of the amount to qualify for free or reduced-price lunch (FRPL) under the National School Lunch Program (Indiana Department of Education, 2017). For a four-person household, that amount is $44,955. Moderate-income families may obtain 50 percent vouchers if their annual income is equal to or less than 150 percent of the amount to qualify for FRPL; for a four-person household, that amount is $67,433 (Indiana Department of Education, 2017).

[2] With the new Trump administration and discussions about turning Title I money into vouchers and the possibility of bundling state and federal education funds, states like Indiana may be poised to significantly expand their voucher programs (Berends, in press). Thus, understanding the effects of Indiana's student voucher use informs state and national education policy at a critical time.

VOUCHER RESEARCH ON STUDENT ACHIEVEMENT OUTCOMES

Voucher programs are typically aimed at low-income families to offer educational opportunities they may not otherwise access: schools that better meet their children's academic needs. Proponents claim that, as more schools compete for students, all schools will become more effective in encouraging positive student outcomes, especially for low-income students (Chubb & Moe, 1990). Friedman (1955, 1962) was one of the first to use this market theory, arguing that the cost of K-12 education should be covered by the government but parents should be able to choose the schools their children attend, whether public or private. Toward this end, Friedman promoted giving parents government vouchers as a way to accomplish a system of education that was publicly financed but delivered privately and publicly.

Critics, however, raise questions about the empirical validity of the market theory's key assumptions about parents as consumers (demand-side), schools (supply-side), and the products that a market in education would generate (Austin & Berends, in press; Finnegan, 2007; Henig, 1995; Hess, 2002, Levin, 1998). They emphasize that public schools support the "common school" model that promotes civic and democratic values among its students. In this light, critics argue, vouchers may increase already existing inequalities by skimming off the best students, decrease support of public schools due to falling enrollments in an era of fiscal challenges, and undermine our democracy. Moreover, students who transfer with vouchers may experience achievement losses because student mobility is often associated with negative school outcomes, independent of the quality of the school (Grigg, 2012; Schwartz, Stiefel, & Cordes, in press).

With the global expansion in the number of voucher programs, research addressing the effects of these programs has increased as well (Berends, in press). Evidence can be drawn from

both publicly- and privately-funded voucher programs in the U.S. and from international research (Epple et al., 2015; Figlio, 2009; Shakeel et al., 2016; Zimmer & Bettinger, 2015).

A number of voucher studies have focused on specific cities—Milwaukee (Greene, Peterson, and Du, 1998, 1999; Rouse, 1998; Witte, 2000; Witte et al., 2014), Charlotte (Cowen, 2008; Greene, 2001), Cleveland (Metcalf et al., 2002), Dayton (Howell & Peterson, 2006), New York City (Barnard et al., 2003; Jin, Barnard, & Rubin, 2010; Krueger & Zhu, 2004) and Washington, DC (Howell & Peterson, 2006; Wolf & McShane, 2013; Wolf et al., 2010, 2011, 2013). Generally, the experimental and quasi-experimental research in these cities shows either modest positive effects on student test scores for certain subgroups of students and for certain years of program participation, or no effects at all (Austin & Berends, in press; Epple et al., 2015; Figlio, 2009; Zimmer & Bettinger, 2015).[3]

More recent statewide studies on the impact of voucher programs in Louisiana and Ohio have shown negative effects on student achievement. Abdulkdiroglu et al. (2015) examined the Louisiana Scholarship Program, analyzing data between 2008 (the first year of the program) and 2012. Following students who won and lost the lottery for a scholarship, Abdulkdiroglu et al. found significant and large negative effects for students who participated in the first year of the voucher program—with declines of 16 percentile points in math and 14 percentile points in reading. The effects were consistent across income groups, geographic areas, and private school characteristics (higher and lower proportion of white students, enrollment, achievement scores, and whether the private school was Catholic).

[3] The exception to these overall findings is a recent study in Washington, DC, on the DC Opportunity Scholarship Program that found negative effects in mathematics after the first year of the program (Dynarski et al., 2017).

Mills & Wolf (in press) investigated the Louisiana program through its second year, reporting negative effects in both math and reading in year one, but less negative effects in year two. Only the effects for mathematics were statistically significant. In mathematics in year two, they found that students who won the voucher lottery and transferred to a public school scored 0.34 of a standard deviation below those students who lost the voucher lottery. "The magnitude of these negative estimates," the researchers wrote, "is unprecedented in the literature of random assignment evaluations of school voucher programs" (p. 2).

These findings are consistent with what Figlio & Karbownik (2016) found in their evaluation of the Ohio EdChoice Scholarship Program. The researchers used propensity score matching to estimate the program's effects because the program did not rely on a lottery to provide scholarships. Analyzing student-level data between 2007 and 2010, with several estimation specifications, they found significant negative effects on both reading and mathematics scores: about -0.40 to -0.20 standard deviations in reading and -0.60 to -0.45 standard deviations in mathematics.

In our study of the ICSP, we also find negative effects in mathematics for students who transfer from public to private schools with a voucher. However, our research differs from evaluations of the Louisiana and Ohio statewide voucher programs in a number of ways. Unlike Louisiana and Ohio, students in Indiana's public and private schools have all taken the same state tests for a number of years. Thus, our findings come from a state context where annual testing in grades 3-8 is common across the board, particularly in a broad sample of over 300 voucher-participating private schools. In the year prior to the voucher program (2010-2011), the average private school has achievement 0.1 to 0.2 standard deviations above the state mean in both math and ELA. While average private school achievement varies substantially, there are

many higher performing private schools participating in Indiana than in other states.[4] In addition to broader income eligibility in Indiana, students from all public schools are eligible as opposed to just those enrolled in the lowest performing schools as in Ohio. While students in low- or modest-income families may be eligible to receive a voucher, we focus on the lowest-income students for estimation purposes and better comparisons of our findings with other contexts.

DATA AND MEASURES

Data Description

We use six years (2009-2010 school year through 2014-2015) of longitudinal, student-level demographic and test score records for this study, obtained through a data-sharing agreement with the Indiana Department of Education. The records contain information about students attending public (traditional, charter, and magnet) and private schools (including voucher and non-voucher students), which participate in the Indiana Statewide Testing for Educational Progress Plus (ISTEP+) program. The ISTEP+ is aligned to the Indiana Academic Standards and serves as the main accountability-linked assessment for Indiana students in grades 3-8. Testing has taken place each spring since 2009 in mathematics and English/language arts (ELA) (Indiana Department of Education, 2011).[5]

Indiana is unique because many private schools participate in the ISTEP+ program and other state reporting (304 schools statewide as of 2015). Participation in ISTEP+ testing is a

[4] Most elite, non-sectarian private schools do not participate in the voucher program.

[5] The ISTEP+ is vertically equated across grades and consists of multiple-choice, constructed-response, and extended-response items scored using item response theory methods. Reliability coefficients range from 0.88 to 0.94 in ELA and 0.88 to 0.95 in math (Indiana Department of Education, 2011).

requirement of all private schools participating in the voucher program.[6] However, nearly all K-8 Catholic schools and over 80 other K-8 private schools, participated in statewide testing as part of their accreditation process for several years prior to the start of the voucher program. Additional private schools began taking the ISTEP+ after starting participation in the voucher program. All students in private schools enrolling students with vouchers take the test, regardless of whether an individual student received a voucher.

The robust annual participation in statewide testing and other reporting by private schools offers several advantages. First, we can make apples-to-apples achievement comparisons between voucher private and non-voucher public school students. Second, the number of participating schools and the testing of non-voucher private school students allows us to better describe the academic composition of the private school sector in Indiana. Third, because each student's testing records are longitudinally-linked, we can observe changes in an individual student's achievement over time, regardless of the sector in which they are enrolled.

Measures

The primary outcomes of interest are students' annual ISTEP+ test scores in mathematics and ELA. These are the two subjects tested annually during grades 3-8. We standardized each of the scaled test scores relative to the mean and standard deviation of students statewide within

[6] The Indiana Department of Education holds voucher program-participating private schools accountable through their performance on the ISTEP+ assessment by restricting their ability to enroll students receiving vouchers should the school have two consecutive years of poor testing performance.

each subject, grade, and year of testing.[7] The standardized measures allow us to draw comparisons, in standard deviation (SD) units relative to the state average of all test takers.

We use several student-level demographic and background characteristics reported in the IDOE data, including indicators of each student's gender, race/ethnicity, free or reduced-price lunch status, English Language Learner status (ELL), special education status, and grade level. We created an indicator for grade retention from the previous year. We also observe whether a student receives a voucher in each year. This allows us to construct an annual indicator of voucher receipt and a measure of the total number of years a student received a voucher.

Along with voucher recipient status, we also observe the student's school of record within each year. The school records contain each school's unique National Center for Education Statistics (NCES) unique identification number. Using the NCES ID, we linked the schools to the Common Core of Data (CCD) and the Private School Universe Survey (PSS) to augment and enhance the available school-level data.[8] We used these data to create binary indicators of the school type (e.g., public, charter, magnet, Catholic, or other private) and private school locale (urban, suburban, or town/rural). We manually enter this information for schools with missing

[7] Although the ISTEP+ is vertically equated, we do not use scaled scores for our outcome as the variation in scales differs between grade levels. This introduces additional measurement error; however, we adjust for differences between years and across tests by controlling for grade-by-year fixed effects in all models.

[8] The CCD contains annual demographic and background information for the universe of public schools. Similarly, the biennial PSS contains similar information for private schools. We applied CCD data to all public schools for each corresponding year, except 2014-2015, for which we use data from the 2013-2014 CCD. Similarly, we applied PSS data from the most recent prior year to all private schools. Private schools in the IDOE data from 2011-2012 through 2014-2015 contain PSS information from 2011-2012, the last year of publicly available data.

data. With the school identifiers, we created several aggregate measures using student-level data, including average school math and ELA achievement as well as various counts of students.

With information about schools, we created two student mobility indicators to identify all students who switch schools between years, regardless of whether a student changes school type (e.g., public to private). The first indicates whether a student made a structural move due to normal grade progression. The second indicates whether a student made a nonstructural move (switching schools for any other reason; we do not observe the underlying reasons). Both variables indicate a switch only in the school year immediately after the switch took place (*t*), even though the switch takes place between years *t* and *t-1*. There is a negative association between mobility and student achievement (see Schwartz, Steifel, & Cordes, in press), so these indicators enable us to parse out the impact of switching schools from any voucher impacts.

ANALYTICAL SAMPLE AND ESTIMATION STRATEGY

Our main research question pertains to the academic achievement of voucher students who attend private schools. In an ideal experimental setting, voucher-eligible students attending public schools ideally would be randomly assigned an offer to receive a voucher. We could then estimate unbiased intent-to-treat effects of being offered a voucher on student achievement by comparing the achievement gains of students offered and not offered a voucher. We would then also be able to use this assignment as an instrument in a two-stage least squares approach for actual voucher use and attendance in a private school. Here, we could obtain the treatment-on-the-treated effects of private school attendance on student achievement. Many voucher programs

(e.g., Milwaukee, New York City, Washington, DC, Louisiana) either randomly assigned vouchers or held voucher lotteries, enabling researchers to estimate causal effects.[9]

In Indiana, vouchers were not randomly assigned to students through the Indiana Choice Scholarship Program. Thus, it is challenging to assess the causal effects of receiving a voucher and attending a private school on student outcomes. Individual private schools participating in the voucher program are not required to hold lotteries to determine enrollment, except for oversubscribed schools. Most private schools had an excess supply of available seats over the period of our study, and we found no private schools that implemented enrollment lotteries.[10] We do observe any student who receives a voucher and attend a private school in grades 3-8.[11]

Without a random assignment of vouchers or a natural experiment such as a lottery, any assessment of the effects of Indiana's voucher program is subject to selection bias. Choosing to apply for and receiving a voucher depends on the active choices of parents and their children. These choices typically depend on student background, parental preferences, motivation, and available opportunities in public or other choice (e.g., charter, magnet) schools. For example, if students with high aptitude or motivation apply for and receive a voucher, then the performance of voucher students might appear better than non-voucher students because of potentially unobserved background differences between students. Thus, we cannot simply compare the achievement of voucher and non-voucher students.

[9] Many recent evaluations of charter schools (e.g., Abdulkadiroglu et al., 2011; Angrist et al., 2012; Dobbie & Fryer, 2011; Clark et al., 2015) use a similar approach in instances where charter schools hold enrollment lotteries.

[10] We contacted each of the five Catholic dioceses in the state, the Indiana Non-Public Education Association, and the Indiana Department of Education to confirm this in the first years of the voucher program.

[11] We observe very few voucher "decliners," or students who apply for a voucher but do not receive one. From principal and parent interviews, families only apply for vouchers if they know they meet the eligibility criteria.

Given the availability of longitudinal data and the eligibility criteria of the Indiana Choice Scholarship Program, we take several steps to mitigate selection bias. First, we describe the process of creating a comparable sample of students who receive a voucher and attend a private school and students who do not receive a voucher and remain enrolled in a public school. Then, we describe multiple strategies used to estimate the effects of the voucher program on student achievement. For both the sample construction and estimation strategies, we draw upon important lessons from recent literature that uses non-experimental approaches to replicate the experimental estimates of school choice evaluations (Anderson & Wolf, 2017; Bifulco, 2012; Fortson, Gleason, Kopa, & Verbitsky-Savitz, 2014).

We implemented several data restrictions prior to sample construction (see Appendix A), including requiring each student to have three years of valid test scores. After these restrictions, we have a possible sample of 11,828 voucher students and 551,110 public school students.

Voucher Student Sample

A student must meet several eligibility criteria to qualify for a voucher in Indiana. One criterion from the initial implementation of the policy was that a student had to be enrolled in a public school (either traditional public, charter, or magnet) for at least one year immediately prior to receiving a voucher. In our cleaned data, 4,415 students moved from a public to a private school for the first time after receiving a voucher.[12] Of the students who were once enrolled in a private school without a voucher, 209 left for one year to attend a public school, and returned to a private school after receiving a voucher.[13] The other 7,204 students received a voucher while

[12] Some of these students eventually exit a private school after receiving a voucher and return to a public school. We include both students who remain in a private school and those who return to a public school in our analysis.

[13] We believe these 209 students and their families made these decisions to become eligible for a voucher.

previously enrolled in a private school, largely a result of expanded voucher eligibility criteria beginning in the 2013-2014 school year.[14]

There are several advantages to focusing our analysis on the voucher students moving from a public to a private school for the first time. First, this movement is typical of other voucher programs, and most evaluations compare voucher and public school students. With longitudinal records of public school students, we can draw comparisons of voucher students switching to private schools with students remaining in public schools and not receiving a voucher. Second, previous enrollment in a public school allows us to establish a baseline level of student achievement before receiving a voucher and attending a private school. We could establish a baseline prior to receiving a voucher for students previously enrolled in a private school; however, these students have prior private school experience. We display comparisons of all voucher and non-voucher private school students in Appendix Table 1. We find voucher students who were always enrolled in private schools are much higher achieving and less diverse.

The second eligibility criterion for all voucher students is based on family income. The voucher income thresholds based on household size directly correspond to the thresholds for reduced-price lunch eligibility (Indiana Department of Education, 2017). Students in families at or below the income threshold for reduced-lunch eligibility can receive a “90 percent” or “full” voucher for tuition at a private school. Students in families at or below 150 percent of the income threshold for reduced-lunch eligibility can receive a “50 percent” or “half” voucher.

Because of the direct correspondence with reduced-price lunch eligibility, we focus on the 3,913 voucher students switching from public to private schools that either receive a “full”

[14] Of these students, 663 later attended public school while 6,541 were always enrolled in a private school.

voucher or received free or reduced-price lunch in the year prior to receiving a voucher. We refer to this group of voucher students as "low income."[15] We find non-low income voucher students have much higher achievement before receiving a voucher and are less diverse.

Public School Comparison Student Sample

As our voucher student sample consists of students leaving public schools to attend private schools, not all Indiana public schools are represented. One of the important takeaways from the education within-study comparison literature and broader quasi-experimental literature (for example, see Cook, Shadish, & Wong, 2008) is that treatment and comparison groups should be drawn from the same geographic location (i.e., the same school). We further constrain our public-school comparison sample to include only public school students in the same grade, year, and school as a student who receives a voucher and attends a private school the following year.[16] This process also establishes a baseline year from which we can draw comparisons between voucher and public school students over time.

Because voucher eligibility is based on family income, we further constrain the public-school comparison group to students who also receive free or reduced-price lunch in the baseline or first post-baseline year. By constraining our sample, we can draw more relevant comparisons between voucher students and non-voucher public students who would also be "voucher-eligible." In effect, this mitigates the unobserved influence that family income may have on selecting to attend a private school. This leaves 121,524 low-income public school students in

[15] As income fluctuates, we wanted to account for indications that a family is low-income in either the year before receiving a voucher (baseline year) or the year after. We use a similar procedure for public school students.

[16] Some public school students have peers who leave to attend a private school with a voucher across several grades and years. To avoid replicating individual students in our sample, we randomly choose which of a given public school student's years serves as the baseline year.

the same school as a voucher student who leaves to attend a private school in the subsequent year. We provide a descriptive comparison of all public school students in Appendix Table 2.

Student Descriptive Characteristics

In Table 1, we describe the sample of 3,913 voucher and 121,524 public school low-income students that were enrolled in the same public school and grade during the baseline year. For each student, we have data from at least three years: pre-baseline, baseline, and at least one year post-baseline. For our descriptive analysis and all subsequent empirical model estimates with this sample, we weight the sample to compare equal numbers of voucher and public school students within each public school, grade, and year at baseline.[17]

More than half of the low-income voucher students are racial or ethnic minorities, with a slightly lower proportion of black students (0.230) and higher proportion of Latino/a students (0.235) relative to their low-income public school peers (0.272 proportion of black students and 0.184 of Latino/a students). The proportion of voucher students classified as English Language Learners is 0.124 and as special education students is 0.118 at baseline. In the voucher sample, ELL students are overrepresented and special education students underrepresented compared to the public school peer sample. Over half of the low-income voucher and public school students are attending urban public schools at baseline.

In terms of academic achievement, low-income voucher students are lower achieving compared to the state average by nearly one-fourth of a standard deviation (SD) in both math and ELA. However, voucher students are higher achieving than their public school peers by about a tenth of a SD in both subjects. Overall, the low average achievement and diversity of low-

[17] Each voucher student has a weight of 1 and each public student has a weight of the total number of voucher students divided by the total number of public students in each public school, grade, and year at baseline.

income voucher students previously attending public schools suggests that private schools are not "cream-skimming" the best students from public schools who are eligible for a voucher.

While Table 1 provides a comparison between low-income voucher and public school students, it is also important to compare back to all other private school students for context (see Appendix Table 1). Low-income voucher students switching from public to private schools tend to be more demographically and academically diverse as well as lower achieving at baseline than their non-low-income voucher peers making the same public to private schools. The differences in demographic and academic composition is particularly stark when comparing to voucher students always enrolled in a private school (receiving a voucher or not). Thus, low-income voucher students are moving into environments substantially behind their peers in terms of academic achievement (by up to a half of a SD).

Propensity Score Matching

Although we have specifically focused on low-income voucher and public school students who are more closely aligned than a broader sample of public school students, we still find a number statistically meaningful differences between the two groups at baseline. These differences on several observable dimensions suggests that students in the two groups may also differ on unobservable dimensions. If we do not fail to account for these differences at baseline, our results may still be subject to selection bias.

Given that qualified students and their families choose to receive a voucher and switch to a private school for many observed and unobserved reasons, we use propensity score matching (PSM) to further align our treatment group of low-income voucher students and comparison group of low-income students remaining in public schools. Pioneered by Rosenbaum & Rubin (1983), PSM has grown in popularity across disciplines as a mechanism to account for selection

bias in observational studies. It is one of the primary techniques used in the within-study comparisons we previously described. In using PSM, we attempt to account for selection bias by modeling a host of observable characteristics measured prior to treatment to predict the likelihood, or propensity, of receiving a voucher to attend a private school. Then, we match low-income voucher students who attend a private school with their low-income peers remaining in a public school that share a similar propensity of receiving a voucher.

Our first step in the propensity score matching approach is to use a linear composite of carefully chosen pre-treatment (baseline) covariates to predict voucher receipt. Following the suggestions of the within-study comparison literature, we include pre-treatment measures of our two primary outcome variables (math and ELA test scores) as predictors in the propensity score model. We also include second and third order polynomials of test scores as well as achievement in the pre-baseline year to account for any test score trends.

In addition to test scores, we also include baseline information about the student's sex, race/ethnicity, special education status, English Language Learner status, whether the student was retained in the baseline year, whether the student attended a charter or magnet school, and public school urban locale. We also include several interactions between the baseline achievement variables and various demographic and academic background characteristics as well as between race/ethnicity and several academic background characteristics. We account for selection effects by grade and year.

We proceed by estimating a logistic regression model with these characteristics. The fitted values for each student from this analysis serve as the probability, or propensity, that a student receives a voucher and switches to a private school in the subsequent year. We note that between the low proportion of voucher students relative to public students and already restricting

our sample on the strongest predictor of voucher receipt – free or reduced price lunch receipt – we find low overall propensities. We are still able to match students well as we describe below.

Next, we match voucher and public school students within each public school, grade, and year at baseline based on each student's propensity score. We match voucher students with up to five public school students who share a propensity score within a likelihood caliper of ±0.003. This value represents one-fifth of a propensity score SD in this sample. If there are no public school comparison students within this caliper and school-grade-year strata, the voucher student is left unmatched. Public school students are matched with replacement and can be matched to multiple voucher students within the school-grade-year strata. With our matching procedure, we matched 83.6 percent of low-income voucher students (3,276 total) to at least one low-income public school peer (12,406 total) in their same school, grade, and baseline year. For all descriptive and empirical analyses with the propensity score matched sample, we also construct weights to enable us to compare equal numbers of voucher and public school students.[18]

After matching, we return to our descriptive results (Table 1) to check for balance between the matched voucher and public students at baseline. Overall, we find excellent balance across a host of covariates, with the only small significant difference in the proportion of ELL students in each group. Perhaps most importantly, the baseline math and ELA achievement of voucher and public students is roughly the same. While propensity score matching only mitigates potential selection bias based on the observable dimensions upon which students are matched, the lack of pre-treatment differences suggests that students are much more likely to be aligned

[18] As before, each voucher student has a weight of 1. Because voucher students may be matched to multiple public students and public students may be matched to more than one voucher student, the weight for a public school student equals the total of voucher students to which a public school student is matched divided by the total number public student matches for those voucher students in each public school, grade, and year at baseline.

along unobservable dimensions as well. Therefore, we rely upon the propensity score matched sample for our empirical models. We also include relevant dimensions of the unmatched and matched voucher student sample in Appendix Table 3.

Estimation Strategies

Through our sample construction, particularly in creating the propensity score matched sample, we have already dealt with many selection bias issues between voucher and private school students. Despite having a comparable sample, a simple comparison of voucher and public school student achievement may still be biased if we have not accounted for unobserved factors that drive selection. We describe our estimation approaches that provide further robustness and enhance the internal validity of our estimates.

OLS Regression

We begin with a OLS regression model with several covariates as shown below.

$$Y_{igt} = \alpha + \beta Voucher_{igt} + \delta \mathbf{W}_i + \delta \mathbf{X}_{igt} + \theta_{gt} + \upsilon_{igt} \quad (1)$$

Here, the achievement level (Y) for each student (i) in grade (g) and year (t) is a function receiving a voucher and attending a private school ($Voucher_{igt}$). We control for a vector of time-invariant ($\mathbf{W}_i$) student characteristics such as sex and race/ethnicity. We also control for time-varying student and school characteristics ($\mathbf{X}_{it}$) that include: ELL and special education status; structural and non-structural school changes in year (t) interacted with grade level (g); public school type (e.g., charter or magnet vs. traditional public); and school locale (suburban or town/rural vs. urban). Grade-by-year effects (θ_{gt}) account for systematic differences across exams and over time. The term υ_{it} represents school cluster-robust standard errors to account for serial correlation amongst students within the same school and is used in all models. We estimate separate models with math and ELA achievement levels.

Our estimate of the voucher program effect (β) will be unbiased if we have accounted for all covariates that could explain differences between voucher and public students. By controlling for many of the same covariates used in the propensity score matching model, we incorporate additional robustness in case of misspecification in either the OLS or propensity score model. However, we are investigating voucher impacts over time and our estimates may be biased if we do not account for pre-treatment differences between voucher and public school students.

Difference-in-Differences

To account for pre-treatment differences, we can modify the OLS model (1) to include a difference-in-differences (DD) estimate of voucher effects on achievement.

$$Y_{igt} = \alpha + \beta Voucher_{igt} + \rho Post_{igt} + \gamma VStud_{igt} + \delta \mathbf{W}_i + \delta \mathbf{X}_{igt} + \theta_{gt} + \upsilon_{igt} \quad (2)$$

In (2), we include a new predictor ($Post_{igt}$) which is a dichotomous indicator for all years after baseline. This accounts for the underlying secular trends in achievement following treatment that impact all students. The other new variable in (2) is the indicator ($VStud._{igt}$). This accounts for pre-treatment differences in achievement levels between voucher and public school students. Our treatment variable ($Voucher_{igt}$) is merely the interaction between the post and voucher student indicators. Thus, β is now the DD estimate, or the added impact on achievement for voucher students when attending private schools after accounting for underlying trends over time and starting-gate differences between voucher and public students.

Regarding internal validity, the balance between voucher and public students in the matched sample combined with the DD model should lend itself to credible estimates of the impact of receiving a voucher and attending a private school on a student's achievement level. However, this claim is only valid if there remains no other unobservables not accounted for in the propensity score matching or DD models and if there are no pre-treatment trends.

Fixed Effects

An analogue of the DD model is the student fixed effects (FE) model, show in (3) below.

$$Y_{igt} = \alpha + \beta Voucher_{igt} + \delta \mathbf{X}_{igt} + \theta_{gt} + \mu_i + \upsilon_{igt} \quad (3)$$

The inclusion of the student-specific fixed effect (μ_i) accounts for unobserved, time-invariant differences between students, thereby removing time-invariant student controls. In the FE model β is the within-student difference in voucher student achievement before and after switching to a private school. As we are estimating voucher impacts for students switching school sectors, the FE model is well suited for identifying effects. However, it is subject to the same limitations as the DD model, and less suitable for comparing voucher and public school student outcomes.

Accounting for Prior Student Achievement to Measure Achievement Gains

One underlying issue with the estimation of achievement levels in all models is that prior test scores influence current achievement. We can account for each student's achievement in the prior year (Y_{igt-1}) as a lag in each model.

$$Y_{igt} = \alpha + \beta Voucher_{igt} + Y_{igt-1} + \delta \mathbf{W}_i + \delta \mathbf{X}_{igt} + \theta_{gt} + \upsilon_{igt} \quad (4)$$

$$Y_{igt} = \alpha + \beta Voucher_{igt} + \rho Post_{igt} + \gamma VStud_{igt} + Y_{igt-1} + \delta \mathbf{W}_i + \delta \mathbf{X}_{igt} + \theta_{gt} + \upsilon_{igt} \quad (5)$$

$$Y_{igt} = \alpha + \beta Voucher_{igt} + Y_{igt-1} + \delta \mathbf{X}_{igt} + \theta_{gt} + \mu_i + \upsilon_{igt} \quad (6)$$

Equations (4), (5), and (6) above represent the inclusion of prior achievement in to the OLS, DD, and FE models, respectively. After accounting for prior achievement, we can describe our estimates of the voucher program effects as value-added achievement gains. One issue with this is that lagged prior achievement scores are endogenous, especially in the post-baseline years. We deal with this issue in two ways. First, we follow the lead of Imberman (2011), whereby we refer to the levels and gains estimates collectively as bounded estimates of the true voucher effect. Second, we include a robustness check where we control for prior achievement only in the pre-

treatment years (baseline and pre-baseline). We find no meaningful differences in our estimates.[19]

The incorporation of prior achievement also provides an advantage in that we are now able to test for the presence of differing pre-treatment trends between voucher and public students. This pre-treatment phenomenon, known in the job-training literature as "Ashenfelter's Dip" (Ashenfelter 1978), suggests that a substantial drop student performance may be a signal to parents to have their child change schools. If this were the case, some students may be more likely to receive a voucher than others, yielding biased estimates.

With the DD model, we can explicitly test for differing pre-treatment trends in two ways. First, in our preferred model (5), the indicator ($VStud_{.igt}$) now measures whether there are any pre-treatment differences in achievement *gains* between voucher and public school students. Second, as we parse out differences in voucher effects by year with the DD model, we include a full "event study" set of estimates across all pre- and post-treatment years. If the ($VStud_{.igt}$) indicator in the main DD model and pre-treatment event study estimates are not statistically significant, this suggests we should not be concerned about pre-treatment trends. We also conduct a host of other robustness checks, all displayed in Table 4 and described in Appendix B.

Because of how we defined our sample, all our estimates of the voucher program effect on achievement rely on students who use a voucher to switch from public to private schools. This limits the generalizability of our findings because we do not estimate voucher effects for those who are always enrolled in private schools.[20] Voucher students switching from public to

[19] Our preferred model is the DD model. If we used the FE model, we would also provide Arellano-Bond estimates.

[20] We do not to estimate voucher effects for students always enrolled in private schools because we do not want to make strong assumptions about prior achievement or geographic matching without a comparison school context.

private schools are different in terms of baseline characteristics from voucher students always enrolled in private schools (see Appendix Table 1). Our approach also requires at least three successive years of test score data, which excludes many students from the analysis. Thus, most our estimates of voucher program impacts are constrained to students in grades 5 to 8.

RESULTS

Main Effects of Receiving a Voucher and Attending a Private School

We next describe the estimated effects of receiving a voucher and attending a private school on academic achievement. In Tables 2 and 3, we display the results of the several models we estimated for mathematics and English Language Arts (ELA), respectively, including our preferred difference-in-difference (DD) model with the propensity score matched (PSM) sample. Overall, based on the DD PSM model, students who switch from a public to a private school with a voucher score 0.086 standard deviations (SD) lower in mathematics compared with their public school peers. In addition, compared to voucher students' achievement while in a public school, voucher students experience an annual loss of 0.157 SD in math when enrolled in a private school (PSM FE model 6).[21] The estimates across our mathematics levels models range from -0.151 SD in the all low-income FE model 3 to -0.063 SD in the OLS model 1 for all low-income students, and the estimates in the mathematics gains models range from -0.168 SD in all low-income FE model 6 to -0.096 SD in all low-income OLS model 1.

--- INSERT TABLE 2 HERE ---

In English Language Arts (ELA), there are no significant effects in our preferred DD PSM levels or gains models. In the other models, there are generally tiny or insignificant effects

[21] The fixed effects model inherently incorporates the post-baseline trends and voucher-public baseline/pre-baseline differences as displayed in the difference-in-differences model.

(see Table 2). Students who transfer to a private school with a voucher score -0.026 SD lower (PSM FE model 6) and experience an annual loss of -0.029 SD (PSM FE model 6) when attending a private school compared with their previous ELA scores in a public school. However, both estimates are only marginally significant and very small (less than 1 percentile point). The range in estimates for the ELA levels models is -0.044 to 0.064 SD.

--- INSERT TABLE 3 HERE ---

One of the important assumptions for the validity of the preferred DD estimates is the lack of differing pre-treatment trends between voucher and public students. We find significantly different pre-treatment trends in the broader unmatched sample. However, we do not find statistically differing pre-treatment trends in our preferred propensity score matched sample. This finding strengthens the credibility of both our DD results and our decision to match students.

Robustness Checks

We also estimated a series of robustness checks for the main mathematics and ELA estimates from our preferred DD PSM levels and gains models in Table 4. We estimate eight alternative models to assess the robustness of the main voucher effects. The robustness checks include: (1) constraining our results to only those students making structural school changes (2) removing mobility indicators; (3) removing special education status as a control; (4) using a gain score as the dependent measure; (5) adding an additional control for prior achievement in the off subject; (6) including only prior achievement during the pre-treatment period; (7) keeping students who exited private schools in the treatment group; and (8) taking out the Indianapolis urban area schools. We detail the rationale behind these robustness checks in Appendix B.

--- INSERT TABLE 4 HERE ---

Compared with our preferred DD PSM mathematics estimates of -0.086 SD in the levels model and -0.100 SD per year in the gains model, the other model specifications and sensitivity analyses reveal estimates ranging from -0.182 to -0.079 SD in the levels models and from -0.123 to -0.071 SD in the gains models. Each of these estimates is statistically significant at the $p \leq 0.05$ level. This suggests that our preferred estimates in mathematics are robust, bounded in a range of -0.182 to -0.071 SD. For ELA, the preferred DD PSM levels and gains estimates are nearly zero and statistically insignificant. Except for one estimate (-0.057 SD; [$p \leq 0.05$] in the structural changes only gains model), the robustness checks reveal that our preferred estimates are null and not statistically significant. Thus, we conclude there is a null average impact of using a voucher to attend a private school on student ELA scores.

Effects by Year in Voucher Program

In order to better understand these overall estimates, we first examined the effects of the voucher program by number of years that a student received a voucher. Given that the program has been in place for four years corresponding with our longitudinal data, we estimate first, second, third, and fourth year effects based on the duration that a given student has received a voucher (see Table 5). In mathematics, the largest losses occur during the first (-0.120 SD) and second year (-0.122 SD) that voucher students attend a private school. Voucher students are still statistically significantly behind their public school peers by -0.089 SD in math in year three. By year four, voucher students who remain enrolled in a private school regain what they lost relative to public school students. There is no statistically significant difference between voucher and public school students' math achievement in year four.

--- INSERT TABLE 5 HERE ---

In ELA, students experience significant losses in year two (-0.087 SD), but recoup those losses in year 3 (gain of 0.065 SD) (see Table 5). These ELA results indicate some flipping between voucher and public school students over the first couple of years from baseline. By year four, voucher students have higher achievement (0.134 SD), although this is only marginally statistically significant ($p<0.10$).

It is important to note that the year three and year four estimates in both subjects are highly variable due to the relatively small number of voucher students we observe across three and especially four years. A summary of the predicted DD mathematics and ELA achievement trends between matched voucher and public students are portrayed Figures 1A and 1B.

--- INSERT FIGURES 1A & 1B HERE ---

Disaggregated Results by Student Group

We disaggregated the results further by student sex and race/ethnicity; student English-Language Learner (ELL) and special education statuses; whether a student remains enrolled in a private school; type of private school; and private school urban locale. We calculated these estimates by introducing a full set of interaction terms between the indicators and the three DD indicators in our preferred model. We represent the results as the additional achievement impact of receiving a voucher and attending a private school for each subgroup.

We display these estimates for mathematics and ELA in Table 6. Across nearly all subgroups of students in the disaggregated results, we find persistent, statistically significant negative impacts of receiving a voucher on average annual mathematics levels and gains. For ELA, we find a variation of positive and negative estimates of annual levels and gains.

--- INSERT TABLE 6 HERE ---

The average effects of receiving vouchers on mathematics levels and gains are negative for both males (-0.089 and -0.093 SD, respectively) and females (-0.085 and -0.107 SD, respectively), with no statistical difference in these losses between males and females. The effects on ELA by student sex were not statistically significant.

We next estimate voucher effects by student race/ethnicity. We find that white and black students who receive vouchers and attend private schools score -0.097 and -0.126 SD lower in mathematics in private schools, respectively, with annual losses of 0.094 SD for white students and 0.156 SD for black students. On the other hand, Latino students experienced null math losses. Overall, we find no statistical differences in impacts between all racial/ethnic groups. The effects on ELA by student race/ethnicity were not statistically significant.

We also estimated the effects for voucher students by ELL status and special education status. In mathematics, non-ELL voucher students score -0.103 SD below their peers in public schools and experience annual losses of -0.109 SD. ELL students experienced null losses in both math and ELA. Special education students receiving a voucher experience significant losses in ELA of -0.130 SD in private schools.

As some students receiving a voucher and transfer to a private school eventually transfer back to a public school, we include separate estimates of voucher “exiters” versus students who continue receiving a voucher and remain enrolled in private schools. Students who received a voucher and then returned to public school in a later year score -0.242 SD lower in mathematics and -0.136 SD lower in ELA when enrolled in a private school. Voucher “exiters” also experience significant annual losses in mathematics (-0.156 SD) and ELA (-0.074 SD). While voucher “stayers” also experience significant losses in math, we note the significantly smaller losses between “stayers” and “exiters” in math and the null losses in ELA.

We also investigated voucher program effects by the type of private school in which a student receiving a voucher enrolled and by private school urban locale. In ELA, voucher students attending Catholic schools are estimated to score 0.071 SD above public school students and experience annual gains of 0.034 SD compared with their public school peers. These estimates are also statistically different from voucher students attending other private schools, who experience significant losses in ELA. Examining impacts by private school locale, we find significant annual mathematics losses whether a student attends a private school in an urban (-0.077 SD), suburban (-0.115 SD), or town/rural (-0.133 SD) location.

DISCUSSION

Although this study was unable to make use of experimental data to investigate the impacts of the Indiana voucher program on student achievement, it is one of the first to estimate voucher effects with state administrative longitudinal records and a rigorous analytic approach. Public and private school students in Indiana, including all students receiving a voucher and attending a private school, have taken the same assessment for several years. This feature is a significant benefit to researchers, allowing for apples-to-apples comparisons of student achievement outcomes and the ability to capture year-to-year student achievement gains.

Generally, we find that voucher students attending private schools experienced similar year-to-year achievement gains in ELA as they did in their public school but substantial annual achievement losses in mathematics. This is one of a small number of studies to estimate such losses, aligning with research on the Louisiana Scholarship Program (see Abdulkadiroglu, Pathak, & Walters, 2015; Mills & Wolf, in press) and the Ohio EdChoice Scholarship Program (Figlio & Karbownik, 2016). We find these general trends for both ELA and mathematics hold when disaggregating the main effects by a number of student and school characteristics.

Although we might have hypothesized differential effects for students of color, the oddity is that we found similar results for white students. These findings raise questions about the mechanisms that may explain these negative effects, such as the mathematics curriculum, instruction, or teacher quality in private schools not being as robust as is found in public schools. At the same time, these results could also point toward issues with changing schools and sectors.

Overall, voucher students are lower-achieving students from the public sector and enter private schools substantially behind their private school peers. During the ICSP's first few years of implementation, many private schools lacked the capacity or experience in educating new students who are academically behind. Whether this is due to curricular issues (e.g., lack of alignment of the private and public school textbooks and other curricular materials), teachers' ability to teach low-achieving students (e.g., using differentiated instructional techniques), or other organizational and instructional conditions, we cannot determine solely using administrative data. Thus, additional information, both qualitative and quantitative, is necessary. Gathering and analyzing such information is part of our ongoing research agenda.

In our qualitative findings from case studies and over 100 interviews in thirteen private schools during the first two years of ICSP implementation, principals and teachers reported that voucher students were generally acclimating well—academically and socially—to their new schools. Yet, principals and teachers also reported that some voucher students were academically behind and struggling with new homework expectations. Principals and teachers were attempting to address these issues while also noting that, because the first year of the voucher program was implemented quickly, significant changes in instruction did not occur (Berends & Waddington, 2014). As expectations or norms may be different in private schools than public schools, voucher

students attending private schools for the first time could be put at a disadvantage beyond negative math scores.

Over time, voucher students may adjust to their new schools, and private schools may make adjustments that better meet the educational needs of voucher students although our findings cannot confirm this possibility with a high degree of precision. In mathematics, students who remain in a private school with a voucher for three or four years make up what they initially lost relative to their public school peers. In ELA, students experience losses in year two, but recoup those losses in year three. By year four, voucher students have higher ELA achievement than their public school peer, though this is only marginally statistically significant. The year three and year four estimates in both subjects are highly variable due to the relatively small number of voucher students we observe across three and especially four years.

These year three and four estimates may also point to student persistence, as the lowest achieving students who receive a voucher and attend a private school tend to return to a public school. Additional years of testing data and information from teachers and principals will shed more light on these trends—and possible explanations for them—across years of the program.

In investigating how voucher effects may differ across types of private schools, we find negative effects in mathematics for both Catholic and other private schools. However, we find modest positive effects of Catholic schools and modest negative effects of other private schools in ELA. The mathematics findings for Catholic schools mirror those we found in previous work on student transfers from public to Catholic schools in Indianapolis (see Berends & Waddington, in press). This is a relevant comparison as it takes place in the same state, includes a handful of the same students, and the mechanism of switching from public to private schools is the same. The negative relationship between mathematics achievement and Catholic school attendance has

also been found in nationally representative data for elementary and middle school students (Carbonaro, 2006; Reardon, Cheadle, & Robinson, 2009; Elder & Jepsen, 2014) and in data for 8th graders in Chicago (Hallinan & Kubitschek, 2012). That said, it remains important to explore the variability of impacts between individual Catholic and other private schools. School-average effects in both subjects range from annual losses of 0.30 SD in both subjects to gains of 0.20 SD in math and 0.40 SD in ELA. These findings speak to the substantial degree of heterogeneity within the private school sector. Some schools were more racially and ethnically diverse prior to the implementation of the voucher program, and therefore may have been better equipped to educate a demographically (and perhaps, academically) diverse group of students.

Our research has its limitations. Although our use of multiple estimation strategies provides a strong methodological approach to examine impacts with longitudinal data, it has drawbacks as described earlier in this paper. We are only drawing generalizations about students using vouchers to switch from public to private schools. Under the original intent of the program—to increase access to private schools for low-income public school families—our preferred modeling strategy aligns well to estimate the program's effects. However, after the law changed in the 2013-14 school year no longer requiring voucher students to move from a public to private school, over half of all students participating in the voucher program in 2014-15 never attended an Indiana public school (Indiana Department of Education, 2017). For these students, it is more challenging to establish an equivalent baseline and assess meaningful voucher effects.

Second, Indiana does not have a common assessment system in the pre-K through second grade levels in public and private schools. Because we used third, fourth, or fifth grade as a baseline for student achievement gains for most students, our research focuses on voucher program effects in the upper elementary and middle school grades. In 2014-15, nearly 50 percent

of the students receiving vouchers statewide were in the K-4 grade levels (Indiana Department of Education, 2017), meaning that current ISTEP+ testing does not capture a significant number of students receiving vouchers. As a result, we may never know whether the ICSP had a significant impact (positive or negative) on students in earlier grade levels.

Finally, voucher programs are designed to provide new learning opportunities, for which achievement gains should serve as a proxy for any program's success for students and schools. Although these outcomes are important for researchers, policymakers, and practitioners to consider, parents make schooling decisions for their children based on a multitude of factors, including academics, location, safety, and religion. Therefore, researchers need to examine outcomes beyond test scores (e.g., educational attainment, engagement, social and emotional learning, character, civic participation, and other non-academic outcomes). Additional data on these other student outcomes needs to be collected and analyzed to provide a more complete picture. To quote Figlio (2009, p. 322), "It is important to be cautious about claiming that school vouchers are unsuccessful just because students who use them do not appear to be benefiting along certain measureable dimensions." In an era of expanding school choice, policymakers must draw from recent findings about statewide voucher programs that there is more to learn about the impacts of large-scale parental choice programs on American families.

REFERENCES

Abdulkadiroglu, A., Pathak, P. A., & Walters, C. R. (2015). School vouchers and student achievement: Evidence from the Louisiana Scholarship Program. Cambridge, MA: National Bureau of Economic Research (Working Paper No. 21839).

Anderson, K. P., & Wolf, P. J. (2017). Evaluating school vouchers: Evidence from a within-study comparison (EDRE Working Paper No. 2017-10). Economics Research Network, Department of Education Reform, College of Education and Health Professions, University of Arkansas, Fayetteville, AR.

Angrist, J. D., Dynarski, S., Kane, T. J., Pathak, P. A., & Walters, C. R. (2012). Student achievement in charter schools. Who benefits from KIPP? *Journal of Policy Analysis and Management, 31,* 837-860.

Ashenfelter, O. (1978). Estimating the effect of training programs on earnings. *The Review of Economics and Statistics, 60,* 47-57.

Austin, M., & Berends, M. (In Press). School choice and the potential of research-practice partnerships. In G. Schneider & G. K. Saw (Eds.), *Handbook of the Sociology of Education in the 21st Century*. New York: Springer.

Barnard, J. Frangakis, C., Hill, J., & Rubin, D. (2003). Principal stratification approach to broken randomized experiments: A case study of school choice vouchers in New York City. *Journal of the American Statistical Association, 98,* 299-323.

Berends, M. (In Press). The evolving choice landscape in the U.S. In R. Papa and S. Armfield (Eds.), *Handbook of education policy*. Hoboken, NJ: Wiley-Blackwell.

Berends, M. & Waddington, R. J. (2014). Blending into my new school: The integration of voucher students in Indiana private Schools. Paper to be presented at the annual meeting of the American Educational Research Association, Philadelphia, PA.

Berends, M., & Waddington, R. J. (In Press). School choice in Indianapolis: Effects of charter, magnet, private, and traditional public schools. *Education Finance and Policy.*

Bifulco, R. (2012). Can nonexperimental estimates replicate estimates based on random assignment in evaluations of school choice? A within-study comparison. *Journal of Policy Analysis and Management, 31,* 729-751.

Carbonaro, W. (2006). Public-private Differences in Achievement among Kindergarten Students: differences in Learning Opportunities and Student Outcomes. *American Journal of Education 113,* 31-65.a.

Chingos, M. M., & Peterson, P. E. (2012). *The effects of school vouchers on college enrollment.* Washington, DC: Brown Center on Education Policy at the Bookings Institution.

Chubb, J. E., & Moe, T. M. (1990). *Politics, markets and American schools*. Washington, DC: Brookings Institution.

Clark, M. A., Gleason, P. M., Tuttle, C. C., & Silverberg, M. K. (2015). Do charter schools improve student achievement? *Educational Evaluation and Policy Analysis, 37,* 419-436.

Cook, T., Shadish, W., & Wong, V. (2008). Three conditions under which experiments and observational studies produce comparable causal estimates: New findings from within-study comparisons. *Journal of Policy Analysis and Management, 27,* 724-750.

Cowen, J. (2008) School choice as a latent variable: Estimating the "complier average causal effect' of vouchers in Charlotte. *Policy Studies Journal, 36,* 301-15.

Cowen, J. M., Fleming, D. J., Witte, J. F., Wolf, P. J. & Kasida, B. (2013). School vouchers and student attainment: Evidence from a state-mandated study of Milwaukee's parental choice program. *Policy Studies Journal, 41*, 147-168.

Dobbie, W. & Fryer, R. G. (2011). Are high quality schools enough to close the achievement gap? Evidence from a social experiment in Harlem. *American Economic Journal: Applied Economics, 3,* 158-187.

Dynarski, M., Rui, N., Webber, A., Gutmann, B., & Bachman, M. (2017). *Evaluation of the DC Opportunity Scholarship Program: Impacts after one year.* (NCEE 2017-4022). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education.

EdChoice (2017). *School choice in America*. Retrieved June 19, 2017 from: https://www.edchoice.org/school-choice/school-choice-in-america/.

Elder, T. & Jepsen, C. (2014). Are Catholic primary schools more effective than public primary schools? *Journal of Urban Economics, 80,* 28-38.

Epple, D., Romano, R.E., & Urquiola, M. (2015). School vouchers: A survey of the economics literature. Cambridge, MA: National Bureau of Economic Research (Working Paper No. 21523).

Figlio, D. N. (2009). Voucher outcomes. In M. Berends, M. G. Springer, D. Ballou, & H. J. Walberg (Eds.), *Handbook of research on school choice* (pp. 321-337). New York, NY: Routledge.

Finnegan, K. S. (2007). Charter school autonomy: The mismatch between theory and practice. *Educational Policy, 21,* 503-526.

Fortson, K., Gleason, P., Kopa, E., & Verbitsky-Savitz, N. (2014). Horseshoes, hand grenades, and treatment effects? Reassessing whether nonexperimental estimators are biased. *Economics of Education Review, 44*, 100-113.

Friedman, M. (1955). The role of government in education. In R. A. Solo (Ed.), *Economics and the public interest* (pp. 123-144). New Brunswick, NJ: Rutgers University Press.

Friedman, M. (1962). Capitalism and freedom. Chicago: Chicago University Press.

Gamoran, A. (2015). *The future of educational inequality in the United States: What went wrong, and how can we fix it?* New York: W.T. Grant Foundation.

Greene, J. P. (2001). Vouchers in Charlotte: Vouchers and the test-score gap. *Education Next, 1*, 55-60.

Greene, J. P., Peterson, P. E., & Du, J. (1998). School choice in Milwaukee: A randomized experiment. In P. Peterson and B. Hassell (Eds.), *Learning from school choice* (pp. 335-356). Washington, DC: Brookings.

Greene, J. P., Peterson, P. E., & Du, J. (1999). Effectiveness of school choice: The Milwaukee voucher experiment. *Education and Urban Society, 31*, 190-213.

Grigg, J. (2012). School enrollment changes and student achievement growth; A case study in educational disruption and continuity. *Sociology of Education, 85*, 388-404.

Hallinan, Maureen T. & W. Kubitschek. (2012). A comparison of academic achievement and adherence to the common school ideal in public and Catholic schools. *Sociology of Education, 85*, 1-22.

Henig, J. R. (1995). *Rethinking school choice: Limits of the market metaphor*. Princeton, NJ: Princeton University Press.

Hess, F. M. (2002). *Revolution at the margins: The impact of competition on urban school systems*. Washington, DC: Brookings Institution.

Howell, W. G., Peterson, P. E. (2006). *The education gap: Vouchers and urban schools*. Washington, DC: Brookings Press.

Howell, W. G., Wolf, P. J., Campbell, D. E., & Peterson, P. E. (2002). School vouchers and academic performance: results from three randomized field trials. *Journal of Policy Analysis and Management, 21*, 191-217.

Imberman, S. (2011). Achievement and behavior in charter schools: Drawing a more complete picture. *The Review of Economics and Statistics, 93*, 416-435.

Indiana Department of Education (2011). *2011-2012 ISTEP+ program manual: Policies and procedures for Indiana's assessment system*. Indianapolis, IN: Author.

Indiana Department of Education (2017). *Choice scholarship program annual report: Participation and payment data*. Indianapolis, IN: Author (Office of School Finance).

Jin, H., Barnard, J., & Rubin, D., B. (2010). A modified general location model for noncompliance with missing data: Revisiting the New York City School Choice Scholarship Program using principal stratification. *Journal of Educational and Behavioral Statistics, 35*, 154–173.

Kashual, N., Magnuson, K., & Waldfogel, J. (2011). How is family income related to investments in children's learning? In G. Duncan and R. Murnane (Eds.), *Whither Opportunity?* (pp. 187- 205). New York: Russell Sage Foundation.

Koedel, C., Mihaly, K., & Rockoff, J. E. (2015). Value-added modeling: A review. *Economics of Education Review, 47*, 180-195.

Krueger, A. B., & Zhu, P. (2004). Another look at the New York City school voucher experiment. *American Behavioral Scientist, 47*, 658-698.

Lareau, A., & Goyette, K. (2014). (Eds.). *Choosing homes, choosing schools.* New York: Russell Sage Foundation.

Levin, H. M. (1998). Educational vouchers: Effectiveness, choice, and costs. *Journal of Policy Analysis and Management, 17*, 392-91.

Metcalf, K. K., West, S. D., Legan, N, Paul, K., & Boone, W. J. (2002). *Evaluation of the Cleveland Scholarship and Tutoring Program, 1998-2001. Summary report and technical report*. Bloomington, IN: Indiana Center for Evaluation.

Mills, J. N. & Wolf, P. J. (In Press). Vouchers in the Bayou: The effects of the Louisiana Scholarship Program on student achievement after 2 years. *Educational Evaluation and Policy Analysis*.

Orfield, G., & Frankenberg, E. (2014). *Brown at 60: Great progress, a long retreat, and an uncertain future.* Los Angeles, CA: Civil Rights Project, University of California Los Angeles.

Reardon, S., Cheadle, J., & Robinson, J. (2009). The effect of Catholic schooling on math and reading development in kindergarten through fifth grade. *Journal of Research on Educational Effectiveness, 2*, 45-87.

Reardon, S.F., Robinson-Cimpian, J.P., & Weathers, E.S. (in press). Patterns and trends in racial/ethnic and socioeconomic academic achievement gaps. In H. A. Ladd & M. E. Goertz (Eds.), *Handbook of research in education finance and policy* (pp. 491-509). Mahwah, NJ: Lawrence Erlbaum Associates

Rouse, C. E. (1998). Private school vouchers and student achievement: An evaluation of the Milwaukee Parental Choice Program. *Quarterly Journal of Economics, 113*, 553-602.

Schwartz, A. E., Stiefel, L, & Cordes, S. A. (In Press). Moving matters: The causal effect of moving schools on student performance. *Education Finance and Policy*.

Shakeel, M. D., Anderson, K. P., & Wolf, P. J. (2016). *The participant effects of private school vouchers across the globe: A meta-analytic and systematic review*. Fayetteville, AR: University of Arkansas, Department of Education Reform (Working Paper 2016-07).

Sharkey, P. (2013). *Stuck in place: Urban neighborhoods and the end of progress toward racial equality*. Chicago: University of Chicago Press.

Witte, J. F. (2000). *The market approach to education: An analysis of America's first voucher program*. Princeton, NJ: Princeton University Press.

Witte, J. F., Wolf, P. J., Cowan, J. M., Carlson, D., & Fleming, D. J. (2014). High stakes choice: Achievement and accountability in the nation's oldest urban voucher program. *Educational Evaluation and Policy Analysis, 36*, 437-456.

Wolf, P., Gutmann, B., Puma, M., Kisida, B., Rizzo, L, Eissa, N., & Carr, M. (2010). *Evaluation of the DC Opportunity Scholarship Program: Final Report* (NCEE 2010-4018). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education.

Wolf, P. J, Kisida, B., Gutmann, B., Puma, J., Rizzo, L., & Eissa, N. (2011). School vouchers in the nation's capital. In M. Berends, M. Cannata, and E. B. Goldring (Eds.), *School choice and school improvement* (pp. 17-33). Boston, MA: Harvard Education Press.

Wolf, P. J, Kisida, B., Gutmann, B., Puma, J., Eissa, N., & Rizzo, L. (2013). School vouchers and student outcomes: Experimental evidence from Washington, DC. *Journal of Policy Analysis and Management, 32*, 246-270.

Wolf, P. & McShane, M. (2013). Is the juice worth the squeeze? A benefit/cost analysis of the District of Columbia Opportunity Scholarship Program. *Education Finance and Policy, 8*, 75-99.

Wolf, P. J., Witte, J. F., & Fleming, D. J. (2012). Special Education and the Milwaukee Parental Choice Program (SCDP Milwaukee Evaluation Report #35). School Choice Demonstration Project, Department of Education Reform, College of Education and Health Professions, University of Arkansas, Fayetteville, AR.

Zimmer, R. & Bettinger, E. P. (2015). Beyond the rhetoric: Surveying the evidence on vouchers and tax credits. In H. F. Ladd & M. E. Goertz (Eds.), *Handbook of research in education finance and policy* (pp. 444-467). New York: Routledge.

Table 1. Descriptive Comparison of Voucher and Public School Students

	All Low-Income			Propensity Score Matched		
	Voucher	**Public**	**Difference**	**Voucher**	**Public**	**Difference**
Students	3,913	121,524	--	3,276	12,406	--
Schools	268	926	--	266	694	--
Female	0.525	0.503	0.018**	0.520	0.512	0.008
Black	0.230	0.272	-0.042***	0.234	0.228	0.006
Latino/a	0.235	0.184	0.051***	0.212	0.202	0.010
Other Race/Ethnicity	0.089	0.088	0.001	0.083	0.083	0.000
Baseline						
ELL	0.124	0.101	0.023***	0.114	0.100	0.014*
Special Education	0.080	0.118	-0.038***	0.074	0.067	0.007
Retained	0.012	0.008	0.004*	0.005	0.006	-0.001
Attend Charter	0.120	0.120	0.000	0.085	0.085	0.000
Attend Magnet	0.030	0.031	-0.001	0.030	0.030	0.000
Suburban School	0.226	0.226	0.000	0.233	0.233	0.000
Town/Rural School	0.215	0.211	0.004	0.232	0.232	0.000
Mean Math Score	-0.247	-0.354	0.106***	-0.246	-0.255	0.009
Mean ELA Score	-0.225	-0.341	0.117***	-0.235	-0.246	0.011
Mean Math Gain	-0.008	-0.028	0.020*	-0.020	-0.013	-0.007
Mean ELA Gain	-0.002	-0.025	0.023*	-0.013	-0.007	-0.006
1st Yr. Post-Baseline						
Attend Catholic	0.538	--	--	0.538	--	--
Attend Other Private	0.462	--	--	0.462	--	--
Mean Math Score	-0.362	-0.309	-0.053***	-0.359	-0.239	-0.120***
Mean ELA Score	-0.209	-0.288	0.079***	-0.211	-0.226	0.016
Mean Math Gain	-0.114	0.045	-0.159***	-0.114	0.015	-0.129***
Mean ELA Gain	0.012	0.055	-0.043***	0.022	0.017	0.005

~p≤0.100; *p≤0.050; **p≤0.010; ***p≤0.001. Table displays voucher and public school students with at least two years of test scores at baseline. Number of schools reported as public schools at baseline and voucher private schools in first year post-baseline. Weighted proportions of students reported for demographic characteristics. Weighted ISTEP+ Math and ELA scores measured in standard deviation units, relative to the Indiana state mean and standard deviation within each grade and year. For demographic and academic background characteristics, statistically significant differences in proportions reported from weighted logistic regression of student characteristic with voucher student status. For test scores, statistically significant differences in means reported from OLS regression of student test score with voucher student status.

Table 2. Main Effects of Indiana Voucher Program on Student Math Achievement

A. Math Achievement Levels						
	All Low-Income			Propensity Score Matched		
	OLS (1)	DD (2)	FE (3)	OLS (1)	DD (2)	FE (3)
Received Voucher	-0.063*	-0.096**	-0.151***	-0.087**	-0.086*	-0.143***
	(0.030)	(0.033)	(0.016)	(0.031)	(0.034)	(0.017)
Post-Baseline		-0.027			-0.022	
		(0.017)			(0.021)	
Voucher Student		0.055***			0.007	
Base./Pre-Base. Diff		(0.014)			(0.015)	
Demographics	Y	Y	N	Y	Y	N
Time-Var. Chars.	Y	Y	Y	Y	Y	Y
Prior Year Ach.	N	N	N	N	N	N
Grade-Year FE	Y	Y	Y	Y	Y	Y
Student FE	N	N	Y	N	N	Y
Observations N	455,331	455,331	455,331	60,933	60,933	60,933
Students N	122,896	122,896	122,896	15,682	15,682	15,682

B. Math Achievement Gains						
	All Low-Income			Propensity Score Matched		
	OLS (4)	DD (5)	FE (6)	OLS (4)	DD (5)	FE (6)
Received Voucher	-0.096***	-0.120***	-0.168***	-0.098***	-0.100***	-0.157***
	(0.016)	(0.021)	(0.017)	(0.017)	(0.022)	(0.018)
Post-Baseline		-0.002			-0.018	
		(0.012)			(0.014)	
Voucher Student		0.032**			0.008	
Baseline Difference		(0.011)			(0.011)	
Demographics	Y	Y	N	Y	Y	N
Time-Var. Chars.	Y	Y	Y	Y	Y	Y
Prior Year Ach.	Y	Y	Y	N	N	N
Grade-Year FE	Y	Y	Y	Y	Y	Y
Student FE	N	N	Y	N	N	Y
Observations N	331,833	331,833	331,833	45,215	45,215	45,215
Students N	122,606	122,606	122,606	15,682	15,682	15,682

~p≤0.100; *p≤0.050; **p≤0.010; ***p≤0.001. ISTEP+ Math achievement measured in standard deviation units, relative to the Indiana state mean and standard deviation within each grade and year. Weights included. Robust standard errors, adjusted for the clustering of students within schools, are in parentheses.

Table 3. Main Effects of Indiana Voucher Program on Student ELA Achievement

	A. ELA Achievement Levels					
	All Low-Income			Propensity Score Matched		
	OLS (1)	DD (2)	FE (3)	OLS (1)	DD (2)	FE (3)
Received Voucher	0.064**	0.006	-0.044***	0.042~	0.025	-0.026~
	(0.024)	(0.027)	(0.014)	(0.024)	(0.027)	(0.014)
Post-Baseline		0.005			0.005	
		(0.016)			(0.021)	
Voucher Student		0.076***			0.021	
Base./Pre-Base. Diff.		(0.012)			(0.013)	
Demographics	Y	Y	N	Y	Y	N
Time-Var. Chars.	Y	Y	Y	Y	Y	Y
Prior Year Ach.	N	N	N	N	N	N
Grade-Year FE	Y	Y	Y	Y	Y	Y
Student FE	N	N	Y	N	N	Y
Observations N	453,372	453,372	453,372	60,907	60,907	60,907
Students N	122,856	122,856	122,856	15,682	15,756	15,756

	B. ELA Achievement Gains					
	All Low-Income			Propensity Score Matched		
	OLS (4)	DD (5)	FE (6)	OLS (4)	DD (5)	FE (6)
Received Voucher	-0.010	-0.037*	-0.051***	-0.008	-0.004	-0.029~
	(0.013)	(0.017)	(0.015)	(0.014)	(0.017)	(0.015)
Post-Baseline		0.010			-0.013	
		(0.011)			(0.014)	
Voucher Student		0.032***			-0.001	
Baseline Difference		(0.010)			(0.011)	
Demographics	Y	Y	N	Y	Y	N
Time-Var. Chars.	Y	Y	Y	Y	Y	Y
Prior Year Ach.	Y	Y	Y	N	N	N
Grade-Year FE	Y	Y	Y	Y	Y	Y
Student FE	N	N	Y	N	N	Y
Observations N	329,693	329,693	329,693	45,180	45,180	45,180
Students N	122,189	122,189	122,189	15,682	15,682	15,682

~p≤0.100; *p≤0.050; **p≤0.010; ***p≤0.001. ISTEP+ ELA achievement measured in standard deviation units, relative to the Indiana state mean and standard deviation within each grade and year. Weights included. Robust standard errors, adjusted for the clustering of students within schools, are in parentheses.

Table 4. Robustness Checks of Main Effects

	Math		ELA	
	Levels	**Gains**	**Levels**	**Gains**
Preferred Model	-0.086*	-0.100***	0.025	-0.004
	(0.034)	(0.022)	(0.027)	(0.017)
Structural Changes Only	-0.182***	-0.123***	-0.056	-0.057*
	(0.053)	(0.026)	(0.042)	(0.027)
No Mobility Indicators	-0.096**	-0.100***	0.017	-0.004
	(0.034)	(0.021)	(0.027)	(0.017)
No Spec. Ed. Control	-0.079*	-0.098***	0.031	-0.002
	(0.035)	(0.022)	(0.028)	(0.017)
Gain Score Outcome	--	-0.118***	--	-0.021
		(0.019)		(0.016)
Off-Subject Prior Ach.	--	-0.105***	--	-0.004
		(0.022)		(0.017)
Prior Ach. Pre-Treat Only	--	-0.083***	--	0.028
		(0.033)		(0.026)
Keep Exit Stud. in Treat.	-0.101**	-0.071***	0.019	0.003
	(0.033)	(0.019)	(0.027)	(0.017)
No Indianapolis Urban	-0.083*	-0.113***	0.020	-0.017
	(0.039)	(0.025)	(0.032)	(0.021)

~p≤0.100; *p≤0.050; **p≤0.010; ***p≤0.001. All results displayed from preferred difference-in-differences model with propensity-score matched students. ISTEP+ Math and ELA achievement measured in standard deviation units, relative to the Indiana state mean and standard deviation within each grade and year. Propensity score matching weights included. Robust standard errors, adjusted for the clustering of students within schools, are in parentheses.

Table 5. Annual Effects of Indiana Voucher Program on Student Achievement

	Math		ELA	
	Levels	**Gains**	**Levels**	**Gains**
Pre-Baseline Year	0.017	--	0.006	--
	(0.020)		(0.018)	
Baseline Year	0.005	0.010	0.023	0.002
	(0.016)	(0.011)	(0.015)	(0.011)
Rec. Voucher Year 1	-0.036	-0.120***	0.071*	0.016
	(0.036)	(0.027)	(0.029)	(0.022)
Rec. Voucher Year 2	-0.178***	-0.122***	-0.081*	-0.087***
	(0.041)	(0.026)	(0.035)	(0.025)
Rec. Voucher Year 3	-0.089~	-0.013	0.041	0.065*
	(0.046)	(0.033)	(0.041)	(0.029)
Rec. Voucher Year 4	0.045	-0.011	0.134~	0.080
	(0.083)	(0.079)	(0.071)	(0.063)

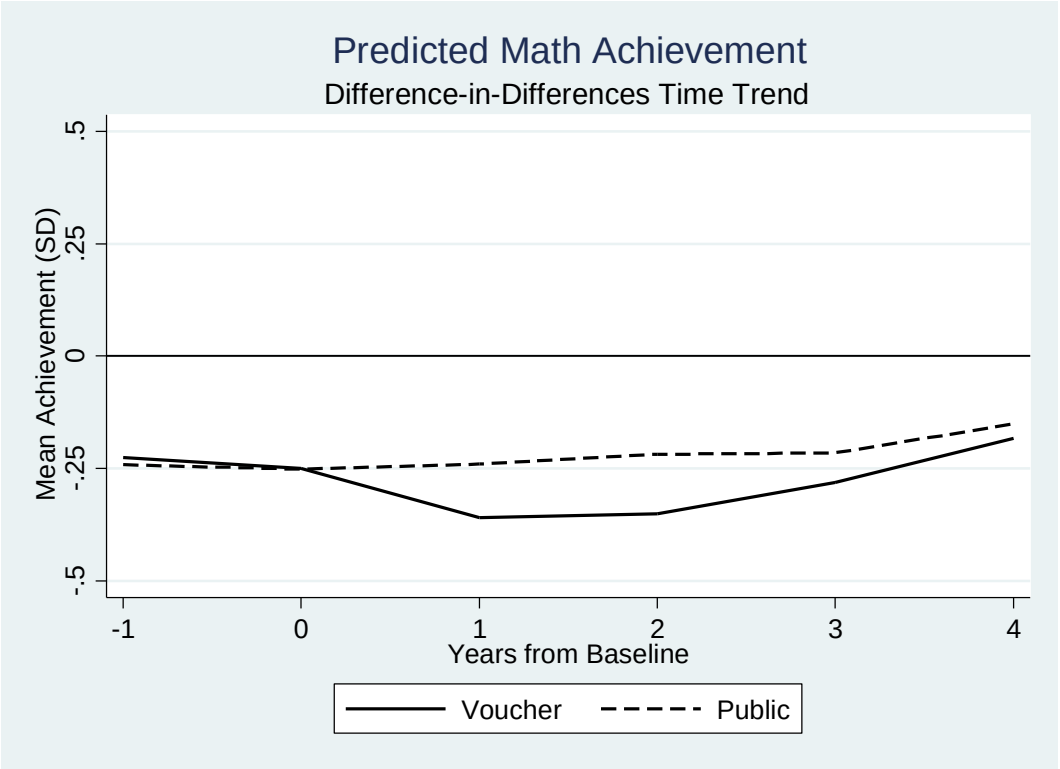
~p≤0.100; *p≤0.050; **p≤0.010; ***p≤0.001. All results displayed from preferred difference-in-differences model with propensity-score matched students. ISTEP+ Math and ELA achievement measured in standard deviation units, relative to the Indiana state mean and standard deviation within each grade and year. Propensity score matching weights included. Robust standard errors, adjusted for the clustering of students within schools, are in parentheses.

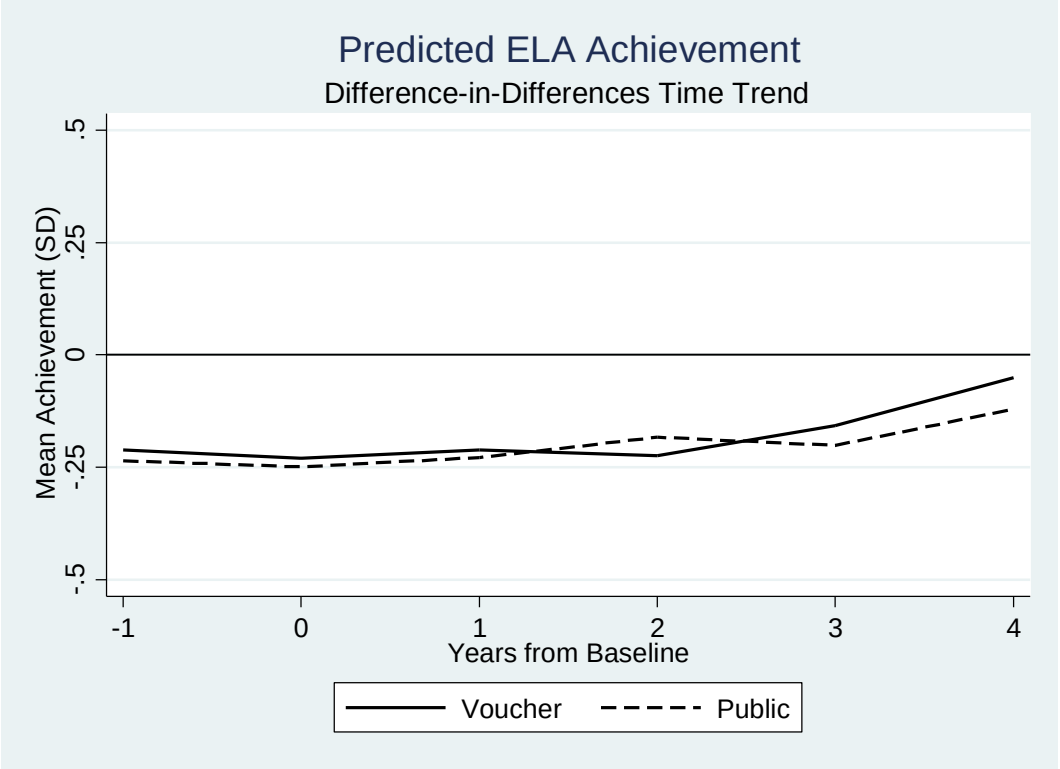
Table 6. Mean Subgroup Effects of Indiana Voucher Program on Student Achievement

	Math		ELA	
	Levels	**Gains**	**Levels**	**Gains**
Male	-0.089*	-0.093***	0.009	-0.022
	(0.042)	(0.028)	(0.035)	(0.024)
Female	-0.085*	-0.107***	0.039	0.013
	(0.038)	(0.025)	(0.031)	(0.020)
White	-0.097*	-0.094*	0.010	0.010
	(0.041)	(0.026)	(0.037)	(0.024)
Black	-0.126*	-0.156***	0.015	-0.044
	(0.060)	(0.047)	(0.049)	(0.035)
Latino	-0.010	-0.038	0.053	0.015
	(0.067)	(0.037)	(0.047)	(0.030)
Other Race/Eth.	-0.109	-0.121*	0.037	-0.027
	(0.094)	(0.061)	(0.078)	(0.060)
Non-ELL	-0.103**	-0.109***	0.012	-0.009
	(0.036)	(0.023)	(0.060)	(0.018)
ELL	0.012	-0.032	0.066	0.014
	(0.073)	(0.058)	(0.057)	(0.043)
Non-Special Education	-0.088*	-0.101***	0.029	-0.005$^{(s)}$
	(0.035)	(0.022)	(0.028)	(0.018)
Special Education	-0.087	-0.091	-0.048	-0.130*$^{(s)}$
	(0.100)	(0.089)	(0.087)	(0.061)
Continue	-0.069*$^{(s)}$	-0.094***$^{(s)}$	0.043$^{(s)}$	0.004$^{(s)}$
	(0.035)	(0.022)	(0.027)	(0.017)
Exit	-0.242***$^{(s)}$	-0.156***$^{(s)}$	-0.136***$^{(s)}$	-0.074**$^{(s)}$
	(0.048)	(0.033)	(0.042)	(0.027)
Catholic	-0.053	-0.079*	0.071*$^{(s)}$	0.034*$^{(s)}$
	(0.037)	(0.020)	(0.029)	(0.017)
Other Private	-0.132*	-0.128***	-0.040$^{(s)}$	-0.055*$^{(s)}$
	(0.053)	(0.035)	(0.035)	(0.025)
Urban	-0.078	-0.077*	0.026	0.009
	(0.048)	(0.034)	(0.038)	(0.024)
Suburban	-0.072	-0.115***	0.063	0.018
	(0.069)	(0.034)	(0.049)	(0.031)
Town/Rural	-0.127*	-0.133***	-0.030	-0.059
	(0.063)	(0.038)	(0.057)	(0.036)

~p≤0.100; *p≤0.050; **p≤0.010; ***p≤0.001. We estimate subgroup effects using the difference-in-differences model with a full set of interactions by subgroup and the three difference-in-differences estimators. $^{(s)}$Indicates significant differences between subgroups (p≤0.050).

Figures 1A & 1B. Predicted Achievement Levels over Time
(Propensity Score Matched Students using Difference-in-Differences Preferred Model)





APPENDIX A
DESCRIPTION OF DATA RESTRICTIONS FOR ANALYSIS

In the process of creating our analytical sample, we made several analytical decisions that pared down the number of voucher and public school comparison students suitable for analysis. We describe these decisions below and follow the number of total voucher students influenced by our decisions in parentheses. We have no evidence that potential public school comparison students were differentially excluded by these decisions.

Between the 2011-12 and 2014-15 school years, there were a total of 19,120 unique students who received vouchers statewide in grades 3-8. We first removed any students whom we observed with multiple observations within a given year or transferred schools within the same year (29). We do not have information from IDOE that allows us to tell which school these students attended first or in which one they were tested. Next, we removed all voucher students (3,101) who had only one total year of testing data. These are mostly 3rd grade students receiving a voucher in 2014-15. We also remove all students (3,371; mostly 4th graders) with only two years of test data. As we later describe, we assess student achievement gains across at least two years, which require at least three years of data. We remove all students (778) who are missing both math and ELA test scores in any given year as they have a gap in their achievement trajectories. Lastly, we remove all students who at some point attended alternative public schools throughout the state (13).

Based on these decisions, we have 11,828 unique voucher students for whom we have at least three consecutive years of test scores in our data. Similarly, there are 551,110 unique students attending an Indiana public school (traditional public, charter, or magnet) with at least three consecutive years of test scores in our data, never receive a voucher, and remain enrolled in some form of a public school through the duration of our available data.

APPENDIX B
DESCRIPTION OF ROBUSTNESS CHECKS

Here, we detail the rationale behind each of the eight alternative models to assess the robustness of the voucher main effects from the difference-in-differences preferred model with the propensity score matched sample.

The first two checks involve student mobility. We first constrain our results to only those students making structural school changes, as families who have higher motivation may be making non-structural moves. For ELA gains, we find a small annual loss (-0.057 SD; $p \leq 0.05$) and larger losses in math compared to our preferred model. The lower achievement of voucher students only making structural moves suggests our hypothesis may be valid, though this is unsurprising with a voucher program designed to encourage mobility. We note that this is the only robustness check for which we observe substantial differences from our main effects. In a second robustness check, we also remove the mobility indicators, which may mask part of the private school effect, and find no differences.

In another robustness check, we remove the control for special education students. Prior research indicated that students are less likely to be classified as special education once enrolled in private schools (Wolf, Witte, & Fleming, 2012). We descriptively find a similar bias in Indiana (though not for English Language Learner classification). To see if this difference in classification impacts our findings, we remove the special education control. We find no meaningful differences in these results and our preferred estimates, suggesting this indicator is not generating additional bias. We leave the special education indicator in our main analysis.

The next three robustness checks all deal with controlling for prior achievement in the gains models. In the first, we use the students gain score (current year achievement—prior year) as the outcome. This is a common approach in the education literature (we use it in our previous

work—see Berends & Waddington, in press), though remains part of an ongoing debate within the education research community. For the second robustness check, we also include prior achievement in the off subject as a control (e.g., prior math score for ELA gains model and vice versa). This decision was influenced by the growing value-added modeling literature (for review see Koedel, Mihaly, & Rockoff, 2015). For the third robustness check, we limit our control for prior achievement from only the baseline and pre-baseline years. We created a new variable where prior achievement is each student's value in the pre-treatment years and zero thereafter. This avoids the issue of controlling for post-treatment outcomes, which could potentially introduce exogeneity into the estimates. Across each of these robustness checks, we find no meaningful differences with our preferred model.

In our next robustness check, we keep students who exit private schools classified in the treatment condition. There are unobserved reasons (time-varying confounding) that may influence the decision to switch back to a public school. We estimate a separate model where these students remain in the treatment condition even after exiting a private school to see if there is a change in our findings. This stems from the work by Hernán, Brumback, & Robins (2000) and Sobel (2012). Again, we find no meaningful differences compared with our preferred model in terms of conclusions, though the estimated annual math loss has shrunk to 0.071 SD per year.

The final robustness check stems from our own prior work. We previously found that students attending Catholic and other private schools in Indianapolis, of whom at least half are voucher students, experience annual achievement losses in math (see Berends & Waddington, in press). To ensure these students are not driving results, we remove all students in the Indianapolis urban area from the analysis. We observe similar findings as our preferred model, suggesting that the voucher student loss in math is statewide.

Appendix Table 1. Comparison of All Voucher and Non-Voucher Private School Students

	Voucher Students						Non-Voucher Students	
	Pub.->Priv. Matched Low Inc.	**Pub.->Priv. Unmatched Low Inc.**	**Pub.->Priv. Non-Low Inc.**	**Priv.->Pub. ->Priv.**	**Priv.->Pub.**	**Always Private**	**Catholic**	**Other Private**
Students	3,276	637	502	209	663	6,541	31,505	12,647
Female	0.520	0.553	0.471	0.559	0.501	0.508	0.495	0.505
Black	0.234	0.208	0.105	0.119	0.249	0.090	0.029	0.054
Latino/a	0.212	0.354	0.079	0.150	0.150	0.138	0.066	0.025
Other Race/Eth.	0.083	0.122	0.088	0.119	0.091	0.060	0.064	0.061
FRPL	0.854	0.895	0.387	0.571	0.696	0.479	0.140	0.158
ELL	0.114	0.176	0.052	0.027	0.104	0.071	0.049	0.026
Special. Ed.	0.074	0.112	0.140	0.036	0.135	0.092	0.087	0.079
Retained	0.005	0.047	0.062	0.000	0.000	0.003	0.012	0.018
			Year Before Voucher (Baseline)					
Mean Math Score	-0.246	-0.255	0.116	-0.232	-0.405	-0.029	--	--
Mean ELA Score	-0.235	-0.172	0.199	-0.020	-0.319	0.094	--	--
			All Years with Voucher				***All Years***	
Mean Math Score	-0.338	-0.332	0.046	-0.249	-0.601	-0.115	0.378	0.224
Mean ELA Score	-0.194	-0.156	0.180	0.008	-0.418	0.026	0.490	0.355

Table displays voucher students with at least two years of test scores prior to receiving a voucher (at least three total years). Proportions of students reported for demographic characteristics. ISTEP+ Math and ELA scores measured in standard deviation units, relative to the Indiana state mean and standard deviation within each grade and year.

Appendix Table 2. Comparison of All Voucher and Non-Voucher Private School Students

	Matched Low Inc. Same Schl.	Unmatched Low Inc. Same Schl.	Non-Low Inc. Same Schl.	All Other Public Students
Students	12,406	109,118	87,920	349,296
Female	0.512	0.500	0.496	0.495
Black	0.228	0.257	0.057	0.078
Latino/a	0.202	0.176	0.038	0.074
Other Race/Eth.	0.083	0.087	0.068	0.067
FRPL	0.854	0.926	0.112	0.529
ELL	0.100	0.102	0.032	0.059
Special. Ed.	0.067	0.127	0.128	0.163
Retained	0.006	0.007	0.007	0.022
Ever Att. Charter	0.109	0.084	0.030	0.029
Ever Att. Magnet	0.063	0.053	0.026	0.018
		Baseline Year		
Mean Math Score	-0.255	-0.339	0.379	--
Mean ELA Score	-0.246	-0.348	0.343	--
		All Years		
Mean Math Score	-0.220	-0.303	0.371	0.067
Mean ELA Score	-0.213	-0.305	0.343	0.057

Table displays public school students with at least three years of test scores and who have never received a voucher. Proportions of students reported for demographic characteristics. ISTEP+ Math and ELA scores measured in standard deviation units, relative to the Indiana state mean and standard deviation within each grade and year.

Appendix Table 3. Additional Description of Voucher Students

	All Low-Income	PS Matched
Total Students	3,913	3,276
Ever Enrolled in Catholic School	2,118	1,774
Ever Enrolled in Other Private School	1,819	1,522
Observed 2011-12 (1st Yr. of Voucher Program)	3,104	2,541
Observed 2012-13	3,730	3,110
Observed 2013-14	3,365	2,781
Observed 2014-15	2,711	2,224
Continue Receive Voucher & Remain Enrolled in Private Schl.	3,291	2,769
Stop Receiving Voucher & Remain Enrolled in Private School	28	19
Stop Receiving Voucher & Return to Public School	594	488
1 Total Year Receiving Voucher	1,758	1,545
2 Total Years Receiving Voucher	1,262	1,023
3 Total Years Receiving Voucher	698	556
4 Total Years Receiving Voucher	195	152
Year of First Voucher Receipt		
2011-12	923	781
2012-13	1,124	932
2013-14	1,057	828
2014-15	809	735
Grade of First Voucher Receipt		
Grade 4	80	48
Grade 5	1,216	1,036
Grade 6	1,215	941
Grade 7	841	744
Grade 8	560	507
% Retained Upon Private School Entry	4.98%	4.79%

Table displays voucher students previously enrolled in a public school with at least two total years of test scores at baseline. Students continuing to receive voucher are students observed receiving a voucher through the final year of the available data (2014-15), eighth grade, or leaving the dataset (e.g., moving to another state). Students returning to public school are observed in a traditional public, charter, or magnet school in at least one year following receiving a voucher and enrolling in a private school.