



The Long-Term Effect of Competition on Public School Achievement: Evidence from the Indiana Choice Scholarship Program

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Abstract: Despite a vast literature on school vouchers, less is known about their long-term competitive effects on public schools. The current paper examines the competitive effect of the Indiana Choice Scholarship Program, the largest single voucher program in the US, on math and ELA proficiency rates in public schools in the last eight years. Exploiting school vouchers' market share as the primary measure of competition, I use two-way fixed effects regression and event study framework to examine the competitive effect. Results indicate that, although competition has a positive effect in the earlier years, it is detrimental in the long term, suggesting that the program created a “voucher shock” that led to an improvement in the short term. However, in the long term, the proficiency rates in public schools that faced higher competition fell and never increased again. The trend of voucher recipients who have prior public-school attendance revealed that the worsening proficiency rates in the public schools that face higher competition were driven by the departure of relatively high achieving students, suggesting that school vouchers inspire sorting. The results are robust to alternative specifications that use the variation in the interaction between the market share of vouchers and geospatial measures of private school density.

Keywords: school choice; school vouchers; competition; sorting

El efecto a largo plazo de la competencia sobre el rendimiento en las escuelas públicas: Evidencia del Programa de Indiana Choice Scholarship

Resumen: A pesar de la vasta literatura sobre los vouchers escolares, se sabe menos sobre sus efectos competitivos a largo plazo en las escuelas públicas. El documento actual examina el efecto competitivo del Programa de Indiana Choice Scholarship, el programa de cupón único más grande de los Estados Unidos de América. En las tasas de competencia en matemáticas y lectura en las escuelas públicas en los últimos ocho años. Aprovechando la participación de mercado de los vouchers escolares como medida principal de competencia, utilizo la regresión de efectos fijos bidireccionales y el marco de estudio de eventos para examinar el efecto competitivo. Los resultados indican que, si bien la competencia tuvo un efecto positivo en los primeros años, es perjudicial a largo plazo, lo que sugiere que el programa generó un “shock de voucher” que condujo a una mejora en el corto plazo. Sin embargo, a largo plazo, las tasas de competencia en las escuelas públicas que enfrentaron una mayor competencia cayeron y nunca volvieron a aumentar. La tendencia de los beneficiarios de cupones que asistieron previamente a la escuela pública reveló que el empeoramiento de las tasas de competencia en las escuelas públicas que enfrentan una mayor competencia se debió a la salida de estudiantes con logros relativamente altos, lo que sugiere que los vouchers escolares inspiran la clasificación. Los resultados son robustos a especificaciones alternativas que utilizan la variación en la interacción entre la participación de mercado de los vouchers y las medidas geoespaciales de densidad de escuelas privadas.

Palabras-clave: elección de escuela; vouchers escolares; competencia; clasificación

O efeito de longo prazo da competição no desempenho nas escolas públicas: Evidências do Indiana Choice Scholarship Program

Resumo: Apesar da vasta literatura sobre vouchers-escola, menos se sabe sobre seus efeitos competitivos de longo prazo nas escolas públicas. O documento atual examina o efeito competitivo do Indiana Choice Scholarship Program, o maior programa de cupom único dos Estados Unidos da América. Taxas de proficiência em matemática e leitura em escolas públicas nos últimos oito anos. Aproveitando a participação de mercado de vouchers escolares como a principal medida de competição, eu uso a regressão de efeitos fixos bidirecionais e a estrutura de estudo de eventos para examinar o efeito competitivo. Os resultados indicam que, enquanto a competição teve um efeito positivo nos primeiros anos, é prejudicial no longo prazo, sugerindo que o programa gerou um “choque voucher” que levou a uma melhora no curto prazo. No entanto, no longo prazo, as taxas de proficiência em escolas públicas que enfrentaram o aumento da competição caíram e nunca mais aumentaram. A tendência de recebedores de vouchers que frequentaram anteriormente escolas públicas revelou que a piora nas taxas de proficiência em escolas públicas que enfrentam maior competição se deveu à saída de alunos com desempenho relativamente alto, sugerindo que a escola de vouchers inspira classificação. Os resultados são robustos para especificações alternativas que usam a variação na interação entre a participação no mercado de vouchers e medidas geoespaciais de densidade de escolas privadas.

Palavras-chave: escolha de escola; voucher-escola; competição; classificação

The Long-Term Effect of Competition on Public School Achievement: Evidence from the Indiana Choice Scholarship Program

School vouchers have become a widespread policy instrument in the United States during the last three decades (Chakrabarti, 2008a; Figlio et al., 2020). The number of voucher students has gradually increased over the years. Across the country, school vouchers have provided private school tuition subsidies for approximately a quarter-million students since the 1990s (EdChoice, 2020). Advocates seek to incentivize innovation and boost student achievement through voucher programs. School vouchers aim to improve educational effectiveness in two ways. The participation effect intends to improve the achievement of students who enroll in private schools using vouchers. The competitive effect aims to bolster the productivity of public schools. In the competitive organizational environment, public schools are encouraged to perform more effectively to secure their revenues (Friedman, 1955; Hoxby, 2003; Walberg & Bast, 2003).

A significant number of studies have indicated that school vouchers' competitive pressures increase public schools' achievement (e.g., Chakrabarti, 2008a; Egalite & Mills, 2019; Figlio & Hart, 2014; Figlio & Rouse, 2006; Hoxby, 2003; Rouse et al., 2013). Other studies found that voucher competition has no significant effect on student achievement in public schools (Bowen & Trivitt, 2014; Greene & Winters, 2006). The discrepancy of competition effects across states suggests that voucher programs' design may shape the competitive effect. Nevertheless, two comprehensive reviews concluded that, on average, school vouchers lead to a modest improvement in student achievement in public schools through competitive incentives (Epple et al., 2017; Jabbar et al., 2019). Many studies examined the competitive effect in the short term, typically in the first years of the programs. However, fewer studies have examined the long-term effect.

Existing studies revealed mixed results of the long-term effect of school vouchers. Using the same method as Hoxby (2003), who found a large effect in the earlier phase, Carnoy et al. (2007) found that Milwaukee's voucher program's large and positive competitive effect on public schools fades out in the long term. On the other hand, Figlio et al. (2020) examined the effect of expanding the voucher program on public school achievement in Florida. They found that the program's expansion led to higher achievement for the schools with a higher initial degree of competition, suggesting that the program produces a positive competition effect in the long term. Comparing the competitive effect of these representative programs, Chakrabarti (2008a) found that the “accountability-tied” voucher design in Florida has a more consistently positive effect over time. In contrast, the positive effect shrank after two years in Milwaukee's “voucher shock” design. Because all other components of the programs are very similar in Milwaukee and Florida, Chakrabarti attributed the difference between the two states to the competitive effect of voucher designs. These studies implied that voucher design might determine the long-term effect of vouchers. However, little is known about the long-term effect of vouchers in other states. This study aims to contribute to this literature by examining the long-term competitive effect of vouchers in Indiana.

The Indiana Choice Scholarship Program (ICSP) offers an excellent opportunity to study the voucher's long-term effect on public school achievement. The program design has a voucher-shock characteristic. Although it uses an A-F grade, a school quality grade to rank schools, as one path of voucher eligibility, the proportion of students who use vouchers under this path is less than 1% (Indiana Department of Education, 2020a). It is one of the most extensive school voucher programs, with more than one in six of the total voucher students in the country (EdChoice, 2020). It started with approximately 4,000 students in the 2011/2012 academic year and eventually extended to over 36,000 students as of 2019/2020 (Indiana Department of Education, 2020a). Further, it has offered vouchers for modest-income families since 2014 in addition to low-income

families, resulting relatively larger number of eligible households than many other voucher programs in the US (Waddington & Berends, 2018). Therefore, ICSP has a potentially higher competitive effect than a voucher program limited to low-income families. Another essential characteristic of the ICSP is that the voucher participation rates by prior public school attendance have changed over the years. The number of students with prior public school attendance decreased, whereas the number of students who never attended a public school increased over the years (Indiana Department of Education, 2016, 2020a). This allows us to examine the competitive effect by the trend of students' prior public-school attendance. Despite these characteristics, studies have paid little attention to its competitive effect on public schools. To date, a few studies have been conducted on its competitive effect (Egalite & Dougherty, 2014), and the findings are limited to the earlier years of the program. Therefore, more evidence is needed to advance our knowledge about ICSP's competitive effect on public schools.

The current paper contributes to this gap in the literature by exploiting a two-way fixed effects regression model and event study approach. I utilize school-level proficiency rates of 1,268 schools from 283 districts in Indiana between 2012 and 2019. I use the proportion of voucher students (i.e., market share of vouchers) in the districts as the primary competition measure. Besides, as the alternative measure of competition, I benefit from the density of private schools within a certain radius before the voucher program was launched. I found that in the very first years, proficiency rates are positively correlated with the competition. However, schools that face higher voucher competition experience a more considerable decrease in proficiency rates due to the flight of relatively high achieving students (i.e., proficient students in state accountability tests) from public schools to private schools.

Theoretical Background

Market theorists argue that competitive pressure stimulates innovative learning environments, diversified programs, and parental satisfaction in public schools. That is, public schools improve their organizations to secure their per-pupil revenues (Chubb & Moe, 1990). Hoxby (2001) makes a clear argument that the effect of the competition is structural and long-lasting, which can keep schools productive for decades. Schools eliminate ineffective instructional practices that do not contribute to the improvement in student achievement. In the competitive organizational environment, private schools enter into the market and serve for many years if they are productive. As a result, competition has more unique characteristics than many other reform ideas that fail to inspire productivity in the long term, Hoxby contends. However, competitive incentives may lead to sorting by achievement. In the competitive organizational environment, schools may seek to shape their intakes to boost their market position. Autonomy in private schools may function as an exclusionary tool to avoid low-achieving students (Lubienski, 2006). Private schools may attract relatively high achieving students among the eligible students for vouchers. Therefore, low achieving students will remain in public schools, resulting in worse peer-effect and learning environment. As a result, school vouchers may impair education quality in public schools (Epple & Romano, 1998, 2008).

Indiana Choice Scholarship Program

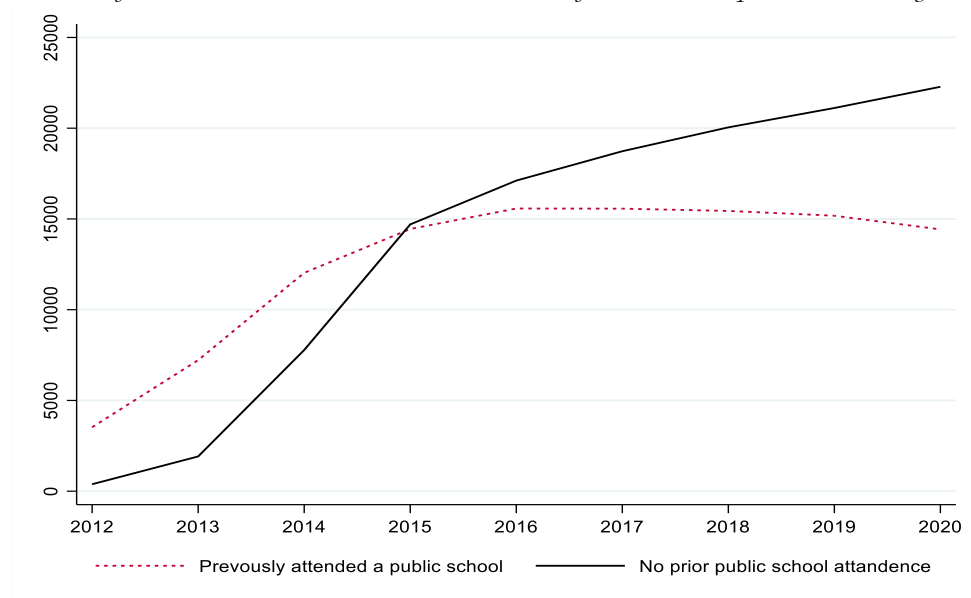
Indiana launched the school voucher program in 2011. House Enrolled Act 1003, coded in state law as Indiana Code 20-51-4, created a School Scholarship and School Scholarship Tax Credit Program. The ICSP offers 90%, 70%, and 50% voucher awards for students. To qualify for these voucher awards, a student must be a household member with an annual income equal to or fewer

than 100%, 125%, and 200% of the amount to qualify for the reduced lunch eligibility, respectively (Indiana Department of Education, 2020b; Moon & Stewart, 2016). In 2011/2012 (hereafter 2012), the program offered a voucher for 3,911 students and gradually expanded over the years. As of 2020, 36,707 students benefit from the voucher. It is equal to 3.2% of the student population in the state.

Over the years, ICSP has made significant changes in eligibility criteria that has shaped the profile of voucher beneficiaries. Among the changes in eligibility criteria, the continuing choice path made the most significant impact on the characteristics of the program. In 2020, students who received the voucher through this path reached 27,830, equal to 75.8% of total beneficiaries. It also led to an increase in the proportion of students who have no prior public-school attendance (Figure 1). In 2020, the number of students who never attended a public school reached 22,281, which constitutes 59.7% of total beneficiaries (Indiana Department of Education, 2020a).

Figure 1

Number of Prior Indiana Public School Attendance of Voucher Recipients Students by Year



Source: Indiana Department of Education (2016, 2017, 2019).

The number of students who attended a public school is vital to understanding the heterogeneity of competitive effect over the years. Until 2016, there was an increase in the number of students who had previously attended a public school. Since then, their numbers have remained stable, suggesting a limited number of new students from public schools used vouchers. In the method section, I will explain why the trend in voucher students by previous public-school attendance offers a unique opportunity to reveal the underlying reasons for the change in proficiency rates.

Prior Literature

Existing literature suggests that, on average, competitive pressure of vouchers leads to a modest improvement in student achievement in public schools (Epple et al., 2017; Jabbar et al., 2019). However, the effect is heterogeneous across voucher programs over the years. Among these programs, the voucher-shock and accountability-tied programs emerged as two representative types.

While voucher-shock programs do not require “failing” public school attendance for students who want to use a voucher, accountability-tied programs do. Under a voucher-shock design, whether public schools have higher or deficient performance, all students who meet the income requirement (or alternative pathways such as having a sibling who uses vouchers) are eligible for vouchers. Schools recognize that better performance can help them to keep some students. Particularly, when the program is introduced, it can make an important shock effect in the short term. However, in the long term, public schools may have less motivation to keep students since their performance makes a limited or no contribution to voucher eligibility. Under accountability-tied programs, public schools recognize that if they satisfy the performance requirement of the accountability policy, such as higher performance than the cut-off score of F grade, they can avoid losing students and corresponding revenue as well as the stigma of being a failing school. As a result, under the accountability-tied design, public schools may have a higher motivation to take action than in the voucher shock design (Chakrabarti, 2008a). Despite this vital difference in voucher programs in the US emphasized by Chakrabarti (2008a), studies neglected to consider it and mostly framed the difference as a factor that drives methodological differences to examine the competition effect (e.g., Figlio & Rouse, 2006). The following section reviews the long-term competitive effect of school vouchers on public schools by voucher designs.

Studies indicate that the positive competitive effect of voucher-shock programs fades out in the long term. In her leading study, Hoxby (2003) examined the competitive effect of the Milwaukee Voucher Program on public schools exploiting the number of eligible students and the difference in differences method. She found that the most threatened public schools have larger and higher productivity. Likewise, Greene and Forster (2002) found significant improvements in the program's early years. However, using a similar design as Hoxby (2003) and adding two additional measures of private school density and student loss, Chakrabarti (2008a) found no effect in the first phase of the program but a modest effect in the second phase. Likewise, Carnoy et al. (2007) found that the program's positive large effect fades out in the long term. In his more recent study, Mader (2010) concluded that the program's effect on public school achievement is much smaller than previously found.

The other important voucher program with a voucher-shock design is the CEO Horizon Scholarship Program implemented between 1999 and 2007 in Edgewood, Texas. It had neither income nor accountability requirements for students' prior public schools. Because most of the families were low-income, all households were eligible to receive vouchers regardless of their income (Merrifield & Gray, 2009). Earlier studies conducted between 1998-2001 found a modest improvement in Edgewood compared to the other districts in the state (Greene & Forster, 2002; Merrifield, 2003). The most recent study by Gray et al. (2016), however, found that its positive impact faded out in the long term. They concluded that “the rate of change growth, however, does slow as the voucher program nears the end of its term, indicating that traditional public-school participants need to believe that these programs are long term (p. 319).”

Unlike voucher-shock programs, the accountability-tied voucher designs produced a long-lasting competitive effect on public school achievement, generally measured with standardized test score gain. However, it is not clear enough whether it is the effect of voucher incentives or the stigma effect of accountability. Studies in Florida generally revealed a positive effect (Figlio & Rouse, 2006; Greene, 2001; Rouse et al., 2013; West & Peterson, 2006). A recent study by Figlio et al. (2020) examined the effect of the Florida school voucher program's expansion on public schools. They found that the program's expansion led to higher standardized test score gain, lower absenteeism, and suspension rates in the schools with a higher initial degree of competition, suggesting that the program produces a positive competition effect in the long term.

Another voucher program that has an accountability-tied design is The EdChoice Voucher Program in Ohio. It offers a voucher for students in persistently low-performing schools in the state accountability test. Benefitting from school-fixed effects, Carr (2011) found that between 2003 and 2008, the competitive effect of the program improved proficiency rates in public schools. Using time series analysis, Lowe (2013) expanded the years to 2012. He found that the competitive thread improved proficiency rates in the public schools that face higher competition in the long run as well.

The intersection of the heterogeneity by voucher design and the duration of competitive effect suggested that a voucher program embedded in an accountability system like in Florida and Ohio may have a longer positive competition effect than a voucher-shock program like in Wisconsin and Texas. An important study conducted by Chakrabarti (2008a), who compared the “accountability-tied” voucher design in Florida and the “voucher-shock” design of Milwaukee on student achievement as two-representative models of vouchers, supported these findings. She found that the accountability type of voucher has a larger positive effect than the voucher-shock design. More importantly, she found that Florida's accountability-tied program has a more consistently positive effect in the long term, while the positive effect of voucher-shock in Wisconsin shrinks over time. However, these results also raised the question of whether the stigma of accountability or the voucher itself drives the improvement. Although many studies have used rigorous methods, such as regression discontinuity, the program's design makes it challenging to purge the competitive effect of vouchers from the stigma effect (Epple et al., 2017; Figlio & Rouse, 2006). For instance, examining the effect of eliminating the voucher threat by the Florida Supreme Court in 2006 on public schools, Bowen and Trivitt (2014) found that voucher threat has no impact on incentivizing student achievement, suggesting that the stigma of being a failing school led to an improvement in public school achievement. Thus, more studies are needed to understand whether school vouchers stimulate higher achievement in the absence of a stigma effect.

ICSP offers an opportunity to examine how school vouchers affect public schools without a stigma effect. However, we have limited evidence about the impact of ICSP on public schools. Egalite and Dougherty (2014) examined its competitive effect and found no significant effect on students' math achievement. They found a modest impact on three of the eight measures of competition in English Language Arts (ELA) achievement. Nevertheless, their study was limited to the first year of the program. Waddington and Berends (2018) examined the participation effect in the first four years of ICSP. Although they did not explore the competition effect of the program, they looked at the demographics of voucher recipients compared to the remaining voucher-eligible students in public schools. They found that students who use vouchers have a higher baseline achievement than their public-school peers by 10% of SD in both ELA and math. Because they focus on the participant effect of vouchers, they did not examine how it affected achievement in public schools. The current study aims to contribute to the literature by studying a more extended period and examining the competitive effect of ICSP on public schools through considering the potential sorting effect.

Empirical Framework

The Measure of Competition

The measure of competition between schools is crucial to examine the competitive effect of school choice programs on public schools. Competition is measured in a variety of ways (Creed, 2016). Some studies utilize geographical measures such as density, proximity, or diversity of competitors in a specific area (Bettinger, 2005; Carr & Ritter, 2007; Egalite & Dougherty, 2014; Figlio & Hart, 2014; Greene & Forster, 2002; Holmes et al., 2003; Hoxby, 1994; Sass, 2006; Zimmer

& Buddin, 2009). Second, some studies use the number of eligible students for charter or school voucher programs (Chakrabarti, 2008b; Hoxby, 2003), while other studies use the competitors' market share (Bohte, 2004; Booker et al., 2008) to capture competitive pressure on public schools. Other than these, some studies employ Regression Discontinuity Design (RDD), in which a specific cut-off score, such as A-F accountability scores, significantly impacts voucher eligibility (Chakrabarti, 2008a; Figlio & Rouse, 2006; Greene, 2001; Rouse et al. 2013; West & Peterson, 2006).

Each of these competition measures has its strengths and weaknesses. Among them, RDD has a unique strength in offering random assignment based on a cut-off score. However, it is essential to acknowledge that RDD does not apply to every choice program. For instance, coming from an F public school constitutes a limited portion of Indiana's total participation by less than 1% (Indiana Department of Education, 2020). Therefore, it potentially fails to capture the competitive effect of ICSP. Some studies exploit the number of eligible students for charter or school voucher programs within a specific area (combined with geographic measures) or an administrative unit (e.g., Chakrabarti, 2008a; Greene & Forster, 2002; Hoxby, 2003). These measures only reveal the potential competition and have limitations in capturing the realized or experienced competition, as not all eligible parents apply for choice programs.

Many other studies benefit from geographical measures of competition, such as density, proximity, or diversity of competitors in a specific area (Bettinger, 2005; Carr & Ritter, 2007; Figlio & Hart, 2014; Greene & Forster, 2002; Holmes et al., 2003; Hoxby, 1994; Sass, 2006; Zimmer & Buddin, 2009). Despite their robustness in revealing the competitive effect, it is only possible to examine competition cross-sectionally in these measures. Because the change in the number or types of private schools in a particular area may indicate a weaker or more robust performance of the public schools, the time-variant measure of competition captures unobserved characteristics of public schools that potentially lead to omitted variable bias (Ni & Arsen, 2010). Therefore, studies prefer to use geographical measures in a time-invariant way. They typically benefit from geographical measures of a year before the introduction of the voucher program to avoid omitted variable bias (e.g., Egalite & Dougherty, 2014; Figlio et al., 2020)

Another important measure of competition is the market share of voucher programs, which is the proportion of voucher students in a school district. The primary motivation for using the district-level market share of the voucher is tied to public schools' organizational structure in the US. Many of the decisions regarding the competition are taken by school districts in the US (Hanushek & Rivkin, 2003; Hoxby, 2000). The other potential strength of a district-level measure is that public schools in the same district influence each other in the market. Schools' position in the market hierarchy shapes their responses to the competitive pressure (Jabbar, 2015a). Since the position in the market hierarchy depends on other schools in the market, the overall competitive environment can affect each school in either direction. Further, market share is a valid proxy for parental awareness about school choice options. Parents potentially have greater knowledge and awareness of the available options in districts in which voucher participation is higher. This, in turn, leads to competitive pressures on public schools (Bohte, 2004).

However, the market share of vouchers at the district level does not capture the variation within districts. This problem is a more critical issue for larger school districts in which some schools face higher competition than others, as the micro-education market characteristics may vary within districts. To avoid this problem, I exploit the interaction between the district-level market share and school-level time-invariant geographical measures of competition as an alternative strategy to check the robustness of the main results (Figlio et al., 2020). The underlying assumption of the robustness check is that the effect of the voucher's market share on public schools should be parallel with the school-level measure of competition. Schools in districts where the voucher's market share is high and have a higher number of private schools around them before the voucher program was

introduced are expected to face a higher level of competition. Thus, I assume that, if the effect of school vouchers is positive, those schools should have a more significant improvement in achievement. Conversely, if the effect is negative, those schools should experience a more considerable decrease in achievement.

One of the serious issues in examining the competition effect is that disentangling the sorting effect from changes in efficiency (or lack thereof). As Hsieh and Urquiola (2006) note, if competition affects both efficiency and sorting, “it is nearly impossible to disentangle their respective magnitude (p.1484).” If this problem is not appropriately addressed, then the interpretation of results may be confusing. The trend in voucher students by their prior public-school attendance offers an excellent opportunity to resolve this issue. As plotted in Figure 1, the number of students previously attended in public schools increases until 2016 and then became stable. If the underlying reason for the change in proficiency rates is sorting, then we may observe that the competition effect has a different trend before and after 2016 because public schools do not lose a significant number of students since 2016. I benefit from this unique opportunity to interpret the results.

Estimation Strategy

Main Effect

To estimate the main effect of competition on achievement, I begin with the below regression specification where s , d , and t denotes school, district, and year, respectively.

$$y_{sat} = \alpha + \beta X_{at} + \sum_{i=1}^6 \delta_i D_{sat} + \theta_d + \vartheta_t + \varepsilon_{sat}(I)$$

y is the proportion of proficient students in school s , district d , and in year t . X_{at} is the market share of school vouchers (i.e., competition measure) in district d and year t . β is the coefficient of interest, and D captures school-level control variables. These include the percent of free lunch students, English language learners, special education students, black, Hispanic, and white students in a given school and year. θ_d and ϑ_t are district and year fixed effects, respectively. The robust standard errors are clustered at the district level to account for the collinearity of the school level errors in Equation I and all other equations in the study.

Heterogeneity of Effect by Year

Following Equation I, which estimates the main results of the competition on achievement, I exploit Equation II to explore the heterogeneity of the impact by year. Equation II uses an event study specification in which each year of market share has its unique regression coefficient.

$$y_{sat} = \alpha + \sum_{t=2012}^{2019} \beta_t X_{at} + \sum_{i=1}^6 \delta_i D_{sat} + \theta_d + \vartheta_t + \varepsilon_{sat}(II)$$

Except for the β_t that estimates the impact of competition (X_{at}), Equation II is the same as Equation I. Note that Equation II is a similar setting with the event study estimation in a typical difference in differences model where groups take a dummy value of treatment status. Here, instead of a dummy, X_{at} is a continuous variable that is the market share of school vouchers, which is the main measure of competition. It takes the value of the market share in a given year and zeroes

otherwise. Therefore, β_t represents the change in percent of proficient students when the market share increases 1% in a given year.

Robustness Check

To explore the robustness of the results, the interaction between district-level time-variant market share (X_{dt}) and school-level time-invariant geographical measures of competition (G_{sd}) is added to Equation II in Equation III:

$$y_{sdt} = \alpha + \sum_{t=2012}^{2019} \beta_t X_{dt} * G_{sd} + \sum_{i=1}^6 \delta_i D_{sdt} + \theta_d + \vartheta_t + \varepsilon_{sdt} \text{ (III)}$$

G_{sd} is the market density, which is the number of private schools within a certain radius two years before the voucher program was introduced. Following Egalite and Dougherty's (2014) study on the competitive effect of vouchers on public schools in Indiana, I used the numbers of private schools within 3, 5, and 10 miles of each public school as the measures of market density. The underlying assumption for using G_{sd} is that, if the market share of vouchers and market density are higher, the school should experience a higher level of competition, as discussed in the previous section. To make a more functional interpretation of the interaction of the market share of vouchers and market density, I used quartiles of market density. In other words, instead of a continuous variable of the number of private schools, I used quartiles of the same variable. Thus, the market density ranges from Q1 through Q4, which denote the lowest and highest market density, respectively. I employ separate regression analyses for market density in a 3, 5, and 10-mile radius.

Finally, I tested the validity of the empirical approach exploring the association between voucher participation and schools' proficiency levels in the pre-policy period. I evaluated whether the percent of proficient students before the introduction of the voucher program drives voucher participation or not. I regress the market share of school vouchers in the first and second years of the program on the percent of proficient students and school demographics of a year before the program exploiting one- and two-years lead regression models.

Data

I used publicly available data from the Indiana Department of Education (IDOE, 2020c), ICSP reports, and Private School Universe Survey (PSS, 2020) from the National Center for Education Statistics. The dependent variable is the proportion of proficient students in ELA and math between grades 3 and 8 in the state accountability test, named I-STEP until 2018 and I-LEARN in 2019. The dependent and independent variables of school demographics were accessed through the state data portal. Independent variables and school demographics cover the school years between 2010/2011 and 2018/2019, the latest publicly available data. The number of voucher students covering the school years between 2011/2012 and 2018/2019 by the district was compiled from ICSP annual reports. Linking these district-level data to data from IDOE, I calculated the competition measure, which is the proportion of voucher students (i.e., market share) at the district level. I used private schools' locations from PSS to calculate the number of private schools within a given radius. It is the proxy of market density for each public school that I revealed through the Geographic Information System (ARCMAP 10.7). Because PSS collects data biennially, I used the data from the school years of 2009/2010 instead of 2010/2011, a year from the first year of ICSP. Therefore, the geographical measures belong to the two years from the introduction of the ICSP. I

assumed that, because the program was not available, a year difference in the number of private schools is negligible. Table 1 reports the summary statistics.

Table 1
Sample Summary Statistics (N= 1,268 Schools from 283 Districts)

	Mean	SD	Max	Min	
School Level Measures					
Proficient Student in ELA (%)	70.2	16.9	100	2.4	
Proficient Student in Math (%)	69.1	18.7	100.0	1.1	
Free Lunch (%)	44.1	21.3	100.0	0.8	
English Language Learners (%)	5.7	8.8	70.7	0.0	
Special Education (%)	16.0	5.1	46.5	0.2	
Black (%)	11.8	18.2	97.8	0.1	
Hispanic (%)	10.9	12.6	81.3	0.2	
White (%)	72.2	26.1	100.0	0.2	
Number Private Schools Within 3 miles	1.65	2.25	13	0	
Number Private Schools Within 5 miles	3.73	4.73	22	0	
Number Private Schools Within 10 miles	10.63	11.55	61	0	
District Level Measures					
Market Share of School Vouchers (%)					
	2012	0.3	0.5	2.3	0.0
	2013	0.9	1.2	4.1	0.0
	2014	1.9	2.5	9.1	0.0
	2015	2.9	3.4	13.3	0.0
	2016	3.2	3.8	15.9	0.0
	2017	3.4	4.0	15.9	0.0
	2018	3.5	4.1	16.0	0.0
	2019	3.6	4.2	15.8	0.0
	2012 to 2019	2.2	3.4	16.0	0.0

On average, between the school years of 2011 and 2019, 70.2% and 69.1% of students were proficient in ELA and math, respectively. It is important to note that, because of the change in the state accountability test, the percent of proficient students fell from 82.1% to 67.9% in ELA and from 83.9% to 62.6% in math between 2014 and 2015 (Appendix 1). Because the year-fixed effect eliminates the discrepancy in proficient students across years, and there is no reason to suspect that the change in proficient students is endogenous to competition, the rapid change in proficient students does not lead to bias.

There is a significant variation in the number of private schools within 3, 5, and 10 miles. For instance, the mean of this variable for 5 miles is 3.73, and the standard deviation is 4.73. While there is a school with 38 private schools within 5 miles, some schools have no private schools within the same radius (Appendix 2). Finally, the market share of school vouchers has grown gradually since 2012. Starting with 0.3% in the first year, they reached up to 3.6% in 2019.

Results

Main Results

Table 2 presents the main effect of competition on public school proficiency rates. Model 1 reports the results without covariates and fixed effects. In Model 1, the relationship between competition and achievement is negative and statistically significant in both subjects. One

percentage increase in school vouchers' market share is correlated with a 3.141 and 3.690 decrease in the percent of proficient students in ELA and math, respectively. Including more covariates reduces the magnitudes of the relationship from Model 1 through Model 5. However, the negative relationships are statistically significant in all models in ELA and math, including in Model 5, which uses full control, district-fixed effect, and year-fixed effect.

The largest change in the magnitude of the coefficient of interest occurs between Model 3 and Model 4, which adds year-fixed effects to full control of school demographics. The coefficient reduces from -2.385 to -.878 in ELA and from -2.856 to -.970 in math.

Table 2
Relationship Between Competition and Percent Proficient Students

	ELA					Math				
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 1	Model 2	Model 3	Model 4	Model 5
Full Control of School Demographics		x	x	x	x		x	x	x	x
District Fixed Effect			x		x			x		x
Year Fixed Effect				x	x				x	x
N	11,396	9,878	9,878	9,878	9,878	11,396	9,878	9,878	9,878	9,878
R ²										
Within	0.319	0.377	0.449	0.829	0.834	0.353	0.429	0.490	0.801	0.804
Between	0.266	0.537	0.338	0.705	0.475	0.289	0.479	0.363	0.663	0.503
Overall	0.284	0.460	0.285	0.772	0.655	0.310	0.446	0.301	0.745	0.661

p* < .05 *p* < .01 ****p* < .001. Robust standard errors are clustered at the district level

Model 5, which uses Equation I as its empirical strategy, adds two-way fixed effects, year- and district-fixed effects, to the full control of school demographics. The result reveals that a 1% increase in district voucher participation is correlated with 0.840 and 0.922% lower proficiency in ELA and math, respectively. Note that the standard deviation of the ELA proficiency rate is 16.9, while math is 18.7 (Table 1), suggesting that the 1% increase in market share (i.e., competition) reduces percent proficiency rates by 0.05 SD in both ELA and math.

The theoretical assumptions suggest that the underlying reason for the negative competitive effect may be sorting. However, without further analyzing the issue by years and other characteristics of the market such as private school density, interpreting the negative effect as the result of sorting may be speculative since unobserved characteristics of schools may lead to omitted variable bias. For instance, public schools that face higher competition may prefer to spend more resources for marketing and promotion and deduct instructional spending (Jabbar, 2015b; Lubienski, 2005), resulting in a worse learning environment for students. Therefore, in the following two sections, I examine the competitive effect over the years and by private school density to further explore the underlying reasons for the negative effect.

Effect Heterogeneity by Year

To explore the heterogeneity of the main effect by years, I employed regression equation II and plotted the point estimates and confidence intervals in Figure 2 (See Appendix 3 for the full results). The model uses an event-study framework. In this framework, each coefficient shows the change in the percent of proficient students in year t when the market share of school vouchers increases by 1% relative to the reference year of 2011. It has a similar interpretation with a difference in differences estimation, except the coefficient of interest is a continuous variable rather than a dummy variable that shows the control and treatment groups. Therefore, the point estimates in Figure 1 illustrate the direction and magnitude of the relationship between competition and percent of proficient students in a given year. It allows us to compare the effect of competition over the years.

Results indicate that the negative effect of competition on the percent of proficient students in public schools is driven by sorting. The competition effect is positive and relatively larger in the earlier years in both subjects. In the first year of the program, the statistically significant effect approximates to 2% in ELA. Note that even though the effect is not statistically significant in the first year in math, the 95% confidence interval's lower bound is not considerably lower than zero.

The effect of competition on proficiency rates in public schools (Figure 2) has an inverse relationship in the first five years with the proportion of students who have prior public-school attendance (Figure 3). As the proportion of voucher students who have prior public-school enrollment increases, achievement in public schools that face higher competition decreases until 2016. Then, the competitive effect remains at the same negative level between 2016 and 2019. The stable and negative competitive effect is correlated with the flat number of voucher students who have prior public-school attendance between 2015 and 2019. If the competitive effect were not driven by sorting, we would not observe an exact overlap between Figure 2 and Figure 3. These results suggest that the decrease in proficiency rates was driven by sorting.

In the next section, I examine the effect heterogeneity by private school density to further analyze the positive competition effect in the earlier years and sorting.

Figure 2
Relationship Between Competition and % of Proficient Students Over Years

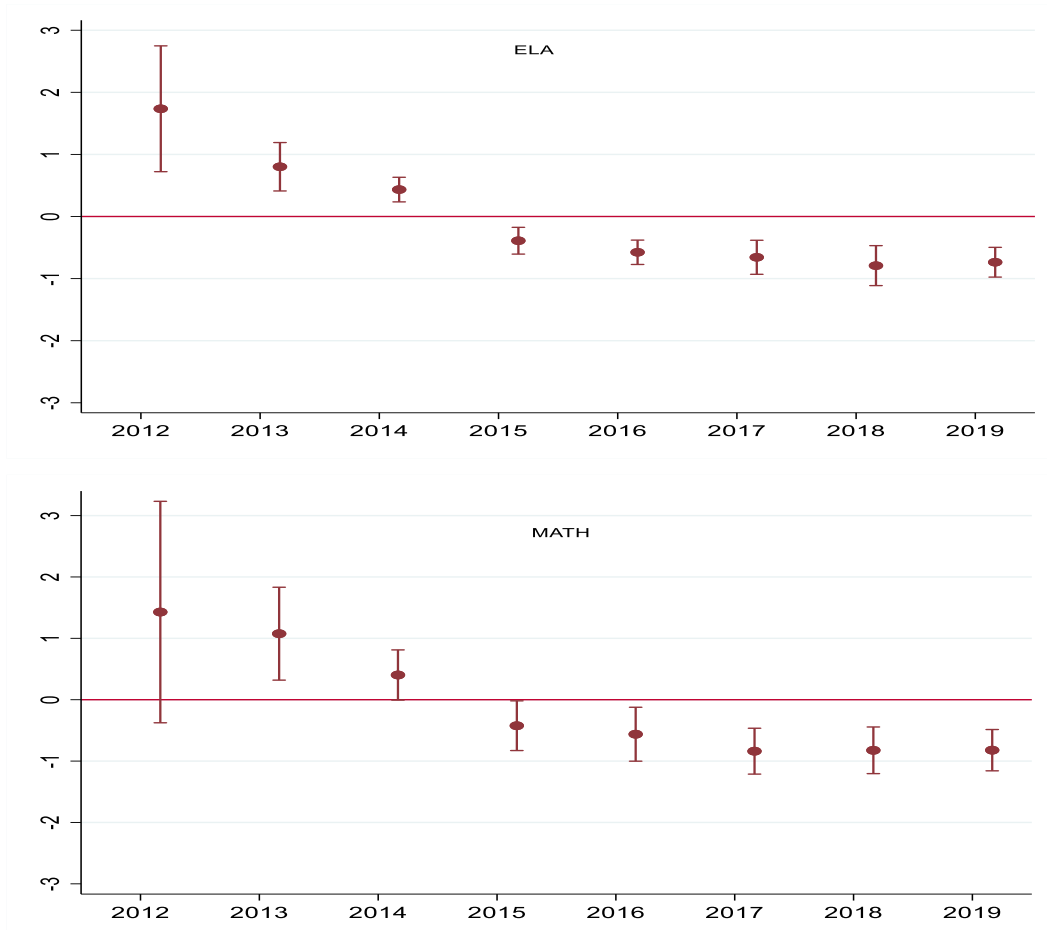
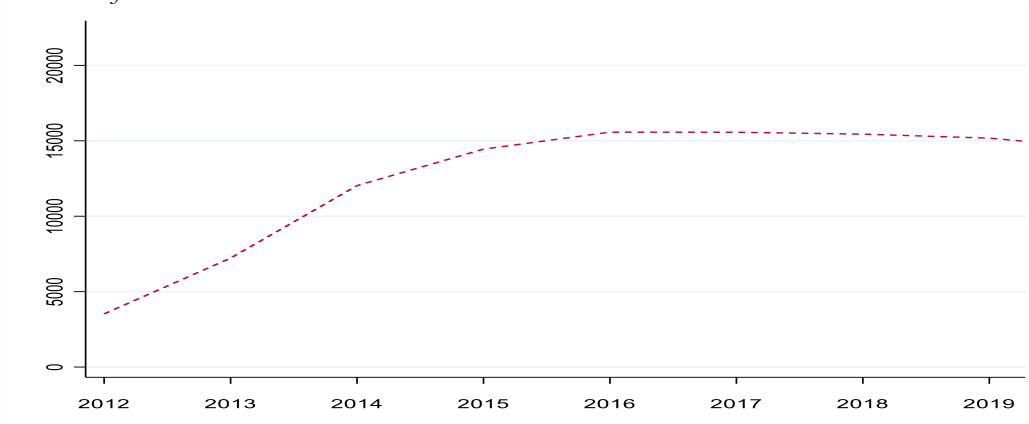


Figure 3
Number of Voucher Students with Prior Public-School Attendance



Note: The figure 2 plots the heterogeneity effect of competition on percent of proficient students. The point estimates revealed through the following regression equation $y_{sdt} = \alpha + \sum_{t=2012}^{2019} \beta_t D_{sdt} + \sum_{i=1}^9 \delta_i D_{sdt} + \theta_s + \vartheta_t + \epsilon_{sdt}$ that uses the event-study framework (see Equation II in the method section). It uses full control of school demographics, district fixed effect and year fixed effect. Spikes show the 95% confidence intervals based on standard errors clustered at the district level. Figure 3 is the same as Figure 1 except it only plots the number of students who previously attended a public school.

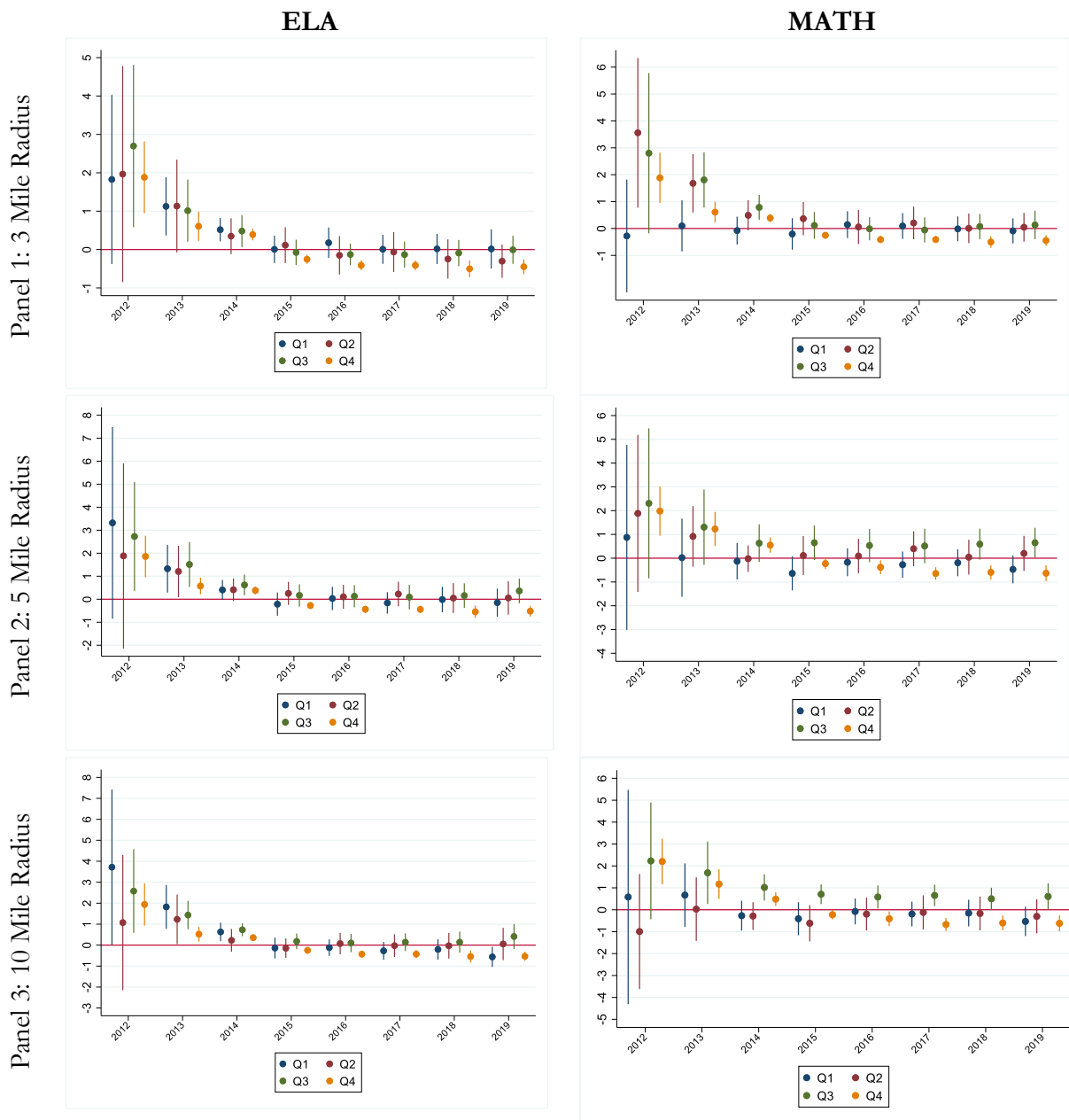
Robustness Check

The Interaction between Market Share of Vouchers and Private School Density

Figure 4 plots the relationship between market share of school vouchers and percent of proficient students by market density over the years. Results indicate that the negative effect of competition on the percent of proficient students is more considerable in high market density areas, suggesting that the results are generally robust to the alternative specification of the interaction between market share of vouchers and market density. The highest market intensity group, those in the fourth quartile (Q4), is the only group with a higher positive competitive effect of vouchers in the earlier years and negative competitive effect of vouchers in recent years at a significant level. Panel 1, 2, and 3 show that, unlike schools with lower market density levels, these schools had consistently positive competitive effects in the first three years with a decreasing magnitude. Likewise, they are the only group that faced a negative competition effect in the last five years at a statistically significant level. These results suggest that schools that face higher competitive pressure lost more high achieving students than those face lower competitive pressure. As a result, the reduction in proficiency rates in high-competition schools is larger than low-competition schools.

Note that Panels 1, 2, and 3 of ELA illustrate that schools that have higher market density, like those in the third (Q3) and fourth (Q4) quartile, have a higher positive statistically significant first-year effect. Conversely, the first-year effect is not statistically different from zero in schools that have lower market density, like those in the first (Q1) and second (Q2) quartile. In math, these patterns are very similar to ELA. Panels 1, 2, and 3 of math show that schools with the highest private school market density (i.e., Q4) are the only group with a statistically significant positive first-year effect. Schools in the third quartile have a relatively higher first-year positive effect, but they are not statistically significant in Panel 2 and Panel 3. The only exception for this pattern is Panel 1, which uses 3 miles as a market density measure, specifically for schools in the second quartile. Note that those schools have an inconsistent pattern by different measures of market density. For instance, the schools in Panel 3 with a 10 miles radius have the lowest first-year effect, even lower than the first quartile, suggesting that the second quartile does not differentiate from the third and fourth quartiles. On the other hand, schools in the first quartile have a more consistent and almost null effect, especially in math. The null competition effect of vouchers does not change over time for this group.

Figure 4
Relationship Between Competition and % of Proficient Students by Market Density Over the Years



Note: Figure 4 plots the effect of competition over years by market density on percent of proficient students. The point estimates revealed through the following regression equation
$$Y_{sdt} = \alpha + \sum_{t=2012}^{2019} \beta_t D_{sdt} * G_{sdt} + \sum_{i=1}^6 \delta_i D_{sdt} + \theta_s + \vartheta_t + \epsilon_{sdt}$$
 uses an event-study framework (See Equation III in the method section). G_{sdt} is the market density. It is the number of private schools within a certain radius before the voucher program was introduced in 2012. To have a more functional interpretation of the $D_{sdt} * G_{sdt}$, I used quartiles of G_{sdt} . Q1, Q2, Q3, and Q4 represent whether a school is at the first, second, third, or fourth quartile of market density in a given radius. The regression specification uses full control of school demographics, district-fixed effect, and year-fixed effect. Spikes show the 95% confidence intervals based on standard errors clustered at district level.

Overall, despite a few discrepancies, the interaction of vouchers' market share and private school intensity reveals consistent results. Across different comparisons, vouchers' competitive effect is generally higher for public schools with a higher number of private schools around them and weaker for public schools that have fewer private schools in the nearest area. These effects are positive in the earlier years and turn negative and remain at the same level over the years due to higher sorting effect.

Voucher Participation

The empirical approach's validity depends on the assumption that market share should not be correlated with schools' pre-policy proficiency levels. In other words, the percent of proficient students prior to the introduction of the voucher program should not drive voucher participation. For instance, if declining achievement trend in pre-policy period (i.e., before 2012) led to higher voucher participation, the result would have misleadingly attributed that trend to competitive effect. To assess it, I regress the market share of school vouchers in the first and second years of the program on the percent of proficient students and school demographics of a year before the program (Table 3). The OLS results in Table 3 utilize one- and two-years lead regression models.

Table 3

The Relationship of Competition with School Proficiency Rates and Demographics (One and Two Years Leads OLS Estimation)

Pre-Policy Characteristics of Schools (2010-2011)	One-year Lead		Two Years Lead	
	β (s.e)	95% Conf. Interval	β (s.e)	95% Conf. Interval
Proficient Student in ELA (%)	.002 (.004)	[-.005 .009]	.006 (.007)	[-.008 .020]
Proficient Student in Math (%)	-.001 (.004)	[-.010 .007]	-.011 (.009)	[-.027 .006]
English Language Learners (%)	-.002 (.008)	[-.018 .014]	.004 (.013)	[-.022 .029]
Special Education (%)	-.008 (.007)	[-.022 .007]	.001 (.016)	[-.030 .032]
Free Lunch (%)	.006*** (.002)	[.002 .011]	.0116*** (.005)	[.002 .021]
Black (%)	.014 (.012)	[-.010 .037]	-.005 (.022)	[-.047 .038]
Hispanic (%)	.000 (.008)	[-.015 .016]	-.029 (.018)	[-.064 .007]
White (%)	-.003 (.009)	[-.021 .016]	-.036 (.020)	[-.075 .003]

* $p < .05$ ** $p < .01$ *** $p < .001$

Results suggest that the pre-policy percent proficiency rates do not drive voucher participation. Both one-year and two-year lead models reveal a statistically insignificant relationship between proficient students and school vouchers' market share. Not surprisingly, the percent of free lunch students is positively correlated with voucher participation because income is one of the most critical factors in determining voucher eligibility.

Discussion

The findings from this study indicated that, despite the positive competitive effect on public school proficiency rates in the earlier years of the voucher program, the effect turns negative in the long term. After three years, it turns to a negative effect and remains stable for the last five years. These findings are consistent with alternative specifications that use the variation in competition and geospatial measures of private school density. Schools in higher private school density areas face higher competitive pressure and, therefore, experience more significant improvement in the first year but also experience the sharpest decrease over the years due to the sorting effect. The decreasing positive effect in the earlier years and long-lasting negative effect in recent years correlate with the number of voucher students who have prior public-school attendance. As the number of students previously attended in a public school increases, the first year's positive competitive effect gradually decreases. Once the number of students with prior public school attendance became fixed for the last five years, the magnitude of the negative effect does not change. Notably, schools that face higher competition due to higher voucher participation and the prevalence of surrounding private schools experience the most significant decrease in proficiency rates.

The positive first-year effect is similar to Egalite and Dougherty (2014). They found positive effects in some geospatial measures of competition in ELA but no significant effect in math. I found that the positive competitive effect is more salient in ELA, though there is no substantial difference by subject in recent years. Findings corroborated with the assumption of “voucher-shock” (Chakrabarti, 2008a), suggesting that the Indiana Choice Scholarship Program produced a positive shock effect for public schools in the first year. The one-time increase and decreasing positive effect over time confirmed the results in Milwaukee (Carnoy et al., 2007; Mader, 2010) and Texas (Gray et al., 2016), where school vouchers have similar designs. The results in this study differ from those conducted in Florida (Figlio et al., 2020) and Ohio (Carr, 2011; Lowe, 2013), where voucher designs are “accountability-tied.” As a result, findings implied that, unlike accountability-tied voucher designs, which exploit the sanctions of A-F grades in improving public school achievement (Bowen & Trivitt, 2014; Epple et al., 2017; Figlio & Rouse, 2006), voucher-shock designs have an important limitation to sustain positive effect in the long term.

A potential mechanism that explains the decrease in public school achievement in the long term is sorting. ICSP appears to lead the flux of relatively high achieving students (among those eligible to receive a voucher) from public schools to private schools. As the number of voucher students who have prior public-school attendance increases, the achievement decreases in schools facing higher competitive pressure between 2012 and 2016. Since the number of voucher students who have prior public school attendance began to flatten in 2016, there is no change in competitive effect until the latest available year of 2019. Waddington and Berends (2018) found a similar result in their study of ICSP between 2012 and 2015. They found that students who used vouchers have a higher baseline achievement than their public-school peers by 10% of SD in ELA and math. Further, the proportion of special education voucher students is lower than their economically similar public-school counterparts. Studies from other states also revealed equivalent results on sorting. These studies found that voucher students have relatively higher initial achievement than their public-school peers who are also eligible for vouchers (Chakrabarti, 2013; Epple et al., 2004; Howell, 2004; McEwan, 2000). As a result, the long-lasting negative effect of the competition in public schools for the last five years of ICSP appears to result from a worsening learning environment (Epple et al., 2004; Epple & Romano, 1998), owed to the departure of relatively high achieving students.

Limitations

A potential limitation of this study is the use of school-level proficiency data as the indicator of achievement. Because proficiency is determined based on a cut-off score, improvements below or above the proficiency cut-off are not captured (Jacob et al., 2014). If the improvement in achievement below and above the proficiency cut-off is correlated with competition, the results would be biased. For instance, if schools that face higher competition focus on students who approach proficiency, the results would be upward bias since proficiency rates would represent a spurious improvement. However, this is less likely to occur since proficiency rates have a limited role in voucher participation in ICSP, unlike accountability-tied programs, as noted. The second point is that if the initial proficiency rates differ by voucher participation, it will be a source of bias. Schools with lower initial proficiency rates may have greater increases over time than those with higher initial proficiency rates since the pool of non-proficient students is larger in the former. However, Table 3 indicates that, on average, the percent of proficient students in ELA and math are not statistically significant predictors of voucher participation. The statistically similar proficiency rates in the pre-policy period suggest that initial proficiency rates are not correlated with voucher participation. Therefore, the program design and empirical evidence suggest that school-level proficiency rates do not lead to biased estimation.

Policy Implications

The voucher reformers look to improve the achievements of students who use vouchers (i.e., participation effect) and those who remain in public schools (i.e., competitive effect). Exploiting the exact matching approach of voucher students and their peers in public schools, Waddington and Berends (2018) examined the impact of ICSP. The results indicated that voucher students in private schools have worse math achievement by a factor of 0.15. SD compare to their virtual peers in public schools. This negative result is persistent throughout the four years of private school enrollment. Their results suggested that ICSP does not meet its expectation of participation effect.

Findings in the current study suggested that it also does not satisfy the expectation of the competitive effect. Decision-makers who are willing to implement or expand school vouchers should consider their long-term effects. These programs may be perceived as incentivizing educational outcomes in the short term, but the direct and indirect effects may be detrimental in the long term. The departure of relatively high achieving, voucher-eligible students from public schools appears to have acute detrimental effects on public schools that face higher competitive pressure that policymakers should recognize. Once those students leave public schools, the fall of the learning environment's quality and student achievement could not be compensated for in the long term.

Implications for Future Studies

This research has raised some questions in need of further examination. As voucher programs expand across the US, the competition effect is needed to be examined in a more extended period. Future studies should consider that the long-term effect of competition may significantly deviate from the short-term effect and may depend on the voucher designs. Additional studies will advance the empirical knowledge about how the long-term effect is mediated by the voucher program's design. Researchers may consider exploiting program-specific information such as enrollment patterns by prior public-school attendance when possible in disentangling the sorting from the competitive effect.

Although studies on peer-effect suggest that a decrease in a school's overall achievement level because of losing relatively high achieving students may lead to a worsening learning environment, we have little knowledge of how it occurs in the competitive organizational environment. Future studies can examine how public schools respond to losing relatively high achieving students. In addition, studies can explore the extent to which voucher shock design programs lead to segregation by race and parental income across schools.

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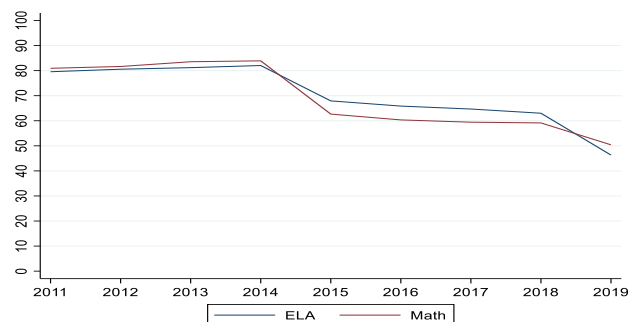
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Appendices

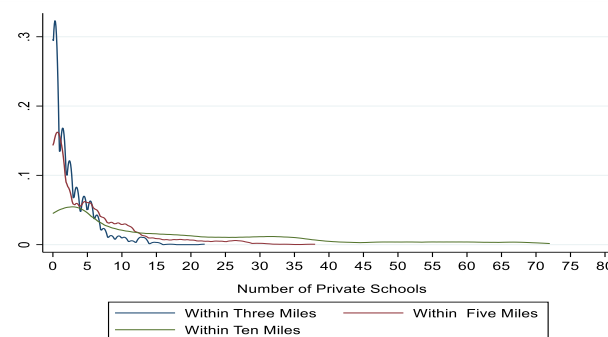
Appendix 1

Trend of % Proficient Students in ELA and Math between 2011 and 2019



Appendix 2

Density of The Number of The Private Schools by Radius



Appendix 3

Relationship Between Competition and % of Proficient Students Over Years

	ELA						Math					
	Coef.	Robust Std. Err.	t	P>t	[95% Conf. Interval]	Coef.	Robust Std. Err.	t	P>t	[95% Conf. Interval]		
2012	1.735	0.515	3.370	0.001	0.722 2.748	1.428	0.917	1.560	0.120	-0.376 3.233		
2013	0.801	0.198	4.050	0.000	0.411 1.191	1.076	0.384	2.800	0.006	0.319 1.832		
2014	0.434	0.101	4.310	0.000	0.236 0.632	0.403	0.208	1.940	0.053	-0.006 0.812		
2015	-0.390	0.110	-3.560	0.000	-0.605 -0.174	-0.424	0.206	-2.060	0.040	-0.829 -0.018		
2016	-0.576	0.100	-5.780	0.000	-0.772 -0.380	-0.562	0.223	-2.520	0.012	-1.001 -0.123		
2017	-0.657	0.139	-4.710	0.000	-0.931 -0.382	-0.839	0.190	-4.420	0.000	-1.212 -0.465		
2018	-0.791	0.163	-4.840	0.000	-1.113 -0.469	-0.824	0.193	-4.270	0.000	-1.204 -0.445		
2019	-0.736	0.122	-6.050	0.000	-0.976 -0.497	-0.822	0.171	-4.810	0.000	-1.158 -0.486		
Special Education	-0.164	0.048	-3.400	0.001	-0.259 -0.069	-0.119	0.065	-1.820	0.070	-0.248 0.010		
FRRLP	-0.027	0.029	-0.950	0.343	-0.084 0.029	-0.100	0.043	-2.310	0.021	-0.185 -0.015		
ELL	-0.181	0.055	-3.310	0.001	-0.288 -0.073	0.179	0.070	2.560	0.011	0.041 0.316		
Black	-0.590	0.087	-6.770	0.000	-0.761 -0.418	-0.523	0.087	-6.020	0.000	-0.694 -0.352		
Hispanic	-0.280	0.076	-3.680	0.000	-0.431 -0.130	-0.583	0.085	-6.890	0.000	-0.750 -0.417		
White	-0.208	0.072	-2.890	0.004	-0.350 -0.066	-0.161	0.079	-2.030	0.043	-0.316 -0.005		
Constant	108.451	7.093	15.290	0.000	94.488 122.414	108.778	7.549	14.410	0.000	93.917 123.639		

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