The Pennsylvania State University

The Graduate School

College of Education

THE EFFECTS OF CATHOLIC AND MAGNET SCHOOLS ON 12TH GRADE MATHEMATICS ACHIEVEMENT

A Dissertation in

Educational Theory and Policy

and

Comparative and International Education

by

Wen-Chun Chen

Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Doctor of Philosophy

August 2011

The dissertation of Wen-Chun Chen was reviewed and approved* by the following:

Suet-ling Pong
Professor of Education, Sociology, and Demography
Dissertation Advisor
Chair of Committee

Gerald LeTendre
Professor of Education and International Affairs
Department Head of Education Policy Studies

Barrett Lee
Professor of Sociology and Demography

Glenn Firebaugh
Roy C. Buck Professor of American Institutions
Professor of Sociology and Demography

George Farkas
Professor of Department of Education
Special Member
University of California, Irvine

*Signatures are on file in the Graduate School

ABSTRACT

Since the 1970s, school choice – the opting out of assigned neighborhood school for other schools – has studied extensively in American education. It is considered a possible means to equalize educational opportunity as well as to achieve educational excellence. The expansion of school choices is an ongoing trend, and so is the debate over school choice's effect on students' academic outcomes. Catholic and magnet schools are two school choices evaluated most often. This study improves previous literature on the Catholic and magnet school effects in the following respects: (1) I use a nationally representative sample that allows for greater generalizability than do local samples; (2) I apply the propensity score matching method to study the school choice effects and their heterogeneity across groups; and (3) I am able to analyze the effect of school choice at the policy levels - state and school districts that are identified with the help of the Geographic Information System (GIS).

Using data from the Educational Longitudinal Study, 2000 Census, Common Core of Data, Private School Universe Survey, and School District Demographics System, the following conclusions are reached. First, Catholic schools benefit students in math learning. Such effect is especially significant for students who are least likely to attend Catholic schools. This Catholic school effect is not uniformly found among all racial/ethnic groups. White and Hispanic students benefits from choosing Catholic schools but Blacks do not. Second, within states, Catholic students, especially Whites and Hispanics, gain more than do their public school peers in math achievement. Third, students with low propensity of attending Catholic school gain more within school districts. The within-school district effect is larger and more significant in the districts where public aid for Catholic schooling is available as compared with other districts. Fourth, there is heterogeneity of Catholic school effects by national origin among Hispanics. The effect is especially large for non-Mexican Hispanics, who come from higher SES families than do Mexicans. The Catholic school effects is also larger among immigrants than natives. Fifth, no significant effect of magnet school on math achievement is obtained.

Several policy implications are discussed in the dissertation. First, within a large school district that serves a large body of minority and low-income students, making Catholic schooling more available for those students is a way to improve student learning. Second, it is essential to make Catholic schooling more accessible for students who would like to participate in quality schools across school district boundaries. Third, the information about quality school choices should be distributed to as many families as possible. Fourth, learning from Catholic school experience can benefit academic achievement for public school students.

Keywords: school choice effect, school choice policy, Catholic school, magnet school, race/ethnicity, immigrant education, math achievement

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

I am grateful to a number of people who supported me through the dissertation process and my entire graduate school life. First and foremost, my immense gratitude goes to my advisor, Dr. Suet-ling Pong for her intellectual inspiration in developing this dissertation, as well as her enthusiasm, patience, and generous support to my life at Penn State. Her sense of humor and straightforward advice on every topic we discussed has benefited me with wisdom for both my professional development and life experiences. She is a true mentor. It is my honor to be her advisee and to work with her.

I am also indebted to the other committee members. The critical comments from Dr. George Farkas paved the road to frame this study and articulate the findings. Dr. Gerald LeTendre contributed to this dissertation with prompt and comprehensive feedback with solid policy perspectives. Dr. Glenn Firebaugh played a key role in developing my methodological mind and provided analytical guidance. Dr. Barrett Lee led me to consider differential educational outcomes across groups and the potential contextual constraints.

Beyond my committee, substantial appreciation is devoted to three professors. Dr. Gordon De Jong provided me with a demography scholarship to complete my dissertation. Dr. Tony Tam and Dr. Ly-yun Chang provided me with the opportunity to step into educational research. Beyond this, their long-term and unfailing support has made my graduate study in the United States complete.

It is my pleasure to acknowledge institutional supports from the Department of Education Policy Studies and Population Research Institute at Penn State. Additionally, a dissertation grant from the American Education Research Association encouraged me to delve into educational research.

Along the journey to complete this study, I would like to thank some valuable friends who have shared their time, happiness, and intellectual ideas with me.Tse-Chuan Yang, Huei-Wen Teng, Ming-Hsuan Kang, Andy Chang, Ellen Rees, Ty Glade, Mira Hidaje, Cindy Ann Rampersad, and my friends at the Population Research Institute are among those who made my life at State College easier and will never be forgotten—You know who you are!

Last but definitely not least, my deepest gratitude goes to my beloved family for their love, sacrifice, and joys they brought into my daily life. Without the unconditional support from my parents, Yun-Sheng Chen and Su-Chu Huang, I would not have been brave enough to pursue my dreams in the U.S. My sister, Yi-Ching Chen, unselfishly helped me through the last stage of dissertation writing was the key to complete this study. Without a doubt, the emotional support and the tolerance of my occasionally irrational moments from my husband, Yen-Chi Chen, relieved the tremendous stress I was experiencing. Most importantly, the joy that my lovely daughter-Connie Chen has brought to my life is the foundation of my happiness. She is also my major source of motivation for educational research. With her, this work became rewarding and cheerful.

Chapter 1

INTRODUCTION

Educational choice has been considered as a means to provide solutions for educational problems (Catterall, 1992), an efficient way to improve school quality (Friedman, 1955), and a mechanism to equalize the opportunity to learn for students from different social backgrounds (Coleman, 1966). Since the 1954 Supreme Court ruling of *Brown v. Board of Education*, policymakers have eradicated the "separate but equal" doctrine and have embraced and expanded various school choice plans. From the 1990s to 2000s, an increasing proportion of students enrolled in schools of their choice. Minority students are more likely to attend chosen public schools than are majority White students (Tice, Princiotta, & Bielick 2006). Among school choices, Catholic and magnet schools serve the majority of student enrollment within the private sector and public school choice, respectively. Catholic and magnet schools are also important educational institutions for low-income and minority students due to the fact that they tend to largely locate in urban areas and inner cities.

School choice is a policy designed under the doctrine of improving social equality by providing equal educational opportunities to all. School choice has received much attention and debate since sociologist James Coleman and his colleagues (Coleman & Hoffer 1987; Greeley & Coleman 1985) reported that Catholic high school students outperformed their public school counterparts. The social implication behind the school choice effect is that through attending schools of choice, students' academic achievement, especially students at risk, can be improved and thus narrow the achievement gap among students from different family backgrounds.

However, critics argue that expanding school choice may be a mechanism to create social segregation. Parents from different racial/ethnic groups and social classes choose schools based on racial preferences, the ability to obtain school information, and the capacity to access favorite schools (Lankford & Wyckoff, 1992; Lee et al., 1994; Henig, 1996; Schneider et al., 2000; DeLuca, 2007). As a result, students of the same race or social class tend to attend schools with a greater proportion of students who share their same racial/ethnic and social class backgrounds. Therefore, unconstrained school choice may thus reinforce social stratification (Astin, 1992).

Existing literature on school choice focuses largely on two scholarships – how and what parents choose and the consequence of school choices. The explanations of how parents choose schools mostly discuss the demand-side factors of school choice. Few researchers have examined the determinants on the supply side. Because school availability is tied to where families live, parents' selections of schools is conditioned by state and district regulations, such as inter- or intra-district enrollment. The limits vary across students' residences.

The selection of schools can lead to various school effects on students' educational outcomes. This is what the second scholarship of literature delved into. Research on the Catholic school effect has found mixed results. A number of earlier studies show positive effects of Catholic schools on academic achievement, especially for low-income or minority students (e.g. Bryk et al., (1993); Coleman et al., (1982)). However, critics of these studies argue that the earlier studies failed to correct for selection bias (Murnane, Willett, & Olsen 1985; Witte 1992). After adjusting for selection bias through the two-stage least square model or instrumental variable analysis, researchers still arrived at inconclusive results (Evans & Schwab 1995; Neal 1997; Noell 1982). Recently, drawing on the merit of counterfactual inference for survey data, Morgan (2001) uses the propensity-score matching method to estimate the causal effect of Catholic school on student achievement. The 1988 data shows that students with low propensity for enrolling in Catholic high schools, who are also more likely to be low-income minority students, benefit from Catholic school attendance. It is unclear, however, if such results of the effect of Catholic high school have held in more recent years.

Since the 1970s, the number of Catholic schools and the share of Catholic school students has declined. Nearly seven percent of Catholic schools have closed in the last few years (Meyer 2007). In the 2007-2008 school year, Catholic school enrollment was 2.27 million, which is less than half of the enrollment in 1960 (McDonald & Schultz 2008). However, the proportion of minority students in Catholic schools has increased, from 11% in 1970, to 19% in 1980, and 29% in 2009. Today, the minority composition in Catholic schools is about 13% Hispanic, 8% Blacks, and 4% Asians (McDonald & Schultz 2009). This demographic shift may be a result of the expansion of the school choice program in many states (Goodman 2009). School choice in the form of voucher or scholarship tax credit programs for private education rose by about 90% over the last five years (Goodman 2009). Many minority students who previously had a low propensity to attend Catholic schools are now able to afford them. This demographic development may have important implications upon the effects of Catholic schools.

In recent years, researchers have begun to turn their attention to the effect of public school choices. Among them, magnet schools remain as the most significant because they serve a large number of minority and low-income students and because their defined mission is to improve school diversity. The number of magnet schools is increasing. In 2006, there were about 4,000 magnet schools, and Black (32%) and Latino (29%) students comprised a much larger proportion in such schools than they did in all public schools (where Black and Latino respectively comprise about 17% and 20% of students). Although the majority of students who attend public schools of choice enroll in magnet schools, compared with charter schools, the studies of magnet schools on students' outcomes is relatively sparse. Yet the findings of the magnet school effect are not conclusive. Two factors often discussed in relation to the inconsistent results are the lack of generalizability and selection bias. Studies from districts and areas show mixed effects (Crain et al. 1999; Betts et al. 2006), so do studies using national datasets (Gamoran 1996; Christenson et al. 2003). Using national datasets fulfill the need for generalizability, while it again raises the question about selection bias.

Despite the two issues that are mostly addressed about school choice, there is a lack of literature about the school effect at the policy level. While school choice policies may vary across different levels of policy authority (i.e. states and school districts), it is very important to analyze the school effect studies at the policy level.

In this thesis, I examine the effects of Catholic and magnet schools on students' academic achievement. The study is based on the first and second waves of data from the recent nationally representative data – Education Longitudinal Study of 2002 (ELS:02). I further use data from the Common Core of Data (CCD), Private School Universe Survey (PSS), School District Demographic System (SDDS), and 2000 Census. In addition, I make methodological advances in several respects. First, I employ quasi-experimental method- propensity score matching, to investigate if the effects of Catholic and magnet schools on students' academic achievements is causal. Second, I control for the effect of state and district regulations by using fixed-effects modeling. Without this control, the between-district variation is very likely to be confounded by unmeasured district characteristics that are correlated with school characteristics, and lead to biased estimates. Because most parents choose schools within districts, restricting the analysis to within-district variation is more likely to avoid such bias. Lastly, this study improves the measure by using GIA technique to take spatial distribution of available schools surrounding in students' residences into account. I also add the policy measure that was not found in the school choice literature. By doing so, this study can contribute to school choice policy formation.

As this study focuses on school choices and their consequences on students' educational outcomes, in chapter 2, I review the relevant literature of school choice effects. I first present the association between social stratification and educational choices. In the second part, I examine why and how parents choose different school destinations. This provides information about school selection and how the measures discussed in the literature can be of use for propensity score matching, which requires valid covariates before school selection. The last major part is the literature about Catholic and magnet school effects on students' academic achievements. In the end, I briefly summarize and conclude with a review and a discussion of the identity gaps in existing literature.

Following the literature review is chapter 3 regarding datasets, variables, and methods used in this study. Before I go into detailed information about my empirical design, I discuss my research questions for this study. Results about the Catholic effects are presented in chapter 4. After presenting the significant causal effect of Catholic schools, another extended examination about Catholic school effect for immigrant students, with special focus on Hispanic immigrants is highlighted in chapter 5. The effect of magnet school is estimated and presented in chapter6. In the last chapter of this thesis, I summarize and conclude the research findings. I also discuss policy implications based on the findings, followed by possible improvements for further research.

Chapter 2

LITERATURE REVIEW

Introduction

Education plays an important role in status attainment through an individual's life course (Svalastoga 1965). Through education, an individual acquires human capital that affects later occupational attainments (Becker 1964). It is associated with social stratification due to its significance as a determinant of differences in wealth, power and prestige (Rosen, Harry, & Nunn 1969). Haller and Portes (1973) shows that educational attainment determines occupational status, which in turn affects income level. Members of a higher social class are capable of controlling the access to education and can reproduce and maintain their social status. Schools that teach a particular status's culture and creates credentials for occupational attainment produce and even exaggerate inequality among groups (Bourdieu & Passeron 1977). Educational inequality, therefore, perpetuates social inequality.

However, with the expansion of education spread through the United States over time, does educational inequality diminish? For instance, high school completion was not universal throughout the first half of the 20 century in the United States (about 9%), when the socioeconomically advantaged groups used their advantages to secure a high level of schooling. In the school year 2007-2008, the average freshman graduation rate among public high school students was about 75% (Grodsky, Warren et al., 2008; Stillwell 2010). But a high school diploma does not present the same credibility across students.

Graduates of elite high schools may have better job opportunities than those from regular high schools.

The “Effective Maintained Inequality” theory (EMI) developed by Samuel Lucas (2001) explains the pattern of maintained social inequality through education. The EMI argues that when the “quantity” of inequality declines with expanding education, the quality of inequality will vary and inequality still exists. The advantaged groups are able to improve their opportunities for advanced attainment within the same educational level. Therefore, while high school becomes universal, the socioeconomically advantaged seek out whatever qualitative differences to maintain their educational advantage.

The “quality inequality” reflects the fact that education is stratified by differences in achievement and opportunities. Educational achievements, in terms of test scores, consistently vary by socioeconomic status and race/ethnicity (Grodsky, Warren et al., 2008). In addition, educational achievements could be driven by students’ opportunity to learn (OTL). That is, the resources available for students to learn, usually within classrooms, can make a difference in their educational outcomes. This reinforces a factor that what and how students are taught and learn, matter. On the other hand, the variation of pedagogy, curriculum, and other features related to teaching are embedded within and between classrooms and schools. Thus, there is between- classroom and -school differences; and, classroom differences are characteristics of schools. Parents choose what their children may learn through choosing schools.

However, parents cannot access the same quality of schools. Schools available for parents/families are based on residential location. This is especially true for public schools. While high quality schools are not equally distributed to every household, schools become a source of social inequality. Differentials in educational outcomes across socioeconomic and racial/ethnic origins are thus attributable to unequal opportunities to choose schools.

The following review constitutes five subsections. First, I introduce the origin and development of educational choices, as well as the significance and debate of choice. The second section focuses on the research findings on socioeconomic and racial/ethnic differences in school selection, followed by the fourth section that reviews the process of school selection for individual students and families. Following this section is the research about Catholic and magnet school effects on students' outcomes, especially academic achievements. Lastly, I summarize the existing findings and probe into the school effect at the policy level.

Educational Choice in the United States

During the first two centuries of colonial American history, education was primarily provided by government funds and operated by private institutions. In the 1640s, two important laws were enforced that every child should be educated (Walberg 2003). The first law made all parents and ministers responsible for children's literacy level to read the Bible and understand the laws. The second law directly required the creation of schools and tax support for those schools. Towns of fifty or more families had to create elementary schools, while towns of one hundred or more families had to create Latin Grammar schools. However, schooling was not totally supported by government taxation nor was it free for everyone. Students were charged a tuition if the education fund was not sufficient. Children from low-income families were less likely to afford formal schooling, while wealthy families sent their children to privileged public schools or elite private schools.

Choosing to attend school did not only depend on family income, it also depended upon the difference in religious beliefs. In the colonial age, the dominant religious belief taught in the public schools was Protestantism (Smith 1981). Irish and German immigrants who entered the United States and settled in New England were mostly Roman Catholic. Those Catholic immigrants felt threatened when their children attended local public schools. There was a strong need to create Catholic schools where Catholic youth could be strengthened by the Catholic faith. Thus, the first Catholic school in North America opened as a fee institution during colonial times to educate the children of the Catholic elite. The poor Catholic children were not left behind. The sponsors of elite Catholic schools used the revenues to open free schools for the poor Catholic children. In 1853, the First Plenary Council in Baltimore dictated that all Catholic bishops establish parish schools to serve the community where the parish churches were located (Walch 1996).

The government support for religious schools did not continue. In 1788, the establishment of the First Amendment the Constitution stated, “Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof...”. It basically prohibited the preference of one religion over another. Since then, religion was gradually privatized and separated from the state. This trend was confirmed in the mid-nineteenth century, while the expansion of public schooling began a strong demand for government funds (Walberg 2003).

The practice of free public schools for all started in the state of Massachusetts in 1837 (Smith 1981). Horace Mann, the first secretary of the board of education in Massachusetts, was the nation’s leader to promote government funds only for public schools. In addition, he successfully pushed for free public schools for all children in Massachusetts. Later on, the “free public school for all” policy became well adopted in other states, and was carried to Congress while Mann was elected to the House of Representative in 1848. By 1850, there were 80,985 public schools in the United States (Smith 1981). In the late nineteenth century, the major four types of schools were distinguished: (1) free public schools, supported by government funds; (2) Catholic schools, supported by Catholic Church scholarship and student tuition; (3) other religious schools, which mainly relied on tuition and donations; and (4) other private non-religious schools, operated mainly through tuition.

Decade by decade into the twentieth century, school choice was innovated and practiced in various forms to fulfill rising demands from the American families. School choice in the educational system was provoked by economist Milton Friedman (1955) with the inspiration that choices can increase school consumers’ sovereignty and raise school competition. Through school competition, school quality can be improved. Along the same line, political scientists Chubb and Moe (1990) believe that school choice is the only policy that can address the problems infecting America’s schools among all school reforms. In the late 1990s, there were about 60% of students attending schools of choice (Henig & Sugarman 1999) – 36% chose neighborhood schools by residential mobility, 10% exercised choice within their districts, 10% chose private schools, and about 2% chose charter schools, homeschooling, interdistrict transfers, and educational vouchers.

Educational choice nowadays is not only taken as a panacea for educational efficiency but also a means for social integration. Choice policy, such as vouchers, is considered to establish a school environment for students from different family backgrounds (Manski, 1992). By design, a choice policy can provide *equal access* to alternative schools for families, and can develop families' *equal ability to exercise choices* among available alternatives (Levin, 1992). Various choices have different purposes, designs, and operations (Raywid, 1985; Schneider et al., 2000).

There are two basic forms of school choices: (1) choices among public school districts; and (2) choice between public and private schools. The former is a form that families choose public schools in certain public school districts through residential mobility. To use this form, families need to have a certain degree of freedom to move. In the United States, the funds for local school districts is mainly from local property taxes, which depend on the housing value within the district. At the same time, good schools and school districts also contribute to housing values (Hoxby 1998). Families that prefer certain kinds of schools sort themselves into different districts. Under the decentralized American school system, families and school districts are thus interdependent – school districts try to fulfill parents' expectations toward public schools through school expenditures and curricula, while parents pay for school expenditures through property taxes. However, for minority and low-income families, the choice among school districts is largely constrained by income and discrimination.

The second form of choice is to choose between school sectors (public versus private), and choose within the sector (i.e. magnet school within public sector and

Catholic school within private sector). The school choices available for contemporary American society are briefly discussed below (Raywid 1985; Levin 2009):

Alternative school

Tracing back to the beginning of educational choice in the 1960s, the first form of public school choice that is widely acknowledged is the alternative school. Alternative schools serve special needs of students and experiment with new pedagogical techniques. This type of school is usually localized or is a single program within a district, designed to solve a single challenge or problem or serve some target groups. Sometimes those are programs within the regular public schools.

Magnet school

This is also an intra-district school reform initiated in the 1970s. It represents a district's commitment to diversification and to desegregate schools. Magnets are schools that (1) offer special or distinctive programs attractive to students of all races; (2) students enter on a voluntary basis; (3) are racially diversified and serve to desegregate (McMillan, 1980). Many school districts created magnet schools to attract students within the district and thereby achieve a racial balance. The majority of students enrolled in public schools of choice are in magnet schools. It is rare to find only one magnet school in a district. In addition, they are also more likely to locate in large and racially heterogeneous central cities (Gamoran, 1996). They could be individual magnet schools or magnet programs within regular public schools.

Open enrollment

After alternative and magnet schools become school options under the traditional education structure, open enrollment programs endow parents more autonomy to choose among schools. It breaks boundaries of school attachment areas. Some parents can choose schools within districts, while in some states (e.g. Minnesota), enrollments are available among districts and students can attend public schools in neighboring districts without paying extra tuition. The latter is rare and has limited impact on the choice market.

Charter school

Charter schools are characterized by having a high level of school autonomy and parental involvement. A charter school is like a regular public school but is open to all students. When it is over subscribed, admission is processed by lottery. Most importantly, the school arrangement is decentralized and designed to meet the needs of parents and to increase their involvement in their children's schooling (Hassel 1998). Each charter school has its special theme, curriculum design, and independent administrative system. They receive direct funds from the state to fulfill certain educational goals that the state approves. Because of their special features and proclaimed effective operation due to a high level of school autonomy, charter schools are drawing overwhelming attention in policy discussions. The number of charter schools is growing. There are about 4,000 charter schools, serving about 2% of elementary and secondary student enrollment in the United States (Levin 2009).

Home schooling

Instead of sending children to schools, some parents choose to educate their offspring at home. This form is choice is still under state law, but the regulation is relatively light compared to other choices. Home schooling is expanding and has gradually developed a trend to cooperate with local charter schools. In some areas, some home schoolers are able to receive charter school programs through the Internet (Herta, Gonzalea, & d'Entremont 2006).

Vouchers

School vouchers were initiated from Friedman's (1955) market approach to provide free choice for students to attend private schools. Under this scheme, school competition can be expected, and thereby increases public school quality. The proponents of vouchers proclaim that public schooling should be a bottom-up system, in which parents should be free to choose better schools among possible choices (Chubb & Moe, 1990).

Vouchers are not under the control of local school districts. The state directly provides parents with vouchers or certificates of tuition of attending approved private schools. Only schools that meet certain standards or regulations are approved to participate in the plan to compete for students. On the other hand, voucher schools can select students based on students' performance or other criteria, such as effort. Such schools also enjoy more autonomy than public school choices, which are under the control of district center offices. Through vouchers, low-income and minority students have more freedom to attend good private schools. The public concern over voucher plans is relatively conservative compared to other choices. Currently, the three-voucher systems- Cleveland, Milwaukee, and Washington, D.C., are only available for low-income families (Levin 2009).

Tuition Tax Credit

For parents whose children enroll in private schools, some states provide tax credits, which reduce the parents' taxes. The reduction could totally or partially cover tuition. Tax reduction is also a form of credit but usually with less support. Unlike schools that participate in voucher programs, there is usually no requirement for schools to provide parents with tax credits.

Private School

Compared with free public schools, parents who can afford tuition choose private schools. Among them, in the school year 2006-2007, Catholic school enrollment constituted of about 39% of private school enrollments, and about 72% of private high school students attended Catholic high schools (Snyder & Dillow 2010). However, Catholic school tuition is on average about 20% less than that of other private schools. Most parents whose children enroll in private schools do not receive vouchers or tax credits. Some students of low-income and minority families may participate in partial private tutoring through compensatory programs sponsored by state funding. However, such a program is only available for students at risk; not every student who needs extra tutoring is eligible to make use of this service (Levin 2009).

As school choice expands overtime, the political debate over school choice is also steaming. Traditionally, the public school system is controlled under local educational agencies, such as school districts. These agencies allocate resources (i.e. teachers and curriculum) with their own agenda. School choice challenges their uses of resources and power in the school (Hill & Jochim 2009). The opponents of choice plans see choice as contradictory to the design of public schools as common schools, where students are from different backgrounds and learn from each other. In addition, schools of choice often are not sustainable due to their inability to attract students and judge teachers by their performance. The operational scheme is less likely to provide a stable employment status for teachers and other employees in the school.

The proponents of school choice consider choice as a mechanism to not only improve public school quality through competition (Friedman 1962), but provide freedom of choice and equity. Through allowing government an active role in choice plans, such as licensing schools, school quality from choice can be monitored and ensured (Chubb & Moe 1990). Charter schools and school contract programs are two typical examples. As education increasingly becomes a policy area for federal and state policymakers, several interest groups intervene in favor of choice expansion. These interest groups include businesses that attempt to operate schools, private religious schools that seek public funding, urban civic organizations and civil right groups that express the need to transform public schools in order to serve poor students (Hill & Jochim 2009). The idea is that parents who are given freedom of choice are also given equal opportunity to choose quality schools to improve children's educational outcomes. Gradually, minorities are more likely to welcome school choice than Whites (Howell, West, & Peterson 2007). There is a rise in the incidence of minority communities promoting school choice. While American society faces an achievement gap between socioeconomic and racial/ethnic groups and stagnant academic achievement, choice is considered a means to overcome such an issue.

Socioeconomic and Racial/Ethnic Achievement Difference in School Choice

Socioeconomic (SES) and racial/ethnic differences in educational outcomes have been a long-term social issue in U.S. society. A large body of research has made a tremendous effort to observe racial/ethnic achievement gaps and to explain the causes of the gap. In their review article, Kao and Thompson (2003) show that the ethnic/racial gap in educational outcomes, such as test scores, high school drop-out rates and completions, and college completion and transition, have decreased over the last decades, but has still remained. In general, Asians and Whites have higher school performance and school progression than Blacks, Hispanics, and Native Americans.

Attending socioeconomically and racially segregated schools plays an important role in dealing with educational gaps. Different schools offer different resources, such as different courses and teacher quality. In a decentralized school system, schools do not follow a national-standardized script for classroom curricula. Therefore, students who enroll in segregated and low-income urban schools do not have the same courses as their more affluent suburban counterparts do. Advanced courses or gifted programs are less likely to be offered in urban schools, which have high proportions of low-income and minority students (Garibaldi 1997). Educational discrimination thus exacerbates educational inequality through schools where predominantly White and wealthy schools offer more high-ability classes, which are not provided in low-income, predominantly minority schools (Orfield, Eaton et al., 1996).

Schools are crucial institutions, which systematically affect educational stratification among social class and among racial/ethnic groups. Being conscious of a school's potential effect on society, the Supreme Court in 1954 *Brown v. Board of Education* mandated desegregation in American schools to equalize educational opportunity. Since then, many school choice policies have been implemented prevalently to provide more school options and to desegregate schools. An education report (Tice, Princiotta et al., 2006) shows increasing trends of student enrollments in chosen schools from 1993 to 2003 (overall change: from 20% to 26%; the rate of change is 1.3). Among racial groups, from 1993 to 2003, non-Hispanic Blacks have the highest proportion of attending chosen public schools (from 19% to 24%; change rate is 1.26), followed by non-Hispanic other races (from 15% to 19%; the change rate is 1.27), Hispanic (from 14% to 15%; the change rate is 1.07), and non-Hispanic Whites (from 9% to 13%; the change rate is 1.44).

In private schools, the enrollment increase from 10% to 12% for Whites, from 4% to 8% for Blacks, whereas there was no change for Hispanics (7%) and a decrease (from 12% to 11%) for other races (U.S. Department of Education 2006). Plank and colleagues (1993) find that ethnic minorities tend to have higher enrollment rates in magnet, Catholic, and other private schools than their White counterparts, while Latino and Black students are over-represented in public schools of choice. Attending non-assigned public schools seems to be more prevalent among minority groups, while Whites are more likely to enroll in private schools as an alternative to their assigned neighborhood schools.

Are schools less segregated after expanding school choice? The answer is inconsistent. Educational statistics show 42% of public school students were minorities in 2005, compared with 20% in 1972. The increasing population reflects a vast rise of Hispanic enrollments that surpassed Black enrollments in 2002 (U.S. Department of Education 2007). However, rising proportions of minority students and expansion of choice plans do not mirror more integrated schools. Although some research explains that "White flight" only exists temporarily and does not last after the year of implementing the desegregation plan (Wilson 1985; Smock & Wilson 1991), recent studies find persistent "White flight" from Black or other minorities by exercising school choices (Lankford, Lee et al., 1995; Andrews 2002). White parents tend not to select schools with high proportions of minority students, whereas minority parents choose schools with high proportions of minority students (Henig 1996). For example, the Arizona charter school enrollment shows significantly higher proportions of White students (Cobb & Glass 1999). In Charlotte, North Carolina, African American students tend to remain in their neighborhood schools, while White students concentrate in chosen schools (Hastings, Kane et al., 2006a).

Choice plans do not appear to exacerbate Latino-White segregation as they do for Blacks and Whites (Saporito & Sohoni 2006). On average, Hispanic students attend a school that is 12% Black, and White students attend a school that is 9% Black (Orfield & Yun 1999). Research finds "Latino flight" from predominantly Black schools. Latinos increased their enrollment in private schools as a result of more private school vouchers available for low-income Latinos (Fairlie 2002). Black and Latino segregation no longer exist in central cities only, but it has moved to suburban areas (Orfield 2001; McArdle 2002). Along with spreading school choice, school segregation has spatially expanded to be metropolitan wide.

My research shows that choice programs to a certain extent do break the poverty boundary and provide minority groups more educational opportunity, thus improving their educational outcomes. However, choice does not truly break SES and race/ethnicity lines in education. Why is that? One explanation is because parents of different backgrounds choose differently.

The Determinants of Parental School Choices

The determinants of school choice can be divided into demand and supply factors. Most research examines parents' demand for better schools, but few researchers have analyzed how local school systems affect school selection by various supply factors.

Demand-Side Determinants

Parental demand for schools varies across households. Existing research shows that parental preferences, information received, and family monetary resources are associated with the choice behavior.

Preference for school quality

Parents have different priorities in evaluating school quality, which affects their choice. Most parents value school academic performance as the most important criterion when choosing schools (Lankford & Wyckoff 1992; Schneider, Teske et al., 2000). Several studies indicate that parents who emphasize academic performance are more likely to exercise school choices (Kleitz, Weiher et al., 2000; Hastings, Kane et al., 2006a). In a study of the Cleveland Scholarship Program, Greene et al., (1998) find the decision to apply for school of choice is motivated largely by academic considerations. Analyzing how minority and majority parents value academic performance differently, Bryk and colleagues (1993) find that White and Asian-American students are more likely to take advanced academic courses than their Black and Hispanic counterparts. Data collected in Milwaukee (Witte et al., 1994) shows that low-income parents also emphasize academic quality as the most important reason for using vouchers for better schools.

Other than choosing schools directly based on school academic outcome, parents also consider the attribute related to school academic values. This attribute is usually taken as the proxy of academic performance, such as academic courses, teacher quality, racial composition, discipline and safety (Schneider, Teske et al., 2000). A study shows that most students listed teacher quality as the most important character of charter schools (Vanourek et al., 1998). By using quasi-experimental design in four school districts located in New York and New Jersey, Schneider and colleagues (2000) find teacher quality is the most frequently cited determinant for choosing schools, followed by high test score. Furthermore, Black and Hispanic parents, public school parents, and urban parents specifically tend to emphasize the importance of campus safety and discipline (Lee et al., 1996; Schneider, Teske, & Marschall 2000).

Racial/ethnic composition

Besides academic considerations, there are differences in parents' preferences for racial composition of schools. White families were more likely to change children's schools to the school with a low proportion of minorities, whereas minority students are more likely to change to schools with a high proportion of minority students. (Henig 1995; Henig 1996). Research finds that parents do not rank race as an important priority to consider which school their children will attend, and diversity of school was more important to more parents than was racial similarity. The importance of considering students of the same race on school selection seems to decline over time. However, this might be due to the fact that those survey participants in their study lived in the New York metropolitan area, where residents have high exposure to heterogeneous racial groups. Diversity is therefore relatively more important and common than in other areas (Schneider, Teske, & Marschall 2000). Interestingly, another study, conducted by Schneider and colleague, uses an Internet-based survey and finds that implicitly race is a fundamentally significant factor that influences parental choice, although parents always respond that academics matter most and race is not a concern (Schneider & Buckley 2002).

Transportation cost

The proximity between home and school is usually an intuitive factor in considering which school to choose (Bridge & Blackman 1978). Distance between the home and school differentiate parents' choice among magnets, non-magnets, and non-choosers. Hastings et al., (2006b) and Hastings and Weinstein (2007) find that proximity is a significant factor associated with parents' choice. Using Texas interview data from charter school parents, Kleitz and colleagues (2000) find that within each racial or socioeconomic subgroup, parents indicate that school location is important. Those who are most likely to point out location is important are less likely to have resources to support daily transportation costs. Therefore, they are less willing to choose schools other than their assigned neighborhood ones.

One explanation for favoring proximity is the transportation cost. Communication time and cost may constrain a family's capacity to send their children to their favorite schools (Goldhaber et al., 2005), which are farther away than neighborhood schools. Thus parental preference is possibly driven by their accessibility to schools, which is affected by income. Rich parents who can afford high transportation costs are more likely to send their children to faraway schools, and leave poor parents to choose nearby neighborhood schools for their children. Alternatively, rich parents move to desirable neighborhoods to take advantage of high-quality neighborhood schools.

Unequal school information

Parents make choices based on what they know about schools. Parents rank their preferences for schools based on the limited school information, which influences decision making. School information conducted by schools or districts is not always easily accessible for every parent. Asymmetric information distributed to parents of different social backgrounds may cause differential school selection (Hamilton & Guin 2005). In general, low-income households may have higher decision-making costs when faced with the complex decision of school selection (Duflo et al., 2006; Winter et al., 2006). The incentives to gather information provided by choice do affect parents' choice behaviors (Glenn et al., 1993; Witt et al., 1992). Both the accessibility to information and the ability to interpret it require experience and capacity in choosing among alternatives, and educational and economic capacity influence whether parents' can make rational decisions (Levin 1992). Low income and minority parents are less aware of magnet school options, and parents participating in voucher programs are more knowledgeable than non-participants (Henig 1996)**.** Using an experimental design in single school districts, Hasting and colleagues (2007) shows that information cost limits low-income parents' capacity to access school information. After providing free and better information, low-income parents becomes more likely to choose academic-based schools.

Obtaining school information does not only depend on social status, but parental involvement. Parents who are more likely to be involved in children's school activities are more capable of collecting accurate information through their social networks and exercise school choice (Schneider et al., 1997; Teske & Schneider 2001).

Schneider (1989) argues that the school market does not always provide the same information, and available information is often stratified by race, class, and geographical location. Parents in suburban districts are more accurate than urban parents about school, even after controlling for socioeconomic status (Schneider, Teske et al., 2000).

Socioeconomic status

The majority of the literature on school choice, focusing either on the family's choice processes or the effect of choice, has highlighted the importance of family socioeconomic status since families provide material and informational resources to support children's education. Research on students' school mobility finds that the sending districts were more likely to be of lower socioeconomic status than the receiving districts (Fossey 1994). In addition, affluent families have more financial freedom to choose schools by changing residential zones or by choosing private schools where the tuition is usually higher than public schools (except Catholic schools). Coleman and Hoffer (1987) find that the higher the family income, the higher the private school enrollment.

Another explanation of why affluent families are more likely to exercise school choice is that they are more capable of accessing reliable information about schools than poor and working class families (Saporito & Lareau 1999). High-SES families generally are more knowledgeable about choosing schools and know the measures of school quality (Schneider et al., 1998). Given the relative high cost of collecting school information, disadvantaged families are more handicapped in accessing school information. Wells (1993) finds that the most important predictors of participating in choice programs are parental education and the level of involvement in their children's education. Research has found that higher educated parents would spend more time involved in their children's schooling (Coleman & Hoffer 1987). Therefore, it is logical that highly-educated parents are more willing to select schools among the alternatives.

Besides, socioeconomic status can play a role in stratifying the choice market through social networks. Parents can collect school information from interpersonal networks (i.e. from the neighborhood or social groups) and formal networks, such as school seminars (Hamilton & Guin 2005; Goldring & Rowley 2006). It is not surprising to find that interpersonal networking is associated with information collection, and higher-SES parents can act more efficiently in selecting schools (Schneider, Teske et al., 1997).

Choice decisions are made when parents have preference and know what alternatives are available. Therefore, selection does not only depend on the demand-side determinants, but it also depends on the supply-side variables that dominate opportunities and constraints for selection. In their early research, Lankford and Wyckoff (1992) point out the importance of taking into account environmental factors that are associated with schools and neighborhoods.

Supply-Side Determinants

The supply of schools can be broken down into three levels of influence: school, school district, and residential neighborhood. There is no doubt that the number of schools and school quality available for choice determines to what degree parents can exercise school choice. However, school availability is not always equally distributed across households, and in fact is largely constrained by district policy and residential location.

More choices

Previous research about the relationship between the available number of schools and parental school selection is rare. Using NELS:88 base-year and first-follow-up data, Schneider and her colleagues (1996) find that when choice of high school is available, disadvantaged families, regardless of race, ethnicity, or education, will exercise choice. Their measure of available choice is constructed from student questionnaires that ask eighth graders whether they would consider one or two public high schools, one or two private schools, and one public and one private school. Then they predict whether students attended the public school of choice or not in 1990 (10^{th} grade) by conditioning on the availability measure.

Consistently, two recent studies also support that school availability matters. The studies by Cullen, Jacob and Levitt (2005) and Hastings (2007) both use geo-coded data to construct distance between home and school as a measure of school availability. Using Chicago Public School data, which includes detailed school characteristic variables and student residential addresses, Cullen and colleagues construct the distance to the closest high-achieving school, closest career academy school, and closest regular school to predict the propensity of opting out of assigned schools. They find that distance is a significant predictor of students' chosen schools. The longer the distance to the closest choice school, the more likely a student remains in the assigned school. In addition, distance to high-achieving schools has greatest impact on students in the top quartile of test scores, and no impact on those in the bottom two quartiles. Distance to the closest career academy has the greatest impact on students in the middle two quartiles of test scores.

Hastings (2007) uses similar information from the Charlotte-Mecklenburg Public School district to examine whether school availability affects students' attending No Child Left Behind (NCLB) schools (usually not neighborhood schools). He finds that the distance to NCLB schools and average distance to schools within five miles are significantly and negatively associated with students' odds of choosing reassigned NCLB schools. Students would not like to attend reassigned NCLB schools if they need to travel far away from home.

In contrast, a British study concludes inconsistent results with the American cases. Burgess and Briggs (2006) measure school availability by looking for whether there are three schools within two kilometers surrounding students' residences. They find that after controlling for available choices, poor children still have a lower probability of attending non-assigned good schools than their wealthier peers. One possible explanation for this is the admission constraint to good schools within the local education authority, which might be more different for poor families.

The measure of school availability used by previous studies is problematic. Survey questions asking whether students ever consider more than one choice are confounded by information about the school choice students have. The research using the distance to school as a measure of school availability uses samples only from certain school districts located in urban areas, where open enrollment schools are more available. These studies tend to neglect the importance of the number of schools available and lack generalizability to other places. Although minority students tend to live in inner cities, there is an increasing minority enrollment in suburban areas. Research has rarely examined the difference in choices between inner cities and urban fringes. Also, it is unknown whether the number of available schools in the vicinity to students' residences is associated with parental school selection, and whether the association differs by race and ethnicity. My study contributes to fill the literature gap by using geo-coded nationally representative data and exploring the association between school availability and school selection.

Previous studies have related school availability to not only the number of schools within a distance, but good schools that are nearby. Those studies use school test score as a measure of school quality. Unfortunately, such information is only available for two school systems - Chicago city and Charlotte-Mecklenburg school district in North Carolina. These data are not publicly accessible. For this study, I use the Education Longitudinal Study of 2002 (ELS: 2002). Because these survey data are nationally representative, I can circumvent the problem of generalizability. The tradeoff is that this dataset does not provide information of the average school test scores nor the test scores for all surrounding high schools. It is only possible to create average school test scores by aggregating the cognitive scores from ELS:2002 student measurements at the school level. The test scores for all surrounding schools are not available. To examine whether more choices motivate parental selection among schools, I also create a measurement for number of schools surrounding students' residences within a certain radius.

District boundary

Even given sufficient schools for choice in residential areas or adjacent residential areas, choices are not always possible due to the constraints from district policy. An estimate from a report shows that choice plans were available in 71% of school districts in the West, 63% in the Midwest, 44% in the South, and 19% in the Northeast in the 1999-2000 school year (Tice, Princiotta et al., 2006). Choice policies are not only regionally different. Under the decentralized U.S. school system, local educational agencies (LEAs) can have different designs on choice policy to fit local needs. Among school districts, there are differences in choice plans and in admission criteria. For instance, in the Minnesota school district, research finds that the district considered admitting inter-district transfers based on test scores and other student qualities (Reback 2006), while race and income were used as criteria to reassign students to schools in Wake County, North Carolina (Hoxby & Weingarth 2005).

Without controlling for district boundary one may come to misleading conclusions about differences in school choice. To remedy this, I will use a school district fixed effects model to avoid potential bias. Without this control, the overall variation is very likely to be confounded by unmeasured district characteristics that are correlated with other features (e.g. neighborhood segregation), and lead to biased estimates. Because most parents choose schools within districts, adjusting for between-district variation will avoid such bias.

Geographical Difference

Choice plans are heterogeneous by geographical locations and student population. Rural and urban districts serve a different population composition. Students tend to be homogeneously White in rural and suburban areas, while racial/ethnic minority students have a high proportion of enrollment in urban schools. School districts do not only differ in student demographic compositions, but also in choice policies and school resources. Urban school districts tend to have more open choice policies to serve diverse populations, whereas the choice plan is usually not considered in rural systems (Tice, Princiotta et al., 2006). Besides, urban schools serve larger student populations, which are poor and require more federal Title I funding than schools in other areas. In urban areas, parents seem to be given more choices than those in non-urban areas. That might be due to large student populations or school desegregation policies. However, we do not know whether more choices benefit minority parents in school selection, compared with their White or advantaged counterparts.

Public school choices are constrained by districts' administrative boundaries that are usually defined by students' residential locations. Where a student lives determines whether the parents are allowed to choose among schools. It is perceived that a residential location can determine the supply of school choice and therefore affect parents' capacity of choosing schools. SES and racial/ethnic differences in residential selection can reflect SES and racial/ethnic differentials in school choice. The reviewed literature has shown SES and racial/ethnic differences in school choice, and SES and racial/ethnic composition do matter when parents face choices.

Neighborhood effect

Another factor related to residential location and school selection is neighborhood characteristics. Families choose residences based on the assessment of the taxes and public services of localities and their own needs (Tiebout 1956). Schools available for families to choose vary across residences. For example, at the time of writing, there are only four large voucher programs in the U.S. – Milwaukee, Cleveland, Florida, and Washington D.C.

Residents also tend to sort themselves into neighborhoods where residents have homogeneous characteristics. Researchers find that residential mobility is associated with local school quality (Figlio & Lucas 2000; Bayer, Ferreira et al., 2007). In general, the housing price is higher in the neighborhood with higher school quality, where average household socioeconomic status is higher (Bayer, Ferreira et al., 2007). Other than public service (i.e. school quality), residential composition is another factor that triggers mobility (Lee, Oropesa et al., 1994). Households are self-segregated on the basis of both race and education (Bayer, Ferreira et al., 2007).

It is conceivable that fewer quality hospitals, clinics, parks, and health clubs are available in poor segregated neighborhoods (Powell et al., 2006). Also, high socioeconomic status (SES) neighborhoods have high SES schools. High SES schools are related to higher academic achievement than are low SES schools (Gamoran, 1987). In Chicago, concentrated neighborhood disadvantage is found to reduce the propensity to make school choices regardless of race (Lauen, 2007).

In his review article, Farkas (2003) highlights the impact of neighborhood environment in the studies of children’s cognitive skills and behaviors. Neighborhood segregation is fundamentally associated with school segregation (Wilson & Taeuber 1978), and segregated neighborhoods produce segregated schools (Reardon & Yun, 2001; Bilfulco & Ladd 2006). School segregation between suburban districts is mainly a result of between-district residential segregation. In large school districts, both school-assignment policies and residential segregation affect school segregation.

Critique about school choice focuses on the fact that choice increases school segregation. Over the past decade, research finds decreasing residential segregation but that school segregation has increased (Logan 2002; Reardon & Yun 2003; Frankenburg et al., 2003; Saporito & Sohoni 2006). The areas that have relatively rising school segregation usually implement school choice policies but not desegregation plans through school reassignment. Saporito and Sahoni's (2006) investigation uncovered that a few school districts with desegregation policies have succeeded in reducing racial segregation. However, when parents are allowed to send their children to non-assigned schools, school segregation reappears. The authors claim that unconstrained school choice will slow or reverse school integration and exacerbate existing racial segregation. School choice policies resegregate schools and offset desegregation efforts.

The effort to improve disadvantaged students' opportunities to learn has not only triggered policies to move students among schools but also to move them among neighborhoods through housing vouchers. The first program, through the Housing Choice Voucher (HCV), is *Gautreaux* in Chicago, which occurred between 1976 and 1998. *Gautreaux* provided rent subsidies that allowed families to live in apartments in a new location with public housing costs. The impact of *Guatreaux* on children is positive, because by attending this program, children from minority families could leave their poor inner-city enclaves to attend better schools in suburban areas, thus avoiding neighborhood violence and delinquency problems (DeLuca et al., 2007).

While the *Guatreaux* program is based on race for residential placement, Moving to Opportunity (MTO) was implemented based on social class in five cities – Baltimore, New York, Chicago, Los Angeles, and Boston in the late 1990s. Moving to better neighborhoods through a housing voucher is supposed to be a rational decision for low-income families. However, research shows that poor minority families do not often use housing vouchers to relocate to areas that are significantly safer or more advantaged than their origin neighborhoods. The reasons are housing discrimination, fear or poor information (South & Crowder, 1997; Yinger, 1995; Charles, 2003). Poor families do exercise school choice, but they have different criteria from middle-class families. Compared with middle-class families, they consider more the proximity to transportation, and to family and friends. Therefore, changing schools through relocating a residence does not lead to better academic performance for low-income children (DeLuca 2007).

Growing up in concentrated-poor neighborhood has more negative consequences for individuals' outcomes than for those in poor families but who reside in affluent neighborhoods (Wilson 1987; Massey & Denton 1993). Concentrated urban poverty is related to children's perceptions of the returns to education. Children who live in concentrated and isolated disadvantaged neighborhoods are more likely to underestimate the value of schooling. Black children who have high exposure to adult role models of dependency and single parenthood have low educational expectations (Massey & Denton 1993). On the other hand, neighborhoods with a high proportion of highly educated residents may provide role models for educational success, and increase children's attachments in school.

Peer influence is another important factor when considering the neighborhood effect on children. Social interaction among peer members of a neighborhood is specifically important for adolescents. Massey and Denton (1993) illustrate that segregation reinforces Black children's isolation from mainstream culture by speaking Standard American English, and absorbing only Black English Vermacular. This behavior may therefore lead segregated Blacks to do poorly in school and job interviews. By concentrating poor children into such an oppositional culture against mainstream educational success in racially homogeneous settings, segregation creates the structural context for the maintenance and perpetuation of an ongoing oppositional culture across generations (Rosenbaum et al.; Jencks & Mayer 1990).

To sum up, school selection is a complex process. Each selection is intertwined with various demand and supply components, which do not only vary by individuals but by context. However, it is important to understand the determinants and the effect of school selection because school choice affects children's schooling experience. School selection could also relate to differentials in children's educational outcomes for children in different schools. This study predicts school selection by taking into account most determinants that are discussed above. In addition, the supply factors are measured in greater precision in the study.

School Choice Effects

A large body of scholarship has found differences in students' academic performance as a result of different school choices. Private school students have test scores and are less likely to drop out than are their public school counterparts (Coleman & Hoffer, 1987). Not only are achievement differences found among school sectors, research also finds that students' test scores differ between those attending chosen public schools and assigned schools. Students who can choose schools that better fit their needs gain more on test scores than non-choosers, and disadvantaged students benefit more than other students by choosing schools (Lavy, 2006). In their experimental-design research, Cullen and collaborators (2005) find that receiving a lottery to opt out of assigned public schools helps students with test score gains. Being able to choose high-performing public schools is an important way to improve test scores (Hastings & Weinstein, 2007).

In general, research shows school choice effect in attributable to differences in school resources and school competition. The variation of resources among schools, such as teacher quality and expenditure per pupil, partially explains achievement differences among students who attend different schools (Hanushek, 1994; 1996). Cullen and colleagues (2005) indicate that holding prior student test scores constant, public school competition from open enrollment (measured by the distance to the closest chosen school) raises the probability of high school graduation for school choosers, compared to their otherwise equivalent peers. The optimism toward school choice policy does not only dwell on the efficiency of schools of choice, but also emphasizes that assigned public schools can ameliorate school quality when they face flaming competition from other schools (Hoxby, 2003; Angrist et al., 2002).

My thesis focuses on the effect of Catholic and magnet schools for several reasons. First, Catholic schools and magnet schools are respectively the majority of private and public schools. Second, both schools accommodate a certain proportion of minority and low-income students. Catholic schools serve a large proportion of minority students within the private sector, while most magnet schools aim to achieve racial/ethnic diversity within the public school system. Lastly, ELS:2002 data does not include sufficient observations for other types of public or private schools of choice. For example, only about 2% of students are in charter schools. For empirical consideration, I only study the Catholic and magnet school effects.

Catholic School Effect

In early colonial America, Catholic schools were established to serve European immigrants who believed in Roman Catholicism. The enrollment in Catholic schools reached its peak in 1965. At that time, Catholic schools educated more than 12% of the student population (Rooney et al.,2006). However, since the 1970s, the number of Catholic schools and the share of Catholic school students has declined. Nearly seven percent of Catholic schools have closed in the last few years (Meyer 2007). In the 2007-2008 school year, Catholic school enrollment was 2.27 million, which is less than half of the enrollment in 1960 (McDonald & Schultz 2008). However, the proportion of minority students in Catholic schools has increased, from 11% in 1970, to 19% in 1980, and 29% in 2009. Today, the minority composition in Catholic schools is about 13% Hispanic, 8% Black, and 4% Asian (McDonald & Schultz 2009).

This demographic shift may be a result of the expansion of the school choice program in many states (Goodman 2009). School choice in the form of vouchers or scholarship tax credit programs for private education rose by about 90% over the last five years (Goodman 2009). Many minority students who previously had a low propensity to attend Catholic schools are now able to afford them. This demographic development may have important implications upon the effects of Catholic schools.

Mixed Catholic school effects

Early research on Catholic schools showed that the achievement gap by family socioeconomic background was smaller in Catholic schools than it was in public schools (Coleman, Hoffer et al., 1982; Greeley 1982; Hoffer, Greeley et al., 1985). In addition, Catholic school students tend to outperform public school students. The explanations of the superior Catholic school effect on achievement focused on the social relationships between parental networks within the Catholic school community, as well as various Catholic school characteristics, including advanced academic courses, high school autonomy, less bureaucracy, and a disciplined school climate (Coleman, Hoffer et al., 1982; Greeley 1982; Hoffer, Greeley et al., 1985; Bryk, Lee et al., 1993).

However, critics have argued that Coleman and his colleagues failed to control for selection bias in their ordinary least square (OLS) regression models that found the existence of the Catholic school effect (Goldberger & Cain 1982; Murnane, Newstead et al., 1985). Whether Catholic-school advantage is attributable to the schools themselves or to the type of students attending Catholic schools has become the key issue in the study of the Catholic school effect (Willms 1985). Several methods have been used to correct for selection bias in Catholic school studies. Murnane, Newstead, and Olsen (1985) used what they called an “S method” that combines the two-stage-least-square (2SLS) method to measure the Catholic school effect on math and reading scores. They found a math test score advantage for Hispanics and Whites, but none for Blacks.

In addition, Murnane and colleagues use the “Olsen test” (Olsen 1982) to test selection bias by measuring the differences in the distribution of achievement residuals between students of high and low probability of attending Catholic schools. Surprisingly, they found no selectivity bias among Black and Hispanic students in either public or private schools. It is religiosity that confounds the Catholic school effect on achievements. Previous studies using the 2SLS method have made a specification error that assumes Catholic affiliation does not affect student achievement. Murnane and colleagues, further, draw attention to taking into account the determinants for school choice and the variables that affect school choice but not educational outcomes – the two factors play an important role in obtaining robust Catholic school effects.

To adjust for selection bias, Sander and Krautmann (1995) used the Heckman (1979) two-stage procedure and found that the dropout rate for high school sophomores is lower for students attending Catholic schools. However, Catholic school students do not attain more years of education than their public school counterparts. Similarly, Adam Gamoran (1996) used the Heckman procedure and did not find the Catholic school effect on math test scores. These results on educational attainment and achievement suggest that the benefits of Catholic schools come mainly from parental selection: parents of Catholic school students are more likely to devote time and other resources for their children’s education. Their children who are sent to Catholic schools are in turn more motivated to perform well in school.

Another method researchers use to correct for selection bias is the instrumental variable (IV) approach. This method requires identifying an exogenous variable that affects the selection into Catholic schools but is not correlated with student outcomes.

Evans and Schwab (1995) used Catholic affiliation as an instrumental variable and showed a favorable Catholic school effect on high school graduation. In addition to Catholic affiliation, Neal (1997) added two other instruments: the Catholic school availability and the proportion of Catholics in the county. Based on the National Longitudinal Survey of Youth data, he found positive effects of Catholic high schools to be greater for Black and Hispanic students than for Whites in inner cities. However, there was no Catholic school effect in suburban areas. The relatively large Catholic school effect on urban minorities is probably due to the poor quality of the public schools serving urban minorities. Public schools in suburban areas are likely to be as competitive as Catholic schools.

These studies using the IV method consistently conclude that Catholic schools appear to do better. However, the validity of using the suggested instrumental variables for Catholic study is questionable. For example, Murnane and colleagues (1985) argue that Catholic affiliation is not an exogenous variable in the achievement/attainment equation. It is hard to find a good instrumental variable that is consistently efficient for Catholic school selection across datasets.

Drawing on the problem of the IV, Altonji, Elder and Taber (2002; 2005) propose another method- the AET approach, to estimate the Catholic school effect with NELS:88 and NLS-72 datasets. This method assumes the degree of selection on observables is a guide to the selection of unobservables. They use observed variables to construct the upper-bounds and lower-bounds of selection bias caused by unobservables. If the lower-bound estimates indicate a substantial Catholic effect, there is evidence of such an effect. They find a positive Catholic school effect on high school graduation and college attendance, but not on achievement test scores. Again, they also find a larger Catholic school effect for minority and urban students. In addition, they test three instrumental variables – Catholic religion, distance to Catholic schools, and distance interacted with religion, and conclude that none is found to be an eligible instrumental variable.

Other than relying heavily on least square estimation and instrumental variables, Morgan (2001) uses the propensity score matching method to estimate the causal effect of Catholic schooling on achievement scores. The idea dwells on matching Catholic and public school students on a set of observed variables that predict the propensity of Catholic school attendance. Catholic and public school students with similar propensity scores stand as counterfactuals to each other. The students who are not matched are dropped from the sample. After obtaining a match sample, the author stratifies the sample by the quintile of propensity scores. He estimates the Catholic effect with the whole match sample and with the sample by stratum (which is called propensity stratum fixed-effect modeling). The results present a positive effect on reading and mathematics scores. The stratum fixed-effect models, furthermore, indicate that students who are least likely to attend Catholic schools gain more from Catholic school attendance. This implies low-income and minority students are more able to benefit from attending Catholic schools. This is consistent with the findings of Neal (1997) and Altonji, Elder, and Taber (2005).

What Accounts for the Catholic school effect?

Given the finding of a positive Catholic school effect, researchers further explain the mechanisms through which Catholic school students outperform in achievement scores over their public school counterparts. Lee and Bryk (1989) suggest that institutional features of Catholic schools, such as unified curriculum, school norm, smaller school size than public schools, and effective school discipline and committed staff, contribute to the success of the Catholic school. These features do not work as efficiently in Catholic schools with high SES backgrounds as they do for Catholic schools with lower SES student bodies.

The concept of Catholic schools as *common* schools provides another explanation (Bryk et al., 1993; Morgan 2001). From the fieldwork of seven Catholic secondary schools and High school & Beyond data, Bryk and colleagues find that there is a form of strong “voluntary community” that structures daily life within Catholic schools. Among the community cores in Catholic schools, the major explanation of the Catholic school effect on students’ achievements is the constrained academic organization.

The authors further explain that academic experiences among students in Catholic and public schools are different. Catholic schools determine what academic courses students have to take, while students in public schools choose their course schedule with a wide range of courses available. The curriculum structure of Catholic secondary schools is relatively homogeneous; the core course is basically college preparatory. In Catholic schools, the average level of mathematics courses taken by all students is higher. This partially explains the Catholic school effect on achievements (Gamoran 1996; Morgan & Sørensen 1999).

However, in public schools, less advantaged students are more likely to enroll in nonacademic courses. Students are responsible for the consequence of their choices and schools are less accountable for social inequalities in students’ exposure to academic knowledge. Disadvantaged students tend to benefit most from attending schools in which there is a strong academic commonality for everyone. The highly differentiated academic structure in comprehensive public high schools tends to amplify initial social differences among students and thus culminates in a less equitable distribution of achievement (Lee & Bryk 1989).

Course taking is related to prior school performance and family SES, while race is associated with family SES (Lucas 1999). If white students are more likely to enroll in Catholic schools than minority students, and if disadvantaged students tend to segregate in neighborhood public schools, the differentials in course-taking between schools and race shall exist and, to a certain extent, account for achievement gaps. Moreover, the Black-White gap in course taking is found to be more significant within public schools, than in Catholic schools (Hallinan 1992; Kelly 2009). Kelly also indicates that Black students in predominantly Black schools (including both public and private schools) have higher chances of being placed in a high mathematics academic track than in other schools. Black students are specifically not capable of enrolling in a high academic track within predominantly White public schools. While Catholic schools could provide better and more equal chances for academic course taking, disadvantaged students may consider Catholic enrollment as an effective way to improve achievement and narrow the achievement gap with privileged students.

The voluntary community is also performed in two phases. This helps explain Catholic school effects- high school autonomy and tight social network. Unlike public schools, the external influence in Catholic schools is relatively low (Bryk et al., 1993). The strong school autonomy in Catholic schools motivates teachers to become more efficient knowledge providers. Teachers are thus more committed to increasing students' academic achievement. In addition, Catholic school faculty are more willing to help students and work with parents, but reciprocity is also expected. The form of “social capital” based on mutual trust facilitates students’ academic learning.

In addition, social networks among families whose children attend Catholic schools form intergenerational closure for students and parents (Coleman & Hoffer 1987). Parents tend to know their children’s friends and their parents, as well as their children’s teachers and school administrators. The formation of social closure is especially tight in Catholic schools where there are often distinctive norms within schools. These common and enforced norms in Catholic schools are usually not found in public comprehensive schools (Hill, Foster et al., 1990). Through sharing norms along with a strong academic focus, social capital generated by social closure bolsters students’ efforts and improves students’ academic performance (Coleman & Hoffer 1987).

To explain the heterogeneity of Catholic school effects for student of different family background, Morgan (2001) provides other perspectives. While good public schools are less accessible for low-SES students, due to the constraint from residential boundary. Catholic schooling becomes a better choice than other poor public alternatives for those low SES students. Being aware of their parents’ financial sacrifice for their Catholic schooling, disadvantaged students may be more motivated to work harder than their advantaged peers. Thus, Catholic school effects are more plausible for those with scant school choices.

Catholic school location

Urbanicity. Most Catholic school populations are concentrated in metropolitan areas. There are about 43% of Catholic schools located in urban areas and inner cities, 37% in suburbs, and 20% in rural areas (McDonald & Schultz 2010).

The existing literature indicates heterogeneity of the Catholic school effect by locations (Altonji, Elder & Taber 2002, 2005; Neal 1997). The Catholic school effects tend to be more favorable for low-income and minority students in the inner-city than for Whites and suburban students (Neal 1997). The heterogeneity effect might be attributed to differences in student composition and school quality by urbanicity. In the suburbs, students are more likely to be from middle-or-high-SES families that have more parental involvement in schooling than are urban students. Suburban students may not differ significantly between public and Catholic schools in terms of SES, while in urban areas, especially in inner cities, public schools are crowded with lower-income and more minority students than in Catholic schools.

If the significant Catholic school effect is solely due to variation in student composition, research should find no significant effect within or between districts after controlling for student background as a selection factor. Otherwise, the left-over effect, if there is any, may indicate the true school effect.

Catholic schools and districts. Holding the quality of Catholic schools constant across locations, the heterogeneity of the Catholic school effect could be due to the fact that public schools are diverse in school quality between urban and suburban districts. Compared with urban districts, suburban local districts are more capable of receiving more resources from local tax income to provide their students with better educational services, such as better school buildings, facilities, staff, and teaching instruction. The suburban public schools are thus comparable to Catholic schools. On the contrary, faced with the relatively low quality of public schools, inner-city Catholic schools play an important role in providing a substitutive but better choice for their surrounding disadvantaged students. In this case, it is more likely to find the Catholic school effect within school districts that have limited resources and serve a large disadvantaged student population.

To understand the association between Catholic schools and school districts is important for policy. In the United States, Catholic schools are accredited by independent and/or state agencies. Schools are supported through tuition payment, and fund raising. These schools enjoy a high degree of autonomy, although they do connect to the government by receiving scholarships and vouchers granted to poor students. The public aid for private schooling is especially available when public schools in the inner city perform poorly in achievements. Federally-funded programs, such as Title I, provide counseling, reading, math, and EFL/ESL help to low-performing students under the poverty line in private schools.

In 2005-06, compared with 56% of public schools, about 37% of Catholic schools reported participating in Title I (U.S. Department of Education 2007). The Title I bill authorizes the local school district to provide services to students in non-public schools who demonstrate need. Further, the No Child Left Behind (NCLB) program requires school districts to evenly distribute their Title I funds among eligible, poor students in both public and private schools (those private schools that choose to participate). The fund to private schools is paid through support services for private schools.

To sum up, districts could manage funds for Catholic schools in two ways – federal funds for disadvantaged students (e.g. Title I and scholarships) and voucher programs. Morgan's (2001) study shows that students who are least likely to attend Catholic schools benefit from Catholic schooling. Those with low propensity of Catholic participation are mostly from low-income and minority families. Thus, in school districts where there is a higher proportion of students in need, public funds to support disadvantaged students' learning opportunities in Catholic schools would be crucial for improving those students' educational achievements. If within school districts, Catholic schooling does benefit their students in test score gains, there is more reason to believe that a policy to subsidize Catholic schooling is needed, especially for students from low SES families.

However, we do not know to what extent Catholic schools affect students' learning within districts, if students are given the Catholic school choice. We also have scant information about what district characteristics are associated with between-district variations in the Catholic school effect, if there is any. The analysis of the Catholic school effect at the school district level is crucial for policy purposes. The policy implications are twofold for the analysis of the within-district effect. First, if there is a positive Catholic school effect within the district, it is important to understand the mechanisms through which Catholic schools improve student learning so that public schools within the same school district can borrow from Catholic school experiences.

Second, analyzing the within-district effect provides research evidence to the recent controversial issue about converting Catholic schools into charter schools in urban school districts. There are about seven Catholic schools in Washington D. C. that were closed due to declining enrollment and the rising operating costs; these were converted to charter schools in 2009[1]. At the same time, in New York, the mayor proposed a conversion plan to turn four Catholic schools into charter schools in Brooklyn and Queens. The latter is still under debate and has not been mandated yet. The positive effect may favor such a policy, and vice versa.

Schools do not perform differently only within school districts, but across districts. If there is a plausible variation of student performance among schools across districts, it is important to analyze what district characteristics contribute to the variation. Is it the difference in student composition, course taking, funding resources, or other characteristics? For example, districts receive educational resources basically from the federal and state governments, as well as from local tax income, and revenue. Expenditures per pupil vary not only by state but by school district (Zhou 2009). While the median expenditure per pupil is the highest in New York State ($15,198), followed by the District of Columbia and New Jersey, the range ratios between top and bottom percentiles existing within states are greatest in Montana, Nevada, and North Dakota.

In addition, private school students in different states or districts do not enjoy equivalent access to public funding for their private schooling. By the end of 2008, only eleven states or districts had enacted twenty programs to provide public funds (through vouchers, scholarships, or tax credits) for private schooling. Some studies have found that low-income and minority students academically improve by attending these programs (i.e. see Wolf 2009 for the Opportunity Scholarship Program at D.C.). Receiving public aid for private schooling or not, may be a feature of districts associated with between-district variations in student educational outcomes. Nonetheless, little is known about the

[1] http://www.nytimes.com/2009/03/09/nyregion/09charter.html

Catholic school effect among districts. To provide a comprehensive understanding of the empirical issues underlying the policy debate, I examine the effect of Catholic school on Catholic school students by taking into account whether a district allows for public aid for Catholic schooling.

My analysis at the district level can further clarify the differential effect by urbanicity found in previous studies. On the one hand, high school urbanicity is basically the same as district urbanicity. Studying the Catholic school effect at the district level takes care of district characteristics, such as urbanicity. On the other hand, analysis at the district level provides more sights for policy interpretation. Therefore, this study does not specifically analyze the Catholic school effect by urbanicity.

Magnet school effect

The magnet school is a government-run school, but may not be a student's assigned neighborhood school. It is a school type that is available for parents to exercise their choice among public schools. These schools are exposed to a large proportion of students at risk. In the U.S., about nine out of ten students enroll in public schools. More students attend non-urban schools than urban schools, where there are more Black and Hispanic students (Kober 2006). Minority students are found to constitute the majority of students in most of the nation's largest districts. Thus, improving urban education has become a striking issue to eliminate educational disparity. Public school choice is considered a means to achieving this goal. Among public choices, the magnet and charter schools are the most discussed. Although there is overwhelmingly interest in charter schools, magnets serve a lot more student populations than charters. In addition, magnet schools receive much support from local school districts, while charters are basically independent from local controls. To examine the public school choice policy at the policy level (i.e. school district), magnet schools make up a better comparison group with assigned neighborhood schools than charter schools.

To pinpoint the significance of studying the magnet school effect, the following first introduces the development of magnet schools. It then discusses the characteristics of magnets, and the debate over the magnet effects.

The development of magnet schools

As a result of the *Brown* decision, policies targeting the desegregation of schools started to emerge and spread. In the early 1970s, “forced busing” was vastly implemented to transport students across school attendance zones. Magnet schools are public schools with specialized themes or curricula. “Magnet” means that such schools and programs are “magnetic” in terms of attracting students from authorized school zones. Some magnet schools draw students only within the school district boundary, while others may draw from multiple districts. Carrying the mission of school desegregation and educational excellence, magnet schools are characterized by quality schooling and student diversity, and thus became popular among families. The demand for magnet schools is usually more than the supply of such schools in most school districts (Blank, Levine, & Steel 1996). Later in the mid 1970s, while the urban housing markets in the North and Midwest were undergoing rapid racial change, more and more urban districts began to offer magnet schools to attract White students to enroll in city schools (Frankenberg & Le, forthcoming). This way, districts could meet their desegregation requirements.

Enrollments in magnets grew vastly. From 1993 to 2007, the enrollments in public schools of choice increased from eleven to sixteen percent of the student population. But enrollments were down from 80 to 73% for students attending assigned public schools in 2007 (Planty et al., 2009). Among the public schools of choice, the magnet school makes up the majority (Frankenberg & Siegel-Hawley 2008). Magnets tend to be located in large, high poverty urban districts, and serve a large proportion of low-income and minority students. About 53% of large urban school districts have magnet school programs (Steel & Levine 1994), and over half of magnet programs/schools are located in low SES districts (Levine 1997). Despite large enrollment, popularity, and diversity, magnet schools remain significant in the educational system by encompassing other features – stable federal support (Christenson et al., 2003), innovation, and freedom of choice (Goldring 2009).

Magnet schools are highly accessible to disadvantaged students. More than half of large urban school districts used magnets as a tool for desegregation (Goldring & Smrekar 2000). Only one tenth of magnets are in small towns or rural areas (Frankenberg & Siegel-Hawley 2008). In addition, over half of magnets are located in low-socioeconomic urban districts that serve large student populations from minority and low-income families (Levine 1997; Goldring & Smrekar 2000; Frankenberg & Siegel-Hawley 2008). A study from the Civil Right Project reports that the percentage of low-income students in all public schools has jumped in the last few years (Orfield & Lee 2007). This is because of a changing population composition and high correlation between race/ethnicity and income. The lower birth rate of White and largely nonwhite immigrants and higher birth rate of immigrants have contributed to the decreasing proportion of Whites and the rising proportion of Latinos in public schools. Since the l960s, the percentage of White students in U.S. schools has declined from about 80% to 58% (Orfield & Lee 2006). Note the increasing percentage of Hispanic students while the majority of White students are from relatively higher income families than most Latinos, the demographic change in schools reflects an increasing proportion of low-income minority students.

Additionally, a minority population tends to geographically concentrate in urban areas and the border states of the West and South. In the West, where Blacks have played a large role in raising civil rights issues and movements, there are now five times as many Latino students as Black students, who now constitute only seven percent of the enrollment. The West is the great center of Latino enrollment with 36% Latino enrollment, and like the South, also foreshadows the increasingly multiracial nature of U.S. education. While magnet schools are mostly located in urban areas, they play an indispensible role in providing quality schooling for disadvantaged students.

Enrollment in magnet schools/programs is open to families across school attendance boundaries. To attract a range of students from different backgrounds and thus to achieve school diversity, magnet schools usually conduct special themes, such as art, sports, or academic programs. This may have contributed to considerable demand for magnet schools and to their popularity. Parents' demands for magnets often exceed available seats (Blank, Levine, & Steel 1996). This becomes a reason for magnets to establish different methods of student admission. Those methods may be lotteries, first come-first served, sibling enrollment, interviews, auditions, or test scores. About one-third of magnet schools use selective criteria for admissions (Smrekar & Goldring 1999).

Specialty magnet schools that use selective criteria often have very competitive admissions. Those are nationally and internationally elite public schools (Frankenberg & Siegel-Hawley 2008). Specialty magnet schools that use competitive admission criteria instead of using race/ethnicity, have been found to have lower levels of school diversity (Frankenberg & Siegel-Hawley 2008). For example, using GPA as an admission factor is highly associated with decreasing integration. Schools that use noncompetitive methods (i.e. lotteries) are more integrated. This is because White and Asian students tend to have higher GPA than other minority students. If an elite magnet school uses only GPA to admit students, it is very likely the student population is composed mostly of White students along with some Asian students.

However, the declining integration at magnet schools is not only attributed to competitive admission methods. There is a disproportionately large decline in the proportion of White students, while there is an increasing percentage of Black and Latino students in magnets (Frankenberg & Siegel-Hawley 2008). For White students, choosing magnet schools tend to integrate them, while choosing magnet schools is more likely to isolate Black students from Whites (Goldring 2009). Even among substantially integrated magnet schools, there is a much lower percentage of White students than the percentage of all public school students. A report found that nearly 57% of newly founded magnet programs were making progress in racial desegregation, while another 43% were experiencing an increase in isolation (Christenson et al., 2003).

The reason for the declining school desegregation in magnet schools may be due to the increased demand for accountability and high stake testing, the court orders that retreat desegregation goals, and the rising competition from other school choices

(Frankenberg & Siegel-Hawley 2008). There has been an increasing emphasis on raising school accountability for students' academic performance, especially after the federal government mandated the No Child Left Behind Act (NCLB). In order to fulfill funding requirements that focus on school improvement based on students test scores, many magnet schools nowadays are expected to develop innovation and academic performance of students besides school desegregation.

The shifting goal of American schools does not only occur at the federal level. The court order of school desegregation has also changed. A series of Supreme Court decisions have tried to limit the use of race/ethnicity as a means to admit students into public schools of choice. One important case is the *Missouri v. Jenkins* decision for magnet programs in Kansas City in 1974. The court order rejected the inference of Kansas City's segregation to interdistrict programs. The decision loosened the commitment to desegregation. The other cases are *Parents Involved in Community Schools Inc. v. Seattle School District* and *Meredith v. Jefferson County (Ky.) Board of Education* in 2000s. Both decisions encourage parents to participate in public school choices, partly to achieve a level of integration that would not otherwise be possible because of racially segregated housing patterns. At the same time, the court also decided that public schools are exempt from the use of race/ethnicity for school integration. That is, school admission policy for magnet schools specifically becomes race neutral. The shifted emphasis from school desegregation at the federal and court level have changed the function of magnet schools to integrate students.

Alongside these policy decisions, magnet schools also face competition from the vastly rising expansion of charter schools. Since NCLB, charter schools have become more and more popular to parents and policymakers. Although magnet schools still served about one million more students than charter schools in 2006, the funding and support for magnet programs has declined. Under the national climate of raising accountability and high stakes testing, magnet schools that compete with charter schools for funding and students inevitably have to make efforts to raise students' academic outcomes. Since the 1990s, the shifted priorities from school desegregation to educational excellence has raised the question of whether magnet schools can positively affect students' educational achievements.

The academic effect of magnet schools

The existing findings about the academic effects of magnet schools are limited and mixed. Two factors often discussed in relation to the inconsistent results are the lack of generalizability and selection bias.

Magnet studies that use datasets from one or a few districts or cities support magnet advantages on educational achievements or attainment. Research employs experimental design in New York City and suggests that lottery winners of career magnet schools gain in reading scores and credits for graduation (Crain et al., 1999). In the late 1980s and early 1990s, these studies consistently highlighted positive magnet effects on test scores (Balnk 1989; Lippitz 1992; Yu et al., 1997; Poppell & Hague 2001; Betts et al., 2006). Samples used by these studies are from large school districts in the South, West, Northeast, and Midwest. The comparisons of magnet lottery "winners" and "losers" consistently show that magnet schools positively affect students' reading and mathematics scores (Blank 1989; Bifulco, Cobb, & Bell 2008). Even students in nonacademic magnets gain more in test score than those in academic magnets, although the effect disappears after controlling for the peer effect (Ballou 2007).

On the contrary, studies that use district-level data still find no magnet effect on achievements. Comparing lottery winners and losers for magnet enrollments, a study of San Diego magnet schools does not find a significant effect on mathematics achievement (Betts et al., 2006). To take selection bias into consideration, Cullen and his colleagues (2005) conducted an Instrumental Variable (IV) analysis with the Chicago Public School data. They found that opting out for chosen schools (mostly magnet programs) does not benefit students' achievement, except for disadvantaged students in career academies. Another study expands their magnet sample to nine magnet sites in large urban school systems and small cities (Kemple & Snipes 2000; Kemple & Scott-Clayton 20040). The researchers only focus on career academy magnet schools. The authors do not find a difference in participants' reading and mathematics achievement tests. Nor is there a difference in average educational attainment (high school graduation, enrollment in college).

Most research on school effects use student samples from a single school district or local area, and the results vary and cannot be generalized to the magnet school population. The problem of generalizability thus arises. To accommodate this issue, using nationally representative data to estimate the average magnet effect could be a good strategy. In previous research, only two studies are conducted with national datasets out of fourteen studies; the others use data from local districts. One is Gamoran's (1996) study that compares school effects among comprehensive public high schools, magnets, Catholic, and other private schools. This study uses the data from the National Education

Longitudinal Study of 1988 (NELS:88). The author first uses the OLS model by controlling for student and school characteristics. He finds that magnets are more efficient at raising high school students' achievements in reading, social studies, and science, but not in mathematics. When a hierarchical linear model is applied, only the estimates for reading and social studies remain statistically significant. After adjusting for selection bias with a 2-stage Heckman Selection Procedure, Gamoran finds that magnets still only benefit students in reading and social studies.

However, a review study raises a methodological question about Gamoran's estimates from Heckman's selection procedure (Ballou 2009). On the one hand, the author questions the validity of the instruments used to estimate the selection. On the other hand, it is difficult to explain why after correcting for selection the estimated effect in math and social studies increases while the effect in reading and science reduce. In addition, the NELS:88 data are outdated. Today the nationwide magnet effect is not clear. The methodological doubt about the Heckman estimator is related to the potential multi-collinearity between variables using in the fitted probit regression and the covariates in the outcome equation (Nawata, 1993). Even ruling out the problem of multi-collinearity, the magnet effect (treatment effect) is still estimated based on comparing students with a wide range of variation in background characteristics.

Christenson and colleagues' (2003) study summarizes achievement gains and characteristics of the Magnet Schools Assistance Program (MSAP)-supported magnets (Christenson et al., 2003). They conclude that the multilevel regression estimates do not show a significant difference in math and reading test scores between MSAP schools and other public schools. However, the study has several limitations. First, the authors collected magnet school data from eight large school districts and assumed the magnet schools they sampled universally practice lottery-based admission criteria, which is not always true. Random assignments among students are an assumption for their school sample, while some lottery winners give up their enrollments into magnet schools and choose to attend other schools. Additionally, their study does not take into account the fact that students may drop out of magnets between survey years. On the other hand, using only school-level data makes it difficult to measure the school effect without controlling for student variation. Lastly, the competition for MSAP grants is rigorous, and winners of MSAP make up only about 9% of all magnet schools. The question about generalizability and sample selection still exists for this study. Their findings leave much room to be explored in further examinations.

The mechanism of the magnet school effect

What accounts for the magnet school effect, if it exists? Choosing a school requires a certain level of parental motivation and involvement, which may be independent of parents' socioeconomic status (Cullen, Jacob, & Levitt, 2005). High parental motivation and involvement are associated with higher student academic achievement (Steinberg et al., 1992). Parents who select magnet schools for their children tend to be more involved in school events and to spend more time with their children (Emrekar & Goldring 1999; Goldring & Hausman 1999). Those parents appear to visit the school more frequently than other non-choosers (Hoxby 1998), and are also more likely to influence school policy (i.e. requesting challenging curricula and a more disciplined environment).

Some school factors have been found to be associated with achievement differentials in magnet schools. These are peer characteristics and prior achievements that largely explain the magnet school effect. The percentage of Black and percentage of low-income students within schools are significantly and negatively associated with 5^{th} -grade magnet school students' mathematics and reading scores. Reducing the percentage of Blacks from 75% to 25% predicts students' test score gain of more than half a year's normal growth (Ballou 2007). This is consistent with what other researchers have found that reducing the Black percentage would produce an increase in seventh grade achievement (Hanushek, Kain, & Rivkin 2002). It is not surprising that prior achievement explains a large proportion of the magnet school effect. Learning is a cumulative process. Students' current academic achievement is based on what they have learned in prior grades. In addition, controlling for prior achievement also takes into account both observed and unobserved covariates that are significantly associated with academic achievement. The other mechanisms for the magnet school effect also include students' high attachment to teachers and specialized programs (Gamoran 1996). Magnet schools usually have smaller class sizes and higher teacher-student interaction than comprehensive public schools. The social tie between students and teachers and high motivation to study for specialized curriculum design (i.e. career academic, art) may benefit students with achievement gains. It is also possible that, compared with comprehensive public schools, there are more resources and stable funding for magnets (Christenson et al., 2003).

Summary and Conclusion

The existing literature on school choice concentrates on two areas of scholarship. One focuses on explaining why and how parents choose schools, and the other examines the consequences of school choices. In fact, these two literatures are closely related. On the one hand, parental selection for schools can affect what and how students learn from schools. On the other hand, school quality influences parents' selection among schools. Parents may choose to opt out of their assigned neighborhood public schools with the expectation that their children will have better educational outcomes by attending chosen schools. Among the measures of school quality, school features related to academic performance are the most emphasized for parents who exercise school choice. Policymakers and school funding authorities also pay substantial attention to the school effect on students' academic performance. They want to be informed so they can make decisions about supporting certain school choice policy within their districts or areas to improve students' academic outcomes, especially for those from low-income and minority families.

Prior research estimates school effect by comparing the effect between school sectors and the effect between public school choices. Catholic school is the most studied private school choice to compare with public schools, while there is increasing research on the charter school effect. However, as discussed in the previous section, Catholic and magnet schools serve the majority of student enrollment in the private school and public school sectors, respectively. The locations of these two types of schools in urban areas and inner cities make them important educational institutions for low-income and minority students.

However, the findings for Catholic and magnet school effects are not conclusive. Previous results are plagued with issues of generalizability and selection bias. The research that uses district data often has data collected by experimental designs. Studies of different districts data are difficult to generalize. Using nationally representative data can remedy the lack of generalizability, such data can suffers from selection bias.

The critics of school effect studies often focus on selection bias – school effect comes from variables related to selection into a school, not from the school per se. For example, parents who choose magnet schools are usually more knowledgeable about available choices than non-choosers. These parents also tend to have high socioeconomic status and tight and informative social networks. On the other hand, the admission methods of magnet schools vary. Some magnet schools use the lottery to randomly assign lottery winners. Some use specific admission criteria, such as art performance and prior test scores, to recruit students who best fit their theme. Selection bias is, therefore, a methodological concern while researchers estimate the school choice effect. Unlike experimental design, studies using observational data (i.e. surveys) are rarely able to remedy the lack of random selection among treatment and control groups. Selectivity is a challenge for most survey studies.

While it is virtually impossible to conduct an experimental design for the school effect study across the nation, reducing selection bias can be done by using more sophisticated methods. Some studies have tried to control selectivity through using the instrumental variable (IV) method (Cullen et al., 2005; Ballou 2007) on observational data. However, it is not easy to dispel doubt about a reliable exogenous variable that affects selection but not the outcome. It is more ideal to use a matching method to control for students’ characteristics before school selection (Rosenbaum 1995). Through comparing outcomes between control and treated groups, the treatment effect for the treated (i.e. Catholic school effect for Catholic school students, or magnet school effect for magnet school students) could be estimated. The matching method is used in this study.

Apart from methodological issues, what is lacking in the existing literature is the study of the school effect at the policy level. In a very decentralized educational system like that in the U.S., school choice policies vary across states and even across school districts within the same state. However, little is known about the school choice effect within states and school districts. To adjust for the weakness of prior research, my dissertation employs propensity-matching methods to study the effect of Catholic and magnet schools on students' academic achievements using a recent nationally representative high school sample. I also account for policy variation by fitting state and school district fixed-effect models. This study aims to provide robust findings to inform school choice policy.

Chapter 3

RESEARCH METHODOLOGY

The purpose of this chapter is to describe key research questions to be answered and the methodological design to be used. The chapter is divided as follows: The research questions are addressed in the first section. The next section describes the data sources and samples used. This is followed by a section that details the multiple approaches and statistical methods for both exploratory and explanatory purposes.

Research Questions

The existing Catholic/magnet school studies have suggested mixed results of Catholic/magnet school effects on either educational achievements or attainments with either national datasets collected in earlier decades, or with data of a specific region or district. With the expanding demand for private vouchers and the rising minority population in Catholic schools, is the Catholic school effect on students' academic achievement persistent? With increasing numbers of minority group members and segregation in magnet schools, is there a magnet school effect on students' academic achievement? This study is a re-examination of the Catholic/magnet school effect with the recent nationally representative dataset.

Catholic school studies mostly rely on four methods – OLS, instrumental variable approach (IV), Heckman procedure, and propensity score matching (PSM). Most magnet school studies use the former three methods, exclusive of PSM. The failure to consider selection bias is a commonly addressed problem for OLS. To account for selection bias, the other three methods are often used. However, the weakness of the IV method is that it is difficult to find an exogenous variable that affects selection but not outcome. This is especially problematic in a large-scale national survey. On the other hand, the Heckman 2-step procedure first estimates the probability of selection, then uses the density and distribution of probability to correct for the OLS estimate in the equation. The problem with the Heckman estimator is the potential multicollinearity between the fitted probit regression (the hazard ratio, λ, from selection equation) and the covariates in the outcome equation (Nawata 1993). Even ruling out the problem of multicollinearity, the Catholic/magnet school effect (treatment effect) is still estimated based on comparing students with a wide range of variation in background characteristics.

The problem of comparing vastly different individuals can be eliminated by implementing the PSM method. This method is based on a similar idea to the Heckman procedure, which estimates the propensity of selection. I use the propensity to match treatment and control groups, similar to a natural experimental design, to obtain a matched sample for further analyses. In other words, Catholic/magnet and other public school students in the sample are supposed to be alike except in the area of school selection. Explicitly, students with similar propensity scores, regardless of school sector, are assumed to have homogeneous characteristics before school selection. The treatment effect estimator from other linear square methodology on the matched sample can be more robustly calculated by using.

My study contributes to the existing research on the Catholic/magnet school effect in two ways. First, I used a recent and nationally representative sample of high school students, rather than a regional or local sample. Second, I further focused on the Catholic/magnet school effect within school districts. If there is a plausible effect within school districts, I further analyze the variation in district characteristics and explain why students move across districts. If there is no effect within school districts, the analysis on school district characteristics does not apply.

Based on the reviewed literature, three empirical questions are developed:

1. Is there any causal effect of Catholic/magnet schools for those who attend Catholic/magnet schools?
2. Is there heterogeneity of the Catholic/magnet school effect?
3. What is the effect of Catholic/magnet school within states and school districts? Do Catholic/magnet school effects differ across states and school districts?
4. What account for Catholic/magnet school effects, if there is any?

Data Sources

Incorporating contextual datasets into student file

Five datasets for this study were obtained from the Educational Longitudinal Study of 2002 (ELS:2002), Common Core of Data 2002 (CCD), Private School Universe Survey 2002 (PSS), the map of the School District Demographic System of 2000

(SDDS), and the 2000 census. ELS:2002 is a nationally representative sample of over 15,000 students in around 750 high schools. The ELS:2002 data includes information of student demographics and family background, schooling experience, parents, and schools. This study uses surveys from the base year and the first follow-up, which were collected in the spring of 2002 and the spring of 2004, respectively. Those measurements were implemented in the second semester of the 10th grade and the second semester of the follow-up 12th grade.

The sample design of ELS:2002 is similar to NELS:88. It uses a two-stage sample selection process. First, 1,221 eligible public and private schools were selected with the probability proportional to size (PPS) method, from a population of about 27,000 high schools that contain 10-grade students (Ingels et al. 2005). The final list of schools that participate in the study is 752. Then these schools provided 10th-grade student lists for the second stage of the sample selection, and approximately 26 students per school were selected from the lists. The sampling frame for public schools was stratified by nine U.S. Census divisions, then by states. For private schools, the sampling frame was stratified by Catholic and other private schools, then four census regions. ELS:2002 also oversamples Hispanics and Asians. Due to the complex sampling structure and oversample, a series of weighting variables are important for data analyses. Three weights are available: a weight for student questionnaire completion, a school weight, and a data weight for the expanded sample (Ingels et al., 2005).

The two important features of ELS:2002 survey design are stratified multistage sampling and clustering. To take into account the design effect, this study estimates a robust standard error by school clustering (students are nested within schools) and uses probability weight in the student sample.

ELS:2002 surveys were filled out by students, parents, and the school administration. Students' academic achievements are measured by mathematics test scores for 10^{th} and 12^{th} graders, and reading scores for 10^{th} grade. ELS:2002 does not follow up on reading measurements after the first year's assessment. Both Morgan (2001) and Gamoran (1996) use prior test scores as a control covariate for their Catholic and magnet school effect study. In order to compare my results with theirs, I use the mathematics test score as the major achievement outcome to estimate the Catholic/magnet school effects. However, I can still analyze the Catholic/magnet school effects on the reading test score in the base-year.

Individual student variables are derived from ELS:2002 data. School information comes from ELS:2002, CCD 2001-2002, and PSS 2001-2002. The CCD data collects information for all public schools and their school districts. It contains measures such as overall enrollment, school racial/ethnic composition, number of students attending free-reduced lunch programs, pupil/teacher ratio, and school district dropout rate. They have been collected annually since 1986. The PSS provides similar information as does CCD, but from private schools.

One purpose of this study is to examine the school effect at the policy level. The ELS:2002 does not provide information on school district characteristics. I use the CCD 2001-02 file to construct variables for school districts that have schools in grades 10 through 12. The CCD district file includes similar information as the CCD school file, but at the district level. The district variables are merged into ELS:2002 to estimate the association between district characteristics and school choice participation. By doing so, I am able to add state identifiers to my ELS:2002student sample for the state fixed-effect analysis. Including the CCD contextual data facilitates the estimation of Catholic and magnet school effects on students' academic achievement within and between states and school districts.

The fourth dataset of this study is the SDDS map file that provides the locations of each high school and the school district boundaries across the U.S. The SDDS data is one of the educational datasets collected by the National Center for Educational Statistics (NCES). What makes SDDS unique is that school district geographical boundaries overlay with neighborhoods, including the 2000 census and the American Community Surveys from 2005 to 2008. Some neighborhood information such as demographics is calculated at the school district level. Both maps and data files are publicly available. Because Catholic schools are not under any district administration, the SDDS map file helps to match Catholic schools to the district boundaries where they are located. Therefore, district characteristics for Catholic schools are available and public schools in the same district can be identified. After extracting this information from SDDS, I then merge them into ELS:2002 student file by the NCES school district identifiers.

Prior research has found that neighborhood concentrated disadvantage is associated with minority groups' less participation in school choices. To control for selection bias, I include neighborhood variables for my matching procedure. These variables are derived from the 2000 Census that are merged into ELS:2002 student samples by students' residential zipcodes. However, they are not completely merged because zipcode boundaries change over time. Some zipcodes collected in 2000 Census year in 1999 have changed while ELS:2002 was collected in 2002 and 2004. There are about 110 ELS:2002 zipcodes not found in the 2000 Census, resulting in about 580 students who do not have neighborhood variables from the census file. The complete data for this study includes variables of students, parents, school administration, all public and private schools, all school districts, and surrounding neighborhoods.

Multiple imputation

There are missing values in the data. Among missingnesses, about 5% are Catholic school students versus 88% public school students. Among complete observations, about 5 % are Catholic school students, versus 90% public school students. I use the multiple imputation (MI) technique to create five imputed datasets (Little 1987; Schafer 1997). MI assumes missing at random (MAR) and bears a close resemblance to the EM algorithm (Rubin 1977) and other computational methods for calculating maximum-likelihood estimates based on observed data. MI estimates missing values from other observed nonmissing values. It is a superior method to listwise deletion (see discussion in King et al., 2001). Except dependent variables, all other variables for this study are used for multiple imputation. I use the R statistical package “Amelia” developed by Harvard professor-Gary King, and his research team to conduct imputation. This software is available for public use at http://gking.harvard.edu/amelia/.

The analyses through this study are based on the five imputed datasets. Estimations are implemented on each imputed data, and the output estimates from the same analytical model with different imputed data are combined. I follow the method suggested by statistician- Joe Schafer, to combine those estimates. In Schafer's website about multiple imputation, he refers to Rubin's (1987) study to combine results from data analyses on imputed data sets (http://www.stat.psu.edu/~jls/mifaq.html#howto). There are four steps to calculate the final results for each analysis.

The first step is to obtain the average of the overall estimates:

$$\overline{Q} = \frac{1}{m}\sum_{j=1}^{m}\hat{Q}_j \, ,$$

where $\hat{Q}_j$ is an estimate obtained from data set *j* (*j*=1,2,...,*m*).

The second step is to calculate the within-imputation and between-imputation variances:

Within-imputation variance: $$\overline{U} = \frac{1}{m}\sum_{j=1}^{m}U_j \, ,$$

Between-imputation variance: $$B = \frac{1}{m-1}\sum_{j=1}^{m}\left(\hat{Q}_j - \overline{Q}\right)^2 .$$

where U_j is the standard error associated with $\hat{Q}_j$.

The overall standard error can then be obtained:

Total variance: $$T = \overline{U} + \left(1 + \frac{1}{m}\right)B .$$

Overall standard error: $\sqrt{T}$

The last step is a significance test of the null hypothesis Q=0, which is performed by Student's t-statistics:

$$t = \overline{Q} / \sqrt{T}$$

The overall estimate $\overline{Q}$, standard error $\sqrt{T}$, and t statistics are reported for each analysis. All the calculations are implemented in the statistical package- Stata 10.

Study samples

I create three subsamples for different purposes of analyses. The first two samples are for Catholic school effect analysis, and the third sample is for the study of the magnet school effect.

The main sample

The main sample for this study only includes students who have non-missing values on 12th grade math scores, which is the major dependent variable. Although 10th grade reading score is used for analysis, it only provides complementary information about the school effect because of the lack of prior reading score. I also use some student variables from base-year survey (10th grade), so the attrition between waves should be addressed here. Approximately 13% of students are dropped due to attrition. The first follow-up weight (*f`1qwt*) is included to adjust for the design effect due to the complex and stratified sampling design (Ingels et al., 2005).

For the Catholic school sample, I drop students who attend rural schools as well as those in other private schools. According to 1999-2000 School and Staffing Survey (SASS) from NCES (2002), there are only 12% Catholic schools in rural areas. Only 1% of ELS:2002 Catholic schools are in rural areas. My purpose is to estimate the Catholic school treatment effect on those who opt out of their public alternatives and choose Catholic schools. Besides, as aforementioned, I am interested in low-income and minority students who are less likely to attend other types of private schools due to high schooling costs, if they are given private choices. Therefore, I focus on the Catholic-public school comparison in urban and suburban areas. The final main sample size for the Catholic school effect (main Catholic sample, hereafter) is about 9,240 students in 540 schools and 430 school districts[2].

District sample

For the separate analysis of the school district Catholic school effect, I create a district sample that constrains my main sample to students in the district that has both Catholic and public schools. This district sample includes about 7,470 students from 440 schools within 320 school districts. About 1,770 public students, 100 public schools, and 110 school districts are dropped from the main sample.

Magnet sample

For the study of the magnet school effect, my sample is comparable to Gamoran's (1996) study. Since magnet schools are mostly located in urban areas where they serve a

---

[2] According to the rule and regulation for the use of NCES restricted datasets, the numbers of observations reported through the whole thesis are rounded by 10 digits.

large proportion of minority students, Gamoran constrains his magnet school sample to stand-alone magnet schools located in central cities. The strategy that Gamoran uses to identify stand-alone magnets and central city on National Education Longitudinal Study of 1988 (NELS:88) data is not completely applicable to ELS:2002 data. A question asked about the type of magnet schools in NELS:88 is not available in ELS:2002. NELS:88 has a question about whether a school currently uses school-within-school with their own administrative staffs, such as alternative or magnet school programs. This question is used by Gamoran to specify whether a magnet school is a stand-alone magnet. But this question is not available in ELS:2002. In addition, NELS:88 uses Quality Education Data (QED) to identify central cities, while ELS:2002 relies on CCD data to identify only three categories of school urbanicity- urban, suburban, and rural. After a series of discussions with the NCES staff who is in charge of ELS:2002 data, I decided to disregard the use of the definitions for magnet schools and urbanicity from ELS:2002. Instead, I use CCD data to identify magnet schools that are located in central cities. This results in about 7.7% of ELS:2002 schools designated as magnet. Compared with 1.8% magnets in Gamoran's study, this amount is larger. However, it is more conservative than the percentage distribution of magnets obtained from ELS:2002 (about 10.2%). The comparison about the samples of magnet schools between NELS:88, 2001-2002 CCD, and ELS:2002 is presented in Table C1 in the Appendix. The relatively larger percent of magnets than the one conducted by Gamoran may be due to the increase of magnet schools from 1988 to 2002. The full analytical sample for the magnet school effect (analytical magnet sample, hereafter) in this study is about 1,560 students in 80 schools and 60 school districts.

I do not specifically create a magnet district sample because all school districts in central cities have both magnet and comprehensive public schools. School districts in urban areas or central cities are usually large districts that provide many public schools to serve a large student population. Therefore, I use the magnet sample to estimate the magnet school effect and the effect within school districts.

Measures

This research includes performance measurement as well as information about the individual, family, schools, school districts, and the neighborhood (zipcode as the unit) as control variables in my analysis. Table 1 lists the variables constructed for the study and their original variables, as well as data sources.

Outcome variable

The dependent variable is 12^{th} –grade math score, which is calibrated via the item response theory (IRT). The ELS mathematics achievement is measured by standardized math test scores. There are several considerations for the use of mathematics scores in the study. First, prior test score in the 10^{th} grade is only available for math but not for other subjects. Also, mathematics tends to be a subject more sensitive to school instruction than reading learning (Borman and D'Agostino 1996; Murnane 1975). Previous research (Hoffer 1995) has shown that students who score higher on mathematics tests are more likely to attend competitive four-year colleges. For high school students, mathematics achievement plays an important role in transitioning to postsecondary education. Thus I focus on mathematics test scores in my study. For results on 10th grade reading performance without controlling for prior test score, see Tables A4 and A5 in Appendix.

Table 1. Variables for the Study

Variable	NCES Variables	Construction of Variables	Data
Dependent variable			
12th-grade math score	f1txm1ir	Continuous IRT score	ELS:2002
Independent variables			
Catholic school participation	bya03i,bya03j,bya03k,bya03l	1= Catholic school; 0= public school	ELS:2002
Magnet school participation	Magnet01, locale, bya03a, f1a05a	1= magnet school; 0=assigned public school	CCD, ELS:2002
Previous math score	f1txmbir	Continuous 10th-grade IRT score	ELS:2002
Demographics & family background			
Asian	race_r	1= Asian; 0=otherwise	ELS:2002
Black	race_r	1= Black; 0=otherwise	ELS:2002
Hispanic	race_r	1= Hispanic; 0=otherwise	ELS:2002
Other race	race_r	1= other race; 0=otherwise	ELS:2002
Male	sex	1=male; 0=female	ELS:2002
Age	f1dob_p	Continuous variable	ELS:2002
Immigrant	byp17,byp20,byp23,	1=immigrant; 0=otherwise	ELS:2002
English as native language	stlang	1=yes; 0=otherwise	ELS:2002
Number of siblings	byp08	Number count	ELS:2002
Step parent	byfcomp	1=living with step parent; 0=otherwise	ELS:2002
Single parent	byfcomp	1=living with single parent; 0=otherwise	ELS:2002
No parent	byfcomp	1=do not live with parent; 0=otherwise	ELS:2002
Socioeconomic status	ses1	Socio-economic status composite from parental occupation, education, and family income	ELS:2002
Mother does not work	byp01,byp03,byp36,byp40	1=mother not work; 0=otherwise	ELS:2002
Mother works part time	byp01,byp03,byp36,byp40	1=mother work part time; 0=otherwise	ELS:2002
Catholic affiliation	byp33	1=catholic; 0=otherwise	ELS:2002
Northeast	region	1=Northwest; 0=otherwise	ELS:2002
Midwest	region	1=Midwest; 0=otherwise	ELS:2002
West	region	1=West; 0=otherwise	ELS:2002
Neighborhood features:			
Neighborhood segregation	P007001-P007017	0 ~ 1; 0= extremely racially integrated neighborhood, and 1=maximally segregated.	Census

Table 1. (continued)

Neighborhood crime: moderate	byp67	1=neighborhood crime is moderate; 0=otherwise	ELS:2002
Neighborhood crime: high	byp67	1=neighborhood crime is high; 0=otherwise	ELS:2002
# public schools within 6 miles	zipcode	Create the number of public schools within 6 miles by using GIS	CCD, SDDS
With Public aid for Catholic schooling	bysreszip, zcta5	1= receiving aid; 0=otherwise	ELS:2002, Census
% in poverty	P089001-P089039	% population below poverty level	Census
Parental education expectation			
Less than high school	byp81	1= less than high school; 0=otherwise	ELS:2002
High school	byp81	1= high school; 0=otherwise	ELS:2002
Less than college	byp81	1= less than college; 0=otherwise	ELS:2002
College	byp81	1= college; 0=otherwise	ELS:2002
Graduate school	byp81	1= graduate school; 0=otherwise	ELS:2002
Parental involvement	byp55a, byp55b, byp56a-d, byp57a-b, byp53a-I, bya54a-e	Scale score	ELS:2002
Parental network	byp60a-byp60d	Scale score	ELS:2002
Schooling experience			
Ever repeated grade	byp46	1= ever repeated grade before high school; 0=otherwise	ELS:2002
Attend general program	bys26	1= in general program;0=otherwise	ELS:2002
Attend vocational program	bys26	1= in vocational program;0=otherwise	ELS:2002
Number of science course taken	f1s16	Number science courses taken in high school	ELS:2002
Number of math course taken	f1s17	Number math courses taken in high school	ELS:2002
Cross school district	leaid, zipcode	1=attend school across district; 0=otherwise	Census, CCD
School characteristics			
Urban	urban	1= urban; 2=suburban; 3=rural	ELS:2002
School offers vocational Program	bya16	1= yes; 0=no	ELS:2002
School mean math score	f1txmbir	Average of student math score	ELS:2002
School climate	f1a38	Scale score	ELS:2002
% out-of-field teaching	bya25a, bya25b	% of teachers who teach subjects without academic trainings	ELS:2002
% in LEP program	bya14h	% of students in the limited English proficiency program	ELS:2002
% receive free-reduced lunch	FRELCH01, REDLCH01, TOTFRL01	% of students receiving free or reduced-price lunch	CCD; PSS
% living in linguistic isolated neighborhood	P020001, p020002	% linguistic isolated in zipcode	CCD, Census

Table 1. (continued)

% school minority	white01, member01	% non-white students	CCD; PSS
% certified teachers	bya24a, bya24b	% of teachers are certified	ELS:2002
School district characteristics			
% in academic program	bya12c	% students/academic counseling	ELS:2002
% in dropout remedial program	bya12e	% students/ dropout program	ELS:2002
% in drug prevention program	bya12g	%students/drug prevention	ELS:2002
% receive free-reduced lunch	FRELCH01, REDLCH01, TOTFRL01	%students/free-reduced price lunch	CCD
%linguistic isolated in Neighborhood	P020001, p020002	%population is linguistic isolated in zipcode	Census, CCD
% school minority	white01, member01	Average %minority in schools	CCD
School district mean score	f1txmbir	Average student math score	ELS:2002
% out-of-field teaching	bya25a, bya25b	Average %out-of-field teaching	ELS:2002
% certified teachers	bya24a, bya24b	Average % certified teachers	ELS:2002
% in vocational program	bya12d	Average % in vocation program	ELS:2002
SES	ses1	Aggregated family SES	ELS:2002
% in poverty	P089001-P089039	% students living in poor neighborhood	Census
% dropout	drp912, member01	Average % dropout	CCD
% White	White01, member01	Average % white	CCD
% Black	Black01, member01	Average % black	CCD
%Limited English Proficiency	lep01, member01	Average % in LEP program	CCD

Independent variables

Catholic and magnet school attendance are a dummy variable identifying whether a student enrolls in a Catholic or magnet school. Students' prior academic performance is measured by 12th graders' 10th-grade mathematics scores. Controlling for prior score is done to stabilize the variation of dependent variable that is associated with prior schooling; as well as to eliminate selection bias. Thus, the effect of Catholic/magnet school on achievement gain within two years of schooling can be more robust. Ideally, it is better to use the prior score before students entered high school (i.e. 9th-grade score) than 10th grade score, which was collected in the sophomore year. However, such an ideal prior score is not available from ELS:2002data.

Student demographics and background

These variables include race-ethnicity (a series of dummy variables that identify a student's race/ethnicity as White, Black, Hispanic, Asian, or other race); gender (male=1, female=0); 12th grade's age (in years); whether student is an immigrant (1=yes, 0=not); whether English is the student's native language (1=yes, 0=not); number of siblings (continuous variable from 0-6, and 6= 6 or more), family composition (dummy variables that categorize whether the student is from a two-parent, single-parent, step-parent, or no-parent household; reference group: two-parent); and working mother (dummy variables that capture whether a student's mother is currently a full-time, part-time employer, or not working; reference group: full-time). SES in ELS data is a continuous composite measure of parental socioeconomic status (including household income, parents' highest education, and parental occupation index). Other background variables include Catholic affiliation (1=Catholic; 0=non-Catholic) and region (dummy variables for each region: northeast, north central, south, and west; reference group: south).

Several neighborhood characteristics are included. Neighborhood segregation is found to be associated with students' propensity of opting out of assigned public schools (Lauen 2007). Students living in segregated disadvantaged neighborhoods are less likely to exercise their school choice. Neighborhood segregation is measured by a diversity index-entropy (Reardon and Firebaugh 2002) of zip codes. Other variables are the level of neighborhood crime reported by parents (dummy variables for low, moderate, and high levels; reference: low), number of public schools available within six miles. I use GIS to calculate the average distance from students' residences to schools. The average distance is about 6.009 miles. Therefore, I use six miles as a radius around students' zipcode areas to calculate the number of public schools available for students to choose. Neighborhood poverty rate measured by the ratio of population below the poverty level over those above poverty by zip codes, and public aid for private schooling is a dummy variable. The variable "public aid for private schooling" identifies whether a student's residential state or county has allowed for public aid to support private schools (regardless religion) or private school students through either voucher or scholarship in the year 2000, the year while ELS students select which high school to attend. The identification is based on two reports: State Regulation of Private School[3] (2002) and Goodman (2009). These counties/cities or states include those that have passed voucher programs – Florida, Maine, Milwaukee (WI), Cleveland (OH), Vermont; and tax credit- Iowa, Minnesota, Pennsylvania, Illinois, Florida, and Arizona. Pennsylvania enacted a scholarship tax credit for private school students in 2001. Receiving public aid might have affected parental selection for Catholic schools. This is a variable that previous research has not used to account for selection bias. This variable is included to represent the possible effect of existing policy on parental decision making of selecting Catholic schools or staying with their assigned public schools. The variable value 1 indicates that a student lives in a school district where public fund is available for Catholic schooling, while 0 indicates no fund is available for Catholic schooling in the school district.

Parental educational expectation

[3] See http://www.ed.gov/pubs/RegPrivSchl/index.html for more details.

Parental educational expectation is categorized by five dummy variables (less than high school, high school, less than college, college, graduate school), which measure students' educational attainments that parents expect them to achieve.

Parental involvement and network

Two measures of parents' social capital are used in this study. Parental involvement measures the level that parents are involved in students' educational activities, and parental network presents the level of networking among parents. The two variables are scale scores created by Cronbach's alpha statistics, with scale reliability over 0.75.

Schooling experience

A set of variables are used to present students' school experience, including high school programs that indicate students' track placement (dummy variables measuring whether a student is in a general, college preparatory, or vocational program; reference: college preparatory), whether 10^{th} graders ever repeated a grade before 10^{th} grade (1=yes; 0=no), number of science and math courses a student has taken since high school (two continuous variables). The variable "cross school district" is a dummy variable that identify whether a student attends his/her school across school the district boundary. The variable is only used for studying the Catholic school effect while there is an effect, because most magnet schools are intra-district choice plans.

School characteristics

School characteristics are measured by the school's urbanicity (dummy variables for schools located in urban and suburban areas), school climate (a continuous scale score for the level of school climate), average school math score (created from the math scores of individual 10th graders within each school), the percent of minority students (percent of non-white students within schools), the percent of certified teachers (percent of teachers receiving teaching certifications), the percent of out-of-field teaching (percent of teachers who teach math but did not major in math or teach math), the percent of English as Second Language program (percent of students in ESL program), the percent of students receiving free-reduced lunches (percent of students free-reduced lunch support), and the level of crime in school neighborhood reported by school administration.

School district variables

These variables include school district SES (average SES composite of districts), the percent of receiving free reduced lunch; district math score (mean of students' math score by district), the percent of students in academic programs (mean of the percent of students in academic program within each school); the percent of ESL (percent of students in ESL program); the percent of minority students.

Analytical Strategy

As discussed in the previous section, the greatest challenge in studying school effect is to rule out biased and inconsistent estimates from least square estimators, whether generated by omitted variables or self-selection. One way is to imitate an experimental design that requires a control and treatment group in which observations in both groups are identical except for the probability of receiving treatment, so that the treatment effect can be compared by the differences in outcomes between the control and treatment groups. Ideally, an experimental design that randomly assigns students to attend Catholic or magnet schools is an efficient way to account for selection effects. However, in reality, it is not practical to assign students randomly into Catholic or public schools (or magnet versus assigned public schools), regardless of their family background and variation of school characteristics. Even with a local sample collected through random assignments, it is also questionable to measure the average Catholic/magnet effect on Catholic/magnet students because in an experiment, the same person cannot be in the treatment and control groups simultaneously.

Social scientists have tried different advanced methods to account for selection bias that is frequently found and criticized in previous research with OLS analyses. Some use value-added models to measure whether Catholic schools are associated with achievement growth. Others introduce instrumental variables (IVs) for Catholic school attendance (e.g. Evans & Schwab 1995; Hoxby 1996; Neal 1997) to resolve the endogeneity of school sector selection. However, a perfect instrument that predicts the treatment variable but does not directly affect the outcome variable is not easy to find, and is usually not able to be tested. For instance, research criticized that religious affiliation, geographic proximity to Catholic schools, and the interaction among them are not valid instruments (Altonji, Elder, and Taber 2002; Grogger and Neal 2000). Based on the counterfactual framework to estimate causal effect, Morgan (2001) then introduced propensity score matching to predict the Catholic school causal effect on Catholic schooling. Although the propensity score matching method also carries the weakness of omitted variables, it is more appropriate than other available methods to draw causal inference in sociological or educational studies. Following Morgan (2001), I use this method in this research to study both Catholic and magnet school effect on student academic achievement.

First, I use the propensity score matching method to create match samples. I then employ OLS on the match samples to estimate the average treatment effect for the treated, that is, attending Catholic or magnet schools, as well as the effect within propensity score strata by using strata fixed effect modeling (Morgan 2001). The third step is to analyze the effects at the state and school district levels by using state and school district fixed-effect models. These three approaches are used for estimating Catholic school effects and they are repeated for estimating magnet school effects. To avoid redundant details, I describe below the methodological consideration by only documenting Catholic school study.

Propensity score matching

The propensity score matching (PSM) is an approach that takes the probability of being selected into a treatment group as a dimension to match each treatment observation to control observations (Rosenbaum and Rubin 1983b). With observational data, there are no treatment and control groups for a specific treatment. That is, the chance to collect two or more identical cases that are different only in treatment status (receiving treatment or not) is close to zero. One solution to this is to obtain counterfactuals for those treatment receivers, then compare the means between the treatment and counterfactuals to estimate the average treatment effect for the treated (ATT).

For example, ELS:2002 provides achievement scores and other information about students who attend Catholic or public schools. It is impossible to know how the same Catholic school students would have performed if they had chosen public schools. If the public school students who are similar to Catholic school students, in terms of prior-selection features, can be obtained, these public students are counterfactuals to Catholic school students. They only differ on school selection.

Based on this logic, the PSM is a method used to find the most matched Catholic and public school students. It is a weighted function of a set of observed covariates to estimate a probability of receiving treatment. Thus, in this study, each student will have a probability of attending Catholic schools, based on students' prior-school-selection characteristics. The probability is named as "propensity score," and is used to match Catholic school students to their similar public counterparts.

The PSM is presented under a strong assumption known as the stable unit treatment value assumption (SUTVA) (Rubin 1986). This assumption states that the outcome value of receiving a treatment for a unit is not affected by how the treatment is assigned and what treatments are received by other units. As Morgan (2001) has discussed, to hold SUTVA in the case of the Catholic school effect, it is assumed that Catholic school effects do not change while the proportion or composition of students in Catholic schools does change. With the limitation of SUTVA on survey data, it is only prudent to estimate the Catholic school effect for Catholic school students. The Catholic school effects for those who are already in public schools and then transfer to Catholic schools might not be properly inferred.

Estimating the propensity score

To implement propensity score matching, assuming SUTVA, I first fit a logit model to compute the conditional probability or the propensity of attending Catholic school for the analytic and district sample specifically:

$$\hat{p}_i \equiv \frac{\exp\left(\hat{\alpha} + \hat{\phi}_c X_i\right)}{1 + \exp\left(\hat{\alpha} + \hat{\phi}_c X_i\right)} \quad , \qquad (1)$$

where $\hat{\alpha}$ is the estimated constant term; $\hat{\phi}_c$ is the estimated vector of coefficients; and X_i is the "pretreatment" variable for individual *i*. Variables that are considered as "pretreatment" student characteristics are not affected by Catholic school attendance. These covariates include the 10^{th}-grade math score, student demographics, family background, and their interaction terms by race/ethnicity and by SES (Morgan 2001; Hong and Raudenbush 2005). All independent variables, interaction terms, and the first follow-up sample weight (*f1qwt*) together make 63 variables in the logistic regression. Morgan (2001) suggested that variables that might be affected by Catholic school enrollment, such as educational expectation and school climate in 10^{th} grade, should be considered exclusive from the propensity score prediction model. The ELS:2002survey tracked samples from 10^{th} grade when students were already enrolled in high schools. I do not know the degree to which selected high schools might have affected parental involvement and social networks. Therefore, I do not match my sample by parental involvement, parental network, school and district characteristics. Ideally, rather than using variables from 10^{th} graders, it is better to use variables of student characteristics before they enter high school for matching. However, there is no such variable available from ELS:2002data. Therefore, this study assumes that the variables used for matching are the same for those students before they enroll in high schools. Tables 2 and 19 show the variables included for matching, except interaction terms. School and school district characteristics are not used for propensity score matching because they are not pretreatment variables.

The design effect is taken care of by estimating robust standard error and controlling for cluster design with sampling weight.

Caliper match within stratum

To get a matched main sample, one approach is to match each Catholic school student with a similar public student, in terms of their propensity for Catholic school attendance ($\hat{p}_i$).The goal is to balance the distribution of all relevant pretreatment variables that predict school sector selection across the two groups under comparison. That is to make the Catholic school and public school students alike, based on their prior high school selection variables. Thus, public school students whose characteristics are balanced with those Catholic school students are considered as the control group (or counterfactual observations) to Catholic school students (treatment group).

The causal effect can be estimated by taking the mean of the differences in outcomes:

$$\hat{\delta} = \left(\hat{\bar{Y}} \middle| C = 1\right) - \left(\hat{\bar{Y}} \middle| C = 0\right) \qquad (2),$$

where $\hat{\delta}$ denotes the estimated average treatment effect, $\hat{\bar{Y}}$ is the average achievement score, C indicates whether a Catholic school student or not. The average treatment effect of Catholic schooling for Catholic students can be obtained from taking the mean of differences in achievement scores between Catholic school students and their matched public school counterparts.

There are different matching methods. The discussion of each method is beyond the scope of this study[4]. To be consistent with Morgan's (2001) study, I use caliper match with distance less than or equal to 1%:

$$\left| \hat{p}_c - \hat{p}_p \right| <= 0.01 \qquad (3),$$

where $\hat{p}_c$ is the propensity score for a Catholic student, and $\hat{p}_p$ is the propensity score for a public student.

After the distances between Catholic and public students are calculated, I match the sample with replacements to ensure every Catholic student is matched with at least one public student who has similar propensity scores. Within a 0.01 distance, if no public student is matched to a Catholic student, the Catholic student is dropped from the dataset. In addition, I do not keep all public students whose propensity scores are different from a Catholic student by 0.01. Only five public students whose scores are closest to the Catholic student within a 0.01 distance are kept and used for my further analyses.

[4] See chapter 4 of Morgan and Winship (2007) for the comparison across those matching algorithms.

Once I obtain a matched sample, I use the stratification method (Rosenbaum and Rubin 1984) to stratify the Catholic school student sample into five strata by the quintiles of the propensity scores. Then I select public school students whose propensity scores match the propensity scores of Catholic school students in five strata. Stratification (or subclassification) is a way to reduce bias in observational studies. Rosenbaum and Rubin (1984) refer to Cochran's (1968) study showing that five subclasses are often capable of removing over 90% of bias due to the subclassifying covariate. Following Morgan's (2001) Catholic school research design, I use five strata for my analysis. All pretreatment covariates are balanced within each strata:

$$\hat{\delta}_i \mid \hat{p}_i = \frac{1}{n}\sum_{i}^{n}\left[\left(\hat{\bar{Y}}_i \middle| C_i = 1, \hat{P}_i\right) - \left(\hat{\bar{Y}}_i \middle| C_i = 0, \hat{P}_i\right)\right] \qquad (2),$$

where $\hat{p}_i$ indicates the propensity score strata student *i* belongs to, and n is the number of matched Catholic students within strata.

Matching within school district

Following the same matching approach for the main sample, I further constrained the caliper matching within each district to obtain a within-district matched sample. Thus Catholic students are matched to public students by their propensity scores within the same school district boundary. I consider within-district match as a way to obtain more robust Catholic effects than by using the cross-district match, although the cross-district match achieves a larger sample size[5]. Matching within school district has its policy

[5] The cross-district matching obtains about 3,800 (720 Catholic and 3080 public) students and 460 schools across 360 school districts.

implications because a voucher program or tax credit for private schooling is implemented based on district administration. In addition, free-reduced price lunch aid and Title I fund for Catholic schools are also district-based. Therefore, the within-district match sample can lead to better estimates of the Catholic school effects.

Estimating the average treatment effect for the Catholic school students

OLS regression analysis on the matched sample

Now I have a matched sample with two groups of students – Catholic school students and public students whose pretreatment characteristics are alike. I use ordinal least square (OLS) models to estimate the average treatment effect for the treated (ATT) - Catholic school effect for Catholic school students. In the first model, I fit an OLS without any adjustment to estimate the main effect of the Catholic school on the matching sample as follows:

$$Y_i = \alpha + \delta(C_i) + \varepsilon_i \qquad (4)$$

where Y_i is students' achievement scores, α is the constant term, δ is the estimate of Catholic school effect, and ε_i is residuals that are normally distributed with mean as 0 and variance σ^2.

Next, I control for the 10th grade math score as well as other background and schooling experience. The 12th grade reading score is not available in ELS:2002data. The 10th grade reading score is analyzed without controlling for the prior score.

$$Y_i = \alpha + \delta(C_i) + \gamma(Test10_i) + b_1 X_{1i} + b_q X_{qi} ..... + \varepsilon_i \qquad (5)$$

As Morgan (2001) discussed, the prior test score is a standardized test score from the 10th grade that is regarded as a value on the dependent variable from an earlier period. Ideally, a prior test score before a student enters high school (e.g. 8th grade math score) is a better parameter than the 10th grade score (while students are already in high schools) to control for pre-high school cognitive skills. The ELS:2002collected surveys from high school sophomores, and the pre-high-school information is not available. Thus, the 10th grade score is considered as a way to reduce bias from the unobserved. The full model includes X_{1i} through X_{qi}, which are variables of student demographics, family background, parental education expectation, parental involvement and network, student's schooling experience, and school characteristics (listed on Table 3 for the Catholic school study and Table 14 for the magnet school study).

Heterogeneity of the Catholic school effect

The OLS estimates with the matched sample from the previous section cannot demonstrate the heterogeneity in a causal effect of Catholic schooling, as found in previous research. They are the average effect for Catholic schooling. The estimation of the heterogeneity of Catholic school effect is to examine whether Catholic school effects differ for students with a different propensity for attending Catholic schools. To answer this question, I then fit a fixed-effect model (Allison 2005) to estimate the overall within-strata effect.

$$Y_{is} = \alpha_s + \beta(C_{is}) + \gamma(Test10_i) + b_1 X_{1i} + b_q X_{qi} + \kappa Z_i + \varepsilon_{is} \qquad (6),$$

where Y_{is} is the predicted score of student *i* in stratum *s*; κ is the estimate for stratum-invariant parameter Z for student *i* (Z is dummy variable for each stratum); and β is the point estimate for student *i*'s Catholic schooling status in strata *s*, C_{is}.

This model allows us to investigate whether Catholic school students benefit from Catholic schooling in general, given similar propensity for Catholic school enrollment. Additionally, I would like to specify which strata of students are more or less likely to be affected by Catholic schooling. I constrain my match sample by strata, and compare the Catholic school effect within and across strata.

Propensity score estimation with state and school district fixed effect

I use match sample with the state fixed effect modeling to examine whether there is a Catholic school effect within the state. To estimate the within-district Catholic school effect, I then use my district match sample, which only contains a match sample of districts that have both Catholic and public schools, to fit a school-district fixed-effect model. The models are the same as model (6), except that Z will be replaced by dummy variables representing each state and school district. For the analysis of the magnet school district fixed effect, I use a magnet analytical sample due to that fact that most magnet schools are intra-district choices.

Analysis of mechanisms of the Catholic school effect within districts

OLS analysis on district characteristics

The first analysis to explain the Catholic school effect dwells in understanding whether school district matters by using within-district match samples. If there is a causal effect of Catholic schooling within school districts, I examine the mechanisms through which district characteristics are associated with Catholic school attendance. I regress various district characteristics on the propensity of Catholic school attendance with the district match sample.

$$Y_d = \alpha \ + b_1 S_1 + ... + b_5 S_5 + \varepsilon_d \qquad (7),$$

Where Y_d is the mean estimate for district characteristic *d*, and *b* is the point estimate for stratum *S*. The residual ε_d is assumed to be normally and independently distributed.

In addition, given the fact that the admission to Catholic schools is not constrained by school district boundaries, many Catholic school students may select Catholic schools outside of the public school district boundaries that are originally assigned to their residence. If there is a within-district Catholic school effect, it is important to understand why some Catholic school students cross school district boundaries for their education. Therefore, I compare characteristics of sending and destination school districts for Catholic school students who cross school district boundaries.

To implement this analysis, I first locate sending school districts for each student record based on the student's residential zipcode. The school districts in ELS:2002data are students' destination districts, which may be different for some students who do not attend their assigned public schools. To locate students' sending school districts, I use geographical correspondence (geocorr) 2000 Census file[6] to link districts to zipcodes. The school district and zipcode boundaries do not completely overlap. In order to locate school districts to most zipcodes, I match school districts and zipcodes in the order of the proportion of zipcodes covered by school district boundaries. In other words, not only the zipcodes that are completely covered by school district boundaries are included, but I also keep those with more than 50% covered by district boundaries. I was able to locate approximately 96% of zipcodes within school districts. After defining sending and destination school districts, I compare the differences in the means of the two groups of district characteristics to examine possible reasons why students choose to cross school district boundaries to attend Catholic schools.

To sum up, this chapter portrays the measures that are used by previous studies and new measures at the policy level specific to this study. The new measures about school choice policy and students' mobility across school district provide information for the potential policy effect as well as the selection pattern of Catholic school students. Also, an analytical plan consisting of four approaches is discussed. From propensity score matching to OLS and fixed effect modeling, this chapter discusses the estimation of the average treatment effect for Catholic/magnet students and the effect at propensity stratum and the policy level. In addition, while a causal effect is found, HLM and OLS modeling are used to explore the mechanisms through which school of choice affects students'

[6] The file can be downloaded from The Missouri Census Data Center (http://mcdc2.missouri.edu/websas/geocorr2k.html).

academic achievement. The next chapter will report the empirical results achieved from the analytical approaches proposed here.

Chapter 4

EMPIRICAL RESULTS 1: CATHOLIC SCHOOL EFFECT

Introduction

This chapter presents the analysis results of the effect of Catholic school on 12th graders' academic achievement. The first section discusses the differences in the characteristics of students, schools, and school districts between Catholic and public school students. Following this section is the match samples from the use of propensity score matching method. After obtaining match samples, the third section reports the results of estimating the causal effect of Catholic schools on students' academic achievement. The fourth section further shows the Catholic school effect at the policy level, and the fifth section indicates why district-level analysis should not be ignored. In the end, the final section summarizes the findings.

Description of Variables

There are 66 variables used for this study. Except for the Catholic school participation and prior test score, the major sets of control covariates include 25, 7, 6, 10, and 10 variables for student demographics and family background, parental influence on students' education, students' school experience, school characteristics, and school district features, respectively. Imputed values are used in the Table 2. The un-imputed variables with missing values are presented in A1 in the Appendix. Table 2 describes the means and standard deviations of these variables from the full analytical sample. In addition, it also presents the differences in means of these variables between Catholic and public school students.

Table 2. Descriptive Statistics for the Full Catholic School Study Sample before Matching

Variables	Overall Mean	Overall SD	Catholic Mean	Public Mean	Difference
Outcome variable: 12th-grade math score	49.18	15.23	55.31	47.75	**
Previous academic performance					
10th-grade math score	43.97	14.00	48.70	42.87	**
Catholic school participation	0.06	0.01	-	-	-
Demographics & family background					
White	0.58	0.01	0.75	0.58	**
Asian	0.04	0.00	0.03	0.04	
Black	0.15	0.00	0.07	0.16	**
Hispanic	0.16	0.00	0.12	0.17	**
Other race	0.05	0.23	0.03	0.06	
Male	0.50	0.01	0.52	0.49	
Female	0.50	0.01	0.47	0.50	
Age	18.35	0.54	18.31	18.36	**
Immigrant	0.24	0.01	0.20	0.33	**
English as native language	0.81	0.39	0.92	0.78	**
Number of siblings	2.30	1.56	2.00	2.37	**
Two parents	0.60	0.01	0.76	0.58	**
Step parent	0.14	0.00	0.08	0.15	**
Single parent	0.21	0.01	0.15	0.22	**
No parent	0.04	0.00	0.02	0.04	**
Socioeconomic status	0.04	0.01	0.46	-0.03	**
Mother does not work	0.24	0.01	0.20	0.24	
Mother works part time	0.19	0.00	0.22	0.18	**
Mother work full time	0.58	0.01	0.58	0.53	+
Catholic affiliation	0.41	0.21	0.80	0.33	**
Northeast	0.20	0.02	0.27	0.18	**
Midwest	0.25	0.03	0.35	0.23	**
South	0.31	0.04	0.24	0.32	**
West	0.22	0.41	0.13	0.24	+
Neighborhood segregation	0.57	0.24	0.60	0.56	
Neighborhood crime: low	0.73	0.02	0.78	0.73	
Neighborhood crime: moderate	0.09	0.05	0.09	0.09	
Neighborhood crime: high	0.02	0.04	0.01	0.02	

Table 2. (continued)

Variables	Overall Mean	Overall SD	Catholic Mean	Public Mean	Difference
# public schools within 6 miles	8.09	9.43	10.12	7.62	**
With Public aid for Catholic schooling	0.21	0.41	0.28	0.19	
Poverty rate	12.27	9.00	9.77	12.85	**
Parental education expectation					
Less than high school	0.01	0.00	0.00	0.01	+
High school	0.07	0.00	0.01	0.07	*
Less than college	0.16	0.01	0.06	0.17	**
College	0.43	0.00	0.51	0.42	**
Graduate school	0.33	0.01	0.41	0.33	**
Parental involvement	-0.01	0.00	0.14	-0.01	**
Parental network	-0.02	0.00	0.21	-0.03	**
Schooling experience					
Ever repeated grade	0.08	0.26	0.05	0.08	**
Attend general program	0.33	0.47	0.20	0.36	**
Attend vocational program	0.10	0.30	0.03	0.12	**
Number of science courses taken	3.10	0.01	4.00	3.03	**
Number of math courses taken	3.21	0.03	4.51	3.13	**
Cross school district	0.24	0.43	0.46	0.15	**
School characteristics					
Urban	0.38	0.49	0.59	0.33	**
School offers vocational program	0.77	0.42	0.30	0.88	**
School mean score	37.82	6.31	42.77	36.66	**
School climate	0.23	0.01	0.40	0.22	**
% out-of-field teaching	4.38	16.21	4.43	4.37	
% in LEP program	4.86	12.01	0.99	5.77	**
% receive free-reduced lunch	26.32	22.00	14.29	29.13	**
% living in linguistic isolated Neighborhood	21.03	19.32	18.93	21.52	
% school minority	37.38	31.25	21.97	40.98	**
% certified teachers	93.55	15.33	82.39	96.15	**
School district characteristics					
% in academic program	82.57	23.46	84.10	82.22	
% in dropout remedial program	27.32	23.21	31.13	26.43	*
% in drug prevention program	49.41	32.16	68.30	44.99	**
% receive free-reduced lunch	26.32	19.12	18.40	28.17	**
% living in linguistic isolated neighborhood	21.03	16.90	19.74	21.33	
% school minority	37.38	29.17	28.48	39.46	**
School district mean score	37.82	5.72	41.75	36.90	**
% out-of-field teaching	4.38	14.39	4.42	4.37	
% certified teachers	93.55	13.16	84.70	95.61	**
% in vocational program	49.67	27.81	48.47	49.95	
SES	0.06	0.39	0.36	-0.01	**

Table 2. (continued)

Variables	Overall Mean	Overall SD	Catholic Mean	Public Mean	Difference
Poverty rate	12.27	6.85	11.29	13.31	*
Percent dropout	6.89	8.91	5.82	7.14	*
% White	61.69	26.91	59.29	62.23	+
% Black	18.62	19.63	23.80	17.45	*
% Limited English Proficiency	25.10	62.16	59.31	17.42	**
N	**9,240**		**1,750**	**7,490**	

** $p<0.01$, * $p<0.05$, + $p<0.1$

Note:

1. Reference categories for race, family composition, mother working status, urbanicity, region, neighborhood crime, and school program attended are White, 2-parent family, mother has full-time work, suburban, south, low neighborhood crime, and college preparatory program.
2. The sample is weighted with first follow-up weight (*f1qwt*) and takes into account sampling design that students are nested within schools.
3. Interaction terms are not listed in the table.
4. From five imputed datasets.
5. According to the regulation of the use of NCES restricted data, all information related to sample size has to be rounded to 10 digits. This rule applies to the content, tables, and figures through the whole document.

Differences between Catholic and public school students

The findings in Table 1 show that students attending Catholic and public schools are different in terms of their mathematic performance, demographics and family background schools, and school district characteristics. I use the t-test to compare the means between Catholic and public school students. On average, students from Catholic schools outperform their public school counterparts in both 10^{th} - and 12^{th} -grade mathematics tests. Demographically, students in Catholic schools are less likely to be Black and Hispanic. Black students are more likely to attend public schools than Catholic schools. About 33% of public school students are immigrants, while only 20% of students are immigrants in Catholic schools. This might be the reason why Catholic schools have a higher proportion of students who speak English as a native language than public schools do. The difference is about 14%. Therefore, students of public schools are more diverse than those in Catholic schools. About 25% of Catholic school students are from a non-White minority, while there are about 42% non-White minority students in public schools.

Students in these two school types also differ in family structure. Public school students are more likely to grow up in stepparent, single parent, and no-parent families. They also tend to have a greater number of siblings than Catholic school students. In addition, families that send their children to Catholic schools are richer and more highly educated. This might explain why mothers of Catholic school students have a higher proportion of working part-time than those in public schools, since they might not need to share the role as family breadwinner and are more capable of being involved in their children's schooling. The difference in socioeconomic status also explains the difference in neighborhood poverty rate and percent of schools receiving free-reduced lunch subsidy. In general, students from public schools live in poorer neighborhoods, and Catholic schools have a lower proportion of students in free-reduced lunch programs. Unlike public education, Catholic schooling is not free for every student. Even scholarships are often available for students who choose Catholic schools; some Catholic school students still have to pay at least partial tuition while most students pay the full tuition. Hence, higher SES families are more able to afford tuition expenses.

Additionally, parents of Catholic school students tend to have higher expectations for their offspring's educational attainment. They also have a higher degree of involvement and stronger social networks to children's education.

The two groups of students have different schooling experience in all measures. On one hand, public school students are more likely to repeat a grade before 10th grade, and tend to choose vocational and general programs rather than college preparatory programs. On the other hand, Catholic school students take more science and math courses in high school. Despite these schooling experiences, Catholic school students are more capable at attending schools across school districts. About 46% of Catholic school students attend schools across districts, whereas only 15% of public school students choose opting out from their assigned neighborhood schools. However, the average number of public schools surrounding residences within 6 mile radius is higher for Catholic school students than public school students. Students in Catholic schools are involved more in academic activities than their public school counterparts. Therefore, the high mobility across school districts for Catholic school students indicates their strong willingness to seek quality schools.

Catholic and public schools are different in providing school programs and the students participating in those programs are different. Most public schools (about 88%) provide vocational programs, while only 30% of Catholic schools have these programs. Most Catholic schools focus on academic programs, such as college preparatory courses. This partially explains why compared with public schools, students of Catholic schools have a lower proportion of attending vocational and general programs.

The school districts where Catholic schools locate are richer and less diverse. However, these districts have a higher percentage of students in dropout and drug prevention programs. It is likely to be related to the Catholic school location. Catholic schools mostly locate in urban areas (about 59%), especially in the Northeast, Catholic schools might serve as substitutive options for higher SES White parents who are faced with poor or struggling neighborhood public schools in urban areas.

In sum, the descriptive statistics show that Catholic schools do better in students' math scores and provide more academic programs. Catholic school students also tend to be take more academic programs and courses. They are also more likely to attend schools across school districts, which may require a longer time to commute than if they stayed in their neighborhood schools. Choosing between Catholic and public schools reflects fundamental differences in students' demographics and family background. Therefore, it is crucial to take into account these differences while estimating the Catholic school effect. In the following, I apply the propensity score matching method to control for selection into Catholic schools, and estimate the causal effect of Catholic schooling.

Results from Propensity Score Matching

Match Samples

The rest of my analyses rely on the matched samples from the propensity score matching method. First, I estimate propensity scores by a logistic regression model that predicts the likelihood of attending Catholic schools. The regression model only includes measures that are supposed to affect the attendance of Catholic schools and not a result of it. Thus, students' school experiences, parental education expectation, and school characteristics are not in the model. There are a total of 27 variables and 32 interaction variables used in the matching model. See Table A2 in Appendix presents the results of the logistic regression model predicting Catholic school participation. In addition to previous mathematics score, features of students' demographics and family background, neighborhood variables, students' school experience, and a series of interaction terms are controlled to predict the propensity score. After propensity scores are obtained, I balance my Catholic and public students on propensity scores, and stratify the sample into five propensity score strata by the quintiles of Catholic school students' propensity scores. Because I only keep the public school students whose propensity scores are closest to that of Catholic school students, and Catholic school students without a good match are also dropped from my sample. The sample size shrinks after I drop poorly matched cases.

Figures 1 and 2 demonstrate the match sample before and after dropping observations for full match and district match samples. After trimming, the relative number of public school students who are matched to Catholic school students increases. However, it is difficult to have many public school students who have a high propensity of attending Catholic schools. The number of public school students in the right tail of the figures is very few and hard to visually observe. In addition, many Catholic school students who have the highest propensity scores are dropped from the sample due to a poor match.

Figure 1. The Distribution of Propensity Scores for Catholic School Students (Treated) and Matched Public School Students (Untreated): The Comparison between before and after Sample Trimming, *Main Match Sample*

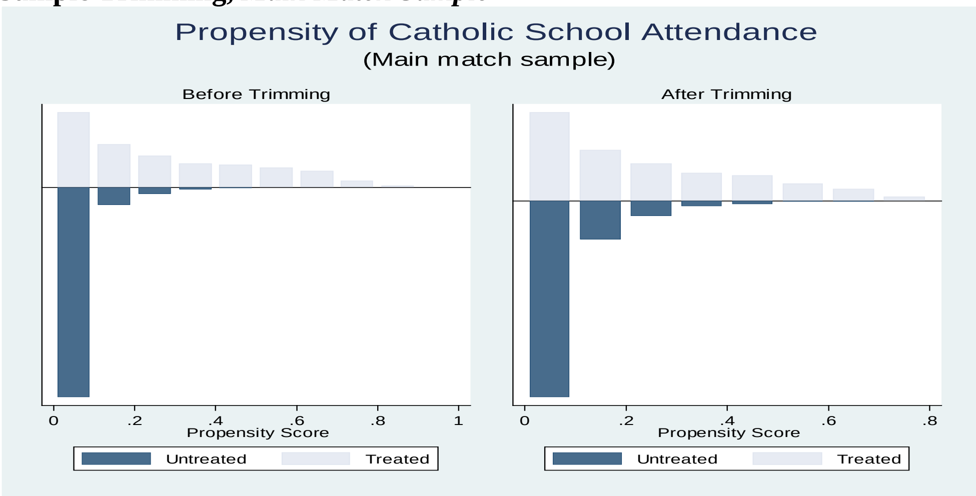
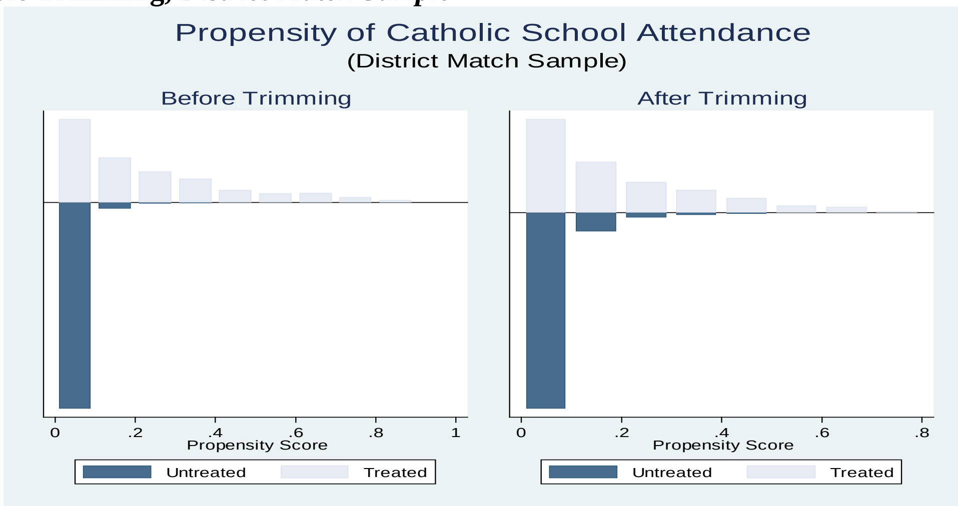


Figure 2. The Distribution of Propensity Scores for Catholic School Students (Treated) and Matched Public School Students (Untreated): The Comparison between before and after Sample Trimming, *District Match Sample*



To further examine the balance of propensity scores, Tables 3 and 4 present the summary statistics of propensity score by five strata. The sample sizes of the main match sample and district match sample have dropped from around 9,240 to 5,430 and to 1,650 students, respectively. The main match sample has about 540 schools and about 440 school districts, and the district match sample has about 450 schools and 380 school districts. The mean and standard deviation within each stratum are approximately the same for Catholic (treatment) and public (control) school students. This suggests that the Catholic-versus-public matches achieved an adequate balance. Students in the same strata are alike in terms of the covariates (e.g. student demographics, family background, and interaction terms) controlled in the matching models. Students in the higher strata (3, 4, 5) are more likely to attend Catholic schools, and vice versa. The sample sizes across strata show that the proportion of public school students in each stratum decreases in higher propensity strata, where there are higher proportions of Catholic students.

Table 3. Summary Statistics of Propensity Score by Strata, Main Match Sample

	Catholic			Public		
	Mean	**Std**	**N**	**Mean**	**Std**	**N**
Stratum1	0.025	0.015	330	0.021	0.014	2130
Stratum2	0.090	0.023	380	0.086	0.023	950
Stratum3	0.185	0.031	340	0.181	0.031	410
Stratum4	0.332	0.053	340	0.314	0.051	200
Stratum5	0.532	0.081	270	0.511	0.080	80

Note: The number of observation is the average of 5 imputed data. The matched sample size is 5,430 students, including 1,660 Catholic school students and 3,770 public school students.

Table 4. Summary Statistics of Propensity Score by Strata, District Match Sample

	Catholic			Public		
	Mean	**Std**	**N**	**Mean**	**Std**	**N**
Stratum1	0.017	0.010	70	0.010	0.010	750
Stratum2	0.063	0.017	100	0.058	0.016	170
Stratum3	0.138	0.028	100	0.132	0.028	70
Stratum4	0.262	0.044	120	0.233	0.037	40
Stratum5	0.520	0.114	220	0.485	0.132	10

Note: The number of observations is the average of 5 imputed data. The matched sample size is 1,650 students, including 610 Catholic school students and 1,040 public school students.

The matched main and district samples only select students who are similar based on their propensity scores. Tables 3 and 4 do not tell us whether or not Catholic school students benefit in academic performance by attending Catholic schools (average treatment effect for the treated, ATT). I further use OLS regression models and fixed-effect modeling (FE) to estimate ATTs for each sample.

OLS and FE Estimates with Main Match Sample

To draw conclusion of the causal effect of Catholic schools, this study employs OLS models to obtain the average Catholic school effect for Catholic school students.

Also, a series of propensity score strata fixed-effect modeling is then conducted to estimate the effect within strata to detect the heterogeneity of the Catholic school effect.

Does attending Catholic schools causally affect students' academic achievement?

The major research question of this study is "whether or not there is any causal effect from Catholic/magnet schools for those who attend Catholic/magnet schools?" The results in Table 5 present OLS estimates from models 1 and 2, which predict the average Catholic school effect for Catholic school students. Without any control, model 1 reports the main effect of Catholic schools on 12^{th} graders' mathematic IRT scores. The Catholic school effect is very strong with a coefficient of 4.72 and a relatively small standard error. The coefficient is significant at 0.05 level (t=5.304).

However, this model is not the definitive proof of the net effect of Catholic schooling. Next I control for confounding factors that account for variations in mathematics achievement. Model 2 estimates the net effect by taking into account the 10^{th} grade mathematic score, student demographics, family background, students' school experience, and school characteristics[7]. The full model (model 2) shows a significantly positive Catholic school effect. The effect size drops about 75% from model 1. After adjusting for other confounders, Catholic school students still have significant gain mathematics test scores from enrolling in Catholic schools. Given the positive effect, my next question is whether certain groups of students gain more from Catholic schooling than others.

[7] The decision about which control variables to be included follows Morgan (2001).

Table 5. Catholic School Effect on Mathematics Achievement for 12th -Graders

Models	Catholic school effect	StdE	t	N
1: Main effect (without covariates)	4.720	0.890	5.304	5,430
2: Full model: (1)+ 10th-grade score + demographics + background	1.222	0.515	2.372	5,430
3: Strata fixed effect	1.113	0.528	2.109	5,430
4: Stratum 1: 1st quintile (lowest)	1.312	0.632	2.074	2,460
5: Stratum 2: 2nd quintile	1.335	0.708	1.886	1,330
6: Stratum 3: 3rd quintile	0.564	0.796	0.709	750
7: Stratum 4: 4th quintile	1.940	0.943	2.057	540
8: Stratum 5: 5th quintile (highest)	-0.017	0.958	-0.017	350
9: 1st – 3rd quintiles, combined	1.259	0.622	2.025	4,540
10: 4th – 5th quintiles, combined	0.974	0.669	1.456	890
11: 1st – 2nd quintiles, combined	1.282	0.547	2.344	3,790
12: 3rd – 5th quintiles, combined	1.181	0.675	1.75	1,640

Note:

1. The number of observations is the average of observations per model from 5 imputed data. The match sample size is about 5,430 students, including about 1,660 Catholic school students and about 3,770 public school students.
2. Design effect is controlled by taking into account school clusters and a probability weighting scheme (using first follow-up student weight *f1qwt*), as well as estimating a robust standard error.
3. Sample sizes are all rounded to the nearest 10.
4. Estimates are from five imputed datasets.

Is there heterogeneity of the Catholic school effect?

The rest of the models 3-12 in Table 5 present the analyses that reveal heterogeneity of the Catholic school effect. Model 3 estimates the overall effect within propensity score strata. In general, the average strata fixed effect model shows significant Catholic school effect. This means that for students with similar propensity of attending Catholic schools, Catholic school students gain more from their schools. The within-stratum analyses (models 4-8) also show significant Catholic school effect in strata 1, 2, and 4. Catholic school students in the 1st and 4th propensity stratum gain 1.312 and 1.940 respectively in mathematics test scores from their schooling with t statistics= 2.074 and

2.057, respectively. Students in the 2nd propensity stratum also benefit from Catholic schooling, although the effect is marginal (t=1.886).

When I aggregate students into two groups - lower propensity (1^{st} -3^{rd} quintiles) and higher propensity (4^{th} – 5^{th} quintiles), similar results to Morgan's (2001) study are found. The students who are less likely to attend Catholic schools benefit more from Catholic schooling than those with a higher propensity of attending Catholic schools, although the effect is marginally significant. Since model 4 presents Catholic school effects within this strata, I then further separate my sample into two groups – students in the 1^{st} and 2^{nd} quintile of propensity as lower propensity group, and 3^{rd} to 5^{th} quintile as higher propensity group, and re-estimate the models. The results distinctly confirm the heterogeneity of the Catholic effect by low and high propensity of Catholic school attendance. The Catholic school effect for students in the lowest two propensity quintiles (strata 1-2) is significantly positive at 0.05 level (t=2.344), whereas this is not the case for students who are more likely (have high propensity score in strata 3-5) to be in Catholic schools.

Explanations for heterogeneity of the Catholic school effect

The previous findings raise the question of what accounts for the heterogeneity of the Catholic school effect. Given that the Catholic school effect is positive for students with low propensity of Catholic schooling, I then examine what student characteristics account for such differences. I compare the means of mathematics test scores and students' demographics and backgrounds between Catholic and public school students, by low and high propensity strata. The results in Table 6 report not much difference in students' background characteristics between Catholic and public school students who have higher propensity (strata 3-5) of Catholic schooling. Nonetheless, within the low propensity strata (strata 1-2), Catholic school students have higher math scores in both 10^{th} and 12^{th} grades. The difference in mean scores seems to be larger in 12^{th} grade than in 10^{th} grade (difference is 3.3 for 12^{th} graders, and is 2.0 for 10^{th} graders), but the gap does not significantly increased from 10^{th} to 12^{th}.

Table 6. Means of Student Characteristics for Catholic and Public Students, by Propensity of Attending Catholic Schools

	strata1-2 (lower propensity)			**Strata3-5 (higher propensity)**		
Variable	Catholic	Public	Difference	Catholic	Public	Difference
12^{th}-grade math score	52.73	49.48	**	57.27	55.81	**
10^{th}-grade math score	46.54	44.49	+	50.40	50.07	
Demographics and Background						
White	0.65	0.60	*	0.81	0.80	
Black	0.12	0.16	+	0.02	0.02	
Asian	0.04	0.05		0.03	0.03	
Hispanics	0.13	0.14		0.09	0.10	
Other race	0.05	0.05		0.04	0.04	
Male	0.49	0.50		0.54	0.52	
Age	18.31	18.33		18.31	18.24	
Immigrant	0.23	0.23		0.15	0.16	
English as native Language	0.89	0.88		0.97	0.96	
Number of siblings	2.11	2.13		1.84	1.92	
Catholic affiliation	0.52	0.39	**	0.98	0.95	*
Northeast	0.22	0.20		0.33	0.35	
Midwest	0.30	0.26		0.29	0.28	
South	0.26	0.30	*	0.23	0.21	
West	0.21	0.21		0.14	0.16	
Urban	0.36	0.39		0.66	0.50	**
Suburban	0.64	0.61		0.34	0.50	**
SES	0.29	0.16	**	0.59	0.57	
Two-parent family	0.67	0.62	+	0.81	0.80	
Step-parent family	0.13	0.13		0.05	0.06	
Single-parent family	0.18	0.21		0.12	0.12	
No-parent family	0.03	0.03		0.01	0.02	

Mother doesn't work	0.19	0.22		0.23	0.22
Mother works part time	0.19	0.18		0.27	0.27
Mother works full time	0.62	0.60		0.50	0.51
Ever repeated grade	0.04	0.07	**	0.04	0.04
Public aid for Catholic schooling	0.23	0.22		0.28	0.27

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

Note:

1. The match sample constitutes about 710 Catholic and 3,080 public students in strata 1-2, and 950 Catholic and 690 public students in strata 3-5. The sample is weighted by first-follow-up student weight (*f1qwt*).
2. The mean estimates are rounded.

In addition, students with low propensity of Catholic schooling differ in some background characteristics. Among students with lower propensity score, Catholic school students, on average, are from higher SES and two-parent families. They are also more likely to be Catholic than their public school counterparts and less likely to repeat a grade. Within higher propensity strata, where students are more likely to attend Catholic schools, there are more Catholic school students attending schools located in urban areas (about 66%), while public school students equally enroll in urban (about 50%) and suburban (about 50%) schools. This might be due to the fact that a large proportion of Catholic schools locate in urban cities.

Is there any racial/ethnic differential in the Catholic school effect?

Within the two propensity groups (lower versus higher) in Table 6, except Whites in the lower propensity group, I do not find significant differences for each race/ethnic group in means of school attendance between Catholic and public school students. There may be Catholic school effect within each race/ethnic group in the full model and the effect may differ across propensity score for each group.

I then estimate the Catholic school effect by race/ethnicity. I do not have sufficient observations for Asian and other-race students in my match sample, so I exclude Asian and other-race students from this analysis. After all, the descriptive statistics from the full main sample in Table 1 show that these two groups do not differ by their participation in Catholic and public schools. The results are presented in Table 7.

Table 7. Catholic School Effect on Mathematics Achievement for 12th –Grade Catholic School Students, by Race/Ethnicity

	Catholic school effect	**StdE**	**t**	**N**
White Students				
1: Main effect (without covariates)	3.451	0.851	4.057	3,110
2: Full model	1.227	0.564	2.174	3,110
3: Strata fixed effect	1.147	0.576	1.99	3,110
4: 1st – 2nd quintiles (lower propensity)	1.711	0.835	2.049	1,000
5: 3rd – 5th quintiles (higher propensity)	0.979	0.601	1.629	2,110
Black Students				
6: Main effect (without covariates)	4.285	1.528	2.804	640
7: Full model	0.822	0.743	1.106	640
8: Strata fixed effect	0.810	0.742	1.092	640
	-0.496	1.334	-	
9: 1st – 2nd quintiles			0.372	200
10: 3rd – 5th quintiles	0.946	0.825	1.146	440
Hispanic Students				
11: Main effect (without covariates)	7.927	1.209	6.555	850
12: Full model	2.416	0.797	3.03	850
13: Strata fixed effect	2.069	0.803	2.576	850
14: 1st – 2nd quintiles	2.325	1.237	1.879	600
15: 3rd – 5th quintiles	2.163	0.856	2.525	250

Note:

1. The number of observations is the average of observations per model from 5 imputed data by race/ethnicity.
2. Match sample for each race/ethnicity is obtained through matching among each race/ethnicity.

3. Design effect is controlled by taking into account school clusters and probability weighting schemes (using first follow-up student weight *f1qwt*), as well as estimating a robust standard error.
4. A full model on the sample without matching is used to estimate Catholic school effect among Black students. The result is not shown on this table. The point estimate is 0.948 with standard deviation = 0.735, t statistics=1.289.
5. The average treatment effects for Catholic students of other races/ethnicities are not estimated due to insufficient observations in higher propensity strata.

Without controlling for covariates, the main effect in model 1 in Table 7 shows statistically significant and positive Catholic school effect for Whites. The full model (mode 2) reports that on average, White students gain in mathematics scores significantly from Catholic schooling after controlling for relevant covariates. The strata fixed effect model (model 3) also presents statistically significant effect of Catholic schooling for White students. For those who are in low propensity strata benefit from Catholic schooling with a significant 1.711 gain in mathematics scores (t=2.049). However, for While students in lower propensity strata, Catholic schooling is not significantly beneficial.

For Black students, Catholic schooling does not matter in their mathematics scores. On the contrary, attending Catholic schools on average benefits Hispanic students with significant test score gain (2.069) in mathematics (t=3.03). Catholic school effects for Hispanic students are positive after taking into account strata. In stratum classified by high and low propensity, Hispanic students differ in math scores by attending Catholic schools. Hispanic students who are less likely to attend Catholic schools gain from Catholic schooling marginally, while those with higher propensity benefit significantly from such schooling with 2.163 score gains. The result of heterogeneity effects for

Hispanic students are different from Whites. Further analysis on Hispanic students can help explain such differences.

The differential effects from models 13-15 is a puzzle about the heterogeneity effect. Some statistical considerations have to be addressed here about the differences in the two modeling. The strata fixed effects model (model 13) shows within-strata averages while holding constant between-strata differences. The models of each of the two strata groups (models 14 and 15) show the averages without adjusting for strata differences. The fixed effects model provides a better way to control for heterogeneity within strata, but embraces more restrictive specification than the within-strata modeling.

Estimating Catholic School Effect at the Policy Level

One weakness of prior research on school effect is the lack of analysis at the policy level. However, school choice is a very policy-driven educational issue. Thus, to fill the literature gap, this study proposes two approaches to estimate the school effect at the policy level. The first approach is to measure the school effect within the policy units of the state and school district. When the variation between policy units is held, students of Catholic and public schools are compared within the same school district or state. Therefore, there is less noise about whether differences in state or school district characteristics (i.e. school choice policies) may have contributed to differences in academic achievement between Catholic and public school students.

The second approach is to evaluate school effect based on the idea of policy intervention. By comparing the effect differences between students who are eligible or not to exercise school choice, we will have a clearer understanding about whether such policy intervention matters in improving students' academic achievement. The rest of this section first demonstrates the results from analyzing the school choice effect at the state and school district level, followed by the discussion of the effect related to school choice policy.

Do Catholic schools causally affect students' achievement within states?

A series of state fixed effects models is used to estimate the effect on students' mathematics score within states. Table 8 reports the state-level analysis. Within states, there is a significant average Catholic school effect (t=2.153). For Black students, attending Catholic schools does not make any difference in their mathematics achievement within the same state. However, Catholic schooling is beneficial to both White and Hispanic Catholic school students. Within state, White Catholic school students outperform public school students with about a 1.241 score gain in mathematics (t=2.043), while Hispanic Catholic school students gain even more (with 2.227 score points; t statistics = 2.553). In general, within state, Catholic school effects vary across race/ethnicity.

Table 8. Catholic School Effect on Mathematics Achievement for 12th Graders within States

	Catholic school effect	StdE	t	N
1: State fixed effect	1.211	0.562	2.153	5,340
2: State fixed effect on White sample	1.241	0.607	2.043	3,100
3: State fixed effect on Black sample	0.820	0.793	1.033	620
4: State fixed effect on Hispanic sample	2.227	0.872	2.553	890

Note:

1. The estimation for state fixed effect is based on the full matched sample.
2. Design effect is controlled by taking into account school clusters and probability weighting schemes (using first follow-up student weight *f1qwt*), as well as estimating a robust standard error.
3. The analysis for the other race/ethnicity groups is not available due to insufficient observations in higher propensity strata.
4. From five imputed datasets.

This raises a question why the Catholic school effect varies across race/ethnicity within the same state, even though they are under similar policy influence. There are two possible explanations for this phenomenon: (1) There are racial/ethnic differences in some features, such as demographics and schooling experience, that are associated with Catholic schooling; and (2) policy effect does not occur at the state level but at the lower level such as the school district. To explore the first explanation, I analyze the racial/ethnic differences for Catholic school students. From Tables 2 and 6, based on the fact that there are differences in student backgrounds and schooling experiences between Catholic and public school students, these variables are selected for the analysis. I do not include general or vocational programs a student attends because most Catholic school students are in college preparatory programs - about 59% Whites, 33% Blacks, and 43% Hispanics attending Catholic schools.

Table 9 shows that Whites are more affluent than Blacks and Hispanics in Catholic schools, whereas Blacks do not differ from Hispanics much. A large proportion of Hispanics Catholic school students are Catholics (about 90%) and immigrants (51%), while most Whites are Catholic (84%) and non-immigrants. Blacks who attend Catholic schools are less likely to be Catholic (34%), and among them 22% are immigrants. Hispanic Catholic school students tend to have a higher proportion experiencing grade retention. This might be due to their immigration status and limited language proficiency in the earlier schooling. However, Hispanic students tend to make as much effort in academic activities as Whites, and more effort than Blacks. They take a similar number of math and science courses as most native Whites do, which are more than native Blacks. This may be due to the fact that they are more likely to repeat a grade. This analysis shows some significant differences in background characteristics and schooling experiences among White, Black, and Hispanic Catholic school students.

Table 9. Differences in Means for Catholic School Student Characteristics, by Race/Ethnicity

				Difference		
Variables	White	Black	Hispanics	WB	BH	HW
SES	0.53	0.18	0.27	**	+	**
Catholic affiliation	0.84	0.34	0.90	**	**	*
Immigrant	0.08	0.22	0.51	**	**	**
Number of siblings	1.93	2.31	2.03	*	*	
Ever repeated grade	0.04	0.05	0.07	+	*	*
Number of science courses	4.08	2.09	4.40	**	**	
Number of math courses	4.79	1.98	4.69	**	**	
N	1,200	170	290			

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

Note:

1. Design effect is controlled by taking into account school clusters and probability weighting schemes (using first follow-up student weight *f1qwt*), as well as estimating a robust standard error.
2. WB: White versus Black; BH: Black versus Hispanic; HW: Hispanic versus White
3. Only the variables that show racial/ethnic differences are reported in the table.
4. From five imputed data.

The differentials in Catholic school students' characteristics across race/ethnicity may explain the racial/ethnic differences in Catholic school effect after adjusting for states. Catholic schooling is beneficial for Hispanic students within states, whereas the effect is not statistically significant for Blacks and Whites. Hispanics' being immigrants and ever repeated grade account for the effect differences. Among Whites, SES may not play an important role in selecting Catholic schools, while SES may significantly affect Hispanics' decision on attending Catholic schools. There are differences in backgrounds and schooling experiences between White and Black Catholic schooling. However, they do not differ in terms of achievement gain from Catholic schooling within state. It is difficult to explain the differential patterns here. It is possible that Catholic schooling is more important for Hispanic immigrants than native students. Further analysis is needed to explain the puzzle.

Catholic school effect within school districts

To what extent should the Catholic school effect be considered at the school district level? To answer this question, I estimate the causal effect of Catholic schools by using a district match sample in which school districts have both Catholic and public schools. The district match sample is from matching within each school district. Therefore, the effect of districts on school selection is considered constant within districts.

An OLS model is used to measure the main effect of Catholic schooling on mathematics achievement. Model 1 in Table 10 reports that from the district match sample, Catholic school students are not superior in mathematics (t=1.485). To estimate the average effect within school districts, I fit a school-district fixed-effect model as model 2. It suggests no significant average effects within school district either (t=1.597).

I further divide the sample by low and high propensity stratum of Catholic school attendance. There exists the within-district Catholic school effect in the lower propensity strata (combined 1st and 2nd quintiles), with about 1.449 gain in mathematics score at a t value of 2.181 (about $p<0.01$). This means that, among students with similar propensity scores in the same school district, Catholic school students perform better than their public school counterparts.

Table 10. Catholic School Effect on Mathematics Achievement for 12th Graders within School Districts

	Catholic school effect	StdE	t	N
1: Full model	0.818	0.551	1.485	1,620
2: School district fixed effect	1.024	0.641	1.597	1,570
3: 1st – 2nd quintiles (low propensity)	1.449	0.664	2.181	1,190
4: 3rd – 5th quintiles (high propensity)	-0.376	1.681	-0.223	380
5a: With public aid for Catholic schooling	2.074	1.114	1.862	400
5b: Without public aid for Catholic schooling	0.445	0.793	0.561	1,180
6a: Strata 1-2, with aid	2.230	1.119	1.993	270
6b: Strata 1-2, without aid	1.036	0.771	1.344	920

Note:
1. The estimation for the state fixed effect is based on the full matched sample, not within-district sample. The rest of analyses for school districts are based on the within-district match sample.
2. The number of observations is the average of 5 imputed data. The match sample includes 1,620 students, including 570 Catholic school students and 1,060 public school students.
3. Design effect is controlled by taking into account school clusters and the probability weighting scheme (using first follow-up student weight f1qwt), as well as estimating a robust standard error.
4.The analysis for the other race/ethnicity groups is not available due to insufficient observations in higher propensity strata.

To analyze the effect of specific school choice that is related to Catholic schooling, I then include a variable of public aid for private schooling. I separate the district match sample into two groups by whether or not Catholic school students in the school districts that receive public aid (e.g. voucher or tax credit) for their education since 2001. Models 5a and 5b in Table 10 are two school district fixed effect models for students who live in school districts where public aid is available for Catholic schooling, and models 6a and 6b are for students who live in school districts where public aid is not available.

Restricting the sample to students in school districts that have public aid, model 5a shows a significantly marginal Catholic school effect within school districts. However, among students living in school district with public aid available, model 5b presents no significant within-district Catholic school effect. Living in the areas with public aid for Catholic schooling or not tend to be an important factor affecting Catholic school students' math achievements.

Given the previous finding that Catholic schooling tend to benefit students who are least likely to enroll in such schools, I further restrict the sample to keep students with lower propensity (strata 1-2, combined) and live in school districts where public aid is available. Model 6a reveals that for students who are least likely to attend Catholic schools and in the districts that provide public aid for Catholic schooling, the Catholic school effects are statistically significant within districts. For those students, they have about a 2.230 gain in mathematics scores (t=1.993). The effect size 2.230 is even larger than that from model 3 (with a coefficient of 1.449, t=2.181), which has all low-propensity students in the sample. Besides, model 6b shows that, for Catholic school students with lower propensity strata, within the same school district, Catholic schooling does not benefit them with mathematics score gain if they are not living in the district boundaries where public aid for Catholic schooling is available. The results from models

6a and 6b suggest that receiving public aid for Catholic schooling or not is important for Catholic school students with lower propensity scores of attending Catholic schools to achieve better outcome on math tests.

Why is having public aid important for Catholic schooling? Table 11 shows how Catholic school students differ from public school students by whether or not public aid is available for Catholic schooling. These students differ in math scores and some demographic and background variables. Living in the areas with public aid available for Catholic schooling, Catholic school students have higher test scores and are more likely to be White and grow up in higher SES family than those in public schools. They also have fewer siblings, live with two parents, and are less likely to be retained in a grade. These Catholic schools largely locate in urban areas (about 84%), where public aid is available.

The differences between Catholic and public school students in districts without public aid for Catholic schooling are mostly significant. Nonetheless, the Catholic school effect for students within districts is not found for those without aid, but is significantly positive for those with aid (finding from Table 10). The findings from both Tables 10 and 11 imply that policies supporting Catholic schooling have a positive effect on Catholic school students’ learning.

The last column (Diff) in Table 11 presents the differences in the public-Catholic differences between those students in districts with and without public aid. These differences could be attributed to between-district variations in students’ test scores, demographics and background. The most noticeable difference is socioeconomic disparity between Catholic and public school students in the two areas. The difference

Table 11. Means of Student Characteristics for Catholic and Public Students, with or without Public Aid Available for Catholic Schooling

Variable	Public Aid is Available: Catholic	Public	Diff1	Public Aid is NOT Available: Catholic	Public	Diff2	Diff = Diff1-Diff2
12th-grade math score	55.35	47.29	8.04**	55.23	46.32	8.91**	0.87
10th-grade math score	48.85	42.42	4.43**	48.56	41.23	7.33**	2.90
Demographics and Background							
White	0.70	0.42	0.28**	0.67	0.36	0.31**	0.03
Black	0.10	0.27	0.17**	0.09	0.27	0.18**	0.01
Asian	0.01	0.04	0.03**	0.05	0.06	0.01	0.02
Hispanics	0.15	0.21	0.06	0.11	0.24	0.13**	0.07
Other race	0.04	0.05	0.01	0.09	0.07	0.02	0.01
Male	0.55	0.47	0.08	0.50	0.49	0.01	0.07
Age	18.31	18.38	0.07*	18.28	18.33	0.05*	0.02
Immigrant	0.20	0.35	0.15+	0.23	0.37	0.14**	0.01
English as native language	0.94	0.80	0.14**	0.93	0.75	0.18**	0.04
Number of siblings	2.03	2.57	0.54*	1.84	2.41	0.57**	0.03
Catholic affiliation	0.78	0.36	0.42**	0.78	0.34	0.44**	0.02
Northeast	0.34	0.17	0.17**	0.25	0.23	0.02	0.15
Midwest	0.32	0.49	0.17	0.07	0.11	0.04*	0.13
South	0.31	0.30	0.01	0.32	0.34	0.02	0.01
West	0.03	0.04	0.01*	0.37	0.32	0.05	0.04
Urban	0.84	0.54	0.30**	0.70	0.47	0.23**	0.07
Suburban	0.16	0.46	0.20**	0.30	0.53	0.23**	0.03
SES	0.45	0.07	0.38**	0.57	-0.07	0.64**	0.26
Two-parent family	0.71	0.54	0.16**	0.71	0.54	0.17**	0.01
Step-parent family	0.09	0.16	0.07	0.09	0.15	0.06**	0.01
Single-parent family	0.18	0.25	0.07	0.19	0.27	0.08*	0.01
No-parent family	0.03	0.05	0.02	0.02	0.04	0.02*	0.00
Mother doesn't work	0.27	0.22	0.05	0.24	0.24	0.00	0.05
Mother works part time	0.22	0.22	0.00	0.21	0.16	0.05+	0.05
Mother works full time	0.50	0.56	0.06	0.55	0.60	0.05	0.01
Ever repeated grade	0.04	0.09	0.05+	0.05	0.08	0.03*	0.02
N	170	220		380	820		

** p<0.01, * p<0.05, + p<0.1
Note: The analysis is based on within-district match sample.

in SES scale for students living in the areas without public aid for Catholic schooling is almost two times (Diff2=0.64) than that in the areas with aid (DIff1=0.38). Catholic school students with aid are from lower SES family than those without aid. Catholic school students living in the area without aid have the highest SES (SES composite scale= 0.57), while public school students are from relatively lower SES family (SES composite scale = -0.07). The finding here presents that public aid for Catholic schooling tend to provide opportunity of quality schooling for lower-SES students.

Why do school districts matter for the Catholic school effects?

The previous finding indicates that for students who are least likely to attend Catholic schools, living in the school district boundaries where public aid is available is crucial for their mathematics score gain. I further demonstrate what features of school districts are associated with students' propensity score of attending Catholic schools. By employing OLS models on 16 school district characteristics as listed on Table 2, Table 12 demonstrates the association among these variables and the propensity score of Catholic schooling. Only those variables that show statistically significant estimates are kept.

Except for students in the fourth stratum (the fourth quintile of propensity score), school district SES is associated with each propensity stratum. School district SES is a measure aggregated from student family SES. While SES is associated with selecting into Catholic schools, it is not surprising that the propensity scores are associated with district-level SES. Compared with students in the 1st stratum of propensity scores (low propensity), students in higher strata (high propensity) are more likely to be in districts with higher % of out-of-field teachers, and experience less school diversity in school racial/ethnic composition. The last column of Table 12 reports that students with higher propensity of Catholic schooling are usually in school districts that have higher school academic performance. In general, students in different propensity score strata experience differential school district characteristics. The school districts with students with higher propensity tend to show more desirable characteristics, than other districts that host more students with low propensity.

Table 12. Regress School District Characteristics on Propensity Score Strata

	District SES	%out of field teaching	%school minority	Average school math score
Propensity Score				
(ref: stratum 1)				
Stratum2	0.206**	-0.018	-0.068**	1.528**
Stratum3	0.278**	-0.028*	-0.047	2.524**
Stratum4	0.157	-0.029*	-0.080+	1.772
Stratum5	0.197*	-0.012	-0.057*	3.785*
Adjusted R^2	0.018	0.039	0.001	0.028
N	1,620	1,620	1,620	1,620

+ significant at 10%; * significant at 5%; ** significant at 1%

Note:

1. Design effect is controlled by taking into account school clusters and the probability weighting scheme (using first follow-up student weight *f1qwt*), as well as estimating a robust standard error.
2. Within-district sample.
3. From five imputed data.

Differences in Means of Sending and Receiving School District Characteristics

An issue arises regarding the district fixed effects of Catholic schooling. How relevant is the school district to Catholic schools? How often do students cross district boundaries to attend Catholic schools? In my sample, about 46% of Catholic school students versus 15% of public school students attend school districts different from their neighborhood districts. The positive Catholic school effect found within school districts triggers the need to examine factors related to Catholic school students who enroll in a school district not the one automatically assigned to them, given their home addresses. To explore why Catholic school students travel across districts. I compare school district characteristics between sending and receiving districts for Catholic school students who cross districts. Then I compare Catholic school students' scores with other students' test scores in both sending and receiving districts.

Table 13. The Comparisons between the Mean of Sending and Receiving School District Characteristics for Catholic School Students Cross School District Boundaries

Variables	Sending	Receiving	Difference
Percent dropout	5.73	5.91	+
Current per student expenditure	10919.6	10602.2	**
% Free-reduced price lunch	18.52	34.80	**
% Black students	14.54	31.30	**
% White students	65.61	47.04	**
% Limited English Proficiency	11.10	14.42	**

Note:
1. Survey design effect is controlled by taking into account the probability weighting scheme (using first follow-up student weight *f1qwt*).
2. The number of observations is about 240.
3. Within-district sample
4. From five imputed datasets.

All analyses in the following are based on the district match sample, where only districts that have both Catholic and public schools remain in the sample. For Catholic school students who attend schools across school districts, Table 13 shows that their sending and receiving school districts differ significantly for several characteristics. The six measures of school district features are extracted from the Common Core of Data. Surprisingly, the results show that the receiving districts are less affluent, in terms of lower current per student expenditure and the higher percent of free-reduced price lunch. The receiving district also has a higher percent of students in limited English proficiency. The differences in the means of those variables are all statistically significant ($p<0.05$). This suggests that students tend to leave their more desirable districts to attend Catholic schools in less desirable districts. This raises a question of why students choose to travel to less attractive districts.

A further analysis looks into this puzzle. I construct four mean mathematic scores by subtracting from the mobile students' score and the average score of the district. Two types of districts are relevant here: the sending and receiving districts of Catholic school students. The sending districts are identified by students' residential zipcodes. I overlay school district boundaries with zipcodes and then identify which school district is for students whose zipcodes are located in the school district boundary. To identify receiving districts for Catholic school students, I use school district boundaries to overlay the Catholic school locations where those students attend. Therefore, I am able to locate school districts for Catholic schools.

Two types of average scores are used: the average score for public school students and the average score for Catholic school students. I compare the mathematics achievement standing of the mobile students in the district where his/her assigned public school is located, with his/her mathematics achievement standing in the district where he/she attends Catholic schools.

Table 14 shows that Catholic school students gain in mathematic achievement by crossing school district boundaries. On average, Catholic school students who move have about 8 points higher mathematics score (with a standard deviation of about 1) than do public students who stay in the sending districts (row 1). They also perform better than Catholic school students who stay in the sending districts (row 2). The average gains from leaving public schools or leaving Catholic schools in the sending districts are about the same (8.00 versus 7.98).

Table 14. The Mean of Math Score Gain for Catholic School Students who Cross School District Boundaries (Within-District Sample)

Comparison Group	Gain	
	Mean	StD
1: (Individual score) – (Average score for public school students, send)	8.00	1.03
2: (Individual score) – (Average score for Catholic school students, send)	7.98	1.28
3: (Individual score) – (Average score for public school students, receive)	5.60	0.99
4: (Individual score) – (Average score for Catholic school students, receive)	2.98	0.67

Note:
1. Survey design effect is controlled by taking into account the probability weighting scheme (using first follow-up student weight *f1qwt*).
2. The number of Catholic school students who cross school district boundaries is about 240.
3. From five imputed datasets.

Compared with public and Catholic school students in the receiving school districts, rows 3 and 4 show that, on average, Catholic school students who move across district boundaries perform better than students in the receiving districts. However, the differences are not as large as those in sending districts. These movers outperform their public school students in the receiving districts by 5.60 points with a standard deviation equal to 0.99. They also achieve higher mathematics scores than Catholic school students in the receiving districts, although the gain is smaller (about a 2.98 score gain). This implies that Catholic school students become more alike, in terms of mathematic achievement, in receiving districts.

Summary

This chapter estimates Catholic school effects on 12th graders' mathematics achievement by taking various analytical approaches. The propensity score matching (PSM) method facilitates drawing a causal inference from each analysis. Based on matched samples, this study uses mean comparisons, OLS, and fixed-effect modeling to evaluate the causal effect of Catholic schools at the individual and policy level.

Catholic and public school students are different in achievement, backgrounds, and their schooling experience. Their school and school districts also vary. Ruling out selection bias by PSM, the Catholic school effect is not statistically significant for the full sample. However, this does not apply to those who are least likely to attend Catholic schools. The heterogeneity of the Catholic school effect is also found among race/ethnicity. Hispanic students tend to benefit from Catholic schooling , and so do White students who have low propensity to attend Catholic schools.

The effect of Catholic schools within states is found among White and Hispanic students regardless of the states in which these students attend Catholic schools. Adjusting for school district variations, Catholic school students of any ethnic group outperform their public school peers. This study goes further to examine the difference in sending and receiving school districts for Catholic school students who go across district boundaries. The causal effect of Catholic schooling is statistically significant for students who have low propensity of attending Catholic schools and who live in school districts where public aid for Catholic schooling is available. These students tend to attend Catholic schools in districts with higher mathematics achievement than districts of these students' assigned public schools.

Chapter 5

EMPIRICAL RESULT 2: CATHOLIC SCHOOL EFFECT FOR HISPANIC IMMIGRANTS

Introduction

In chapter 4 I find that Hispanic students benefit from attending Catholic schools. Since a large proportion of Hispanic students are immigrants students and Mexicans comprise a large proportion of Hispanic immigrants. This chapter investigates the Catholic school effects for Hispanic immigrant students, and explicitly focuses on Mexican immigrants.

American schools have been experiencing a vast demographic shift since the mid-1990s. An increase of more than 55% of Hispanic populations in the public school systems drives the trend of changing racial/ethnic composition. During the same period of time, the growth of Hispanic enrollment contributes to 60% of the total growth in public school enrollments. In 2005-06, Hispanics accounted for 19.8% of public school enrollments (Fry 2007). To accommodate the growing student population, there were 15,368 more public schools opened. Within the new schools, about half of the enrollments are Whites. Older schools experienced a decline in the White enrollments. By contrast, most of the new Hispanic students enroll in older schools (Fry 2006).

Private schools are not immune from this changing landscape. From 1980 to 2010, the minority population increased from 19.4% to 29.8% in Catholic schools. In 2010, Hispanics make up the majority of the minority population with a share of 12.8%

Catholic school enrollments, followed by 7.5% Blacks, 4.5 % Asians, and 3.7% multiracial (McDonald and Schultz 2010). Both public and Catholic schools serve more and more Hispanic students, although new public schools continue to open while the number of Catholic schools drops over time. The two patterns discussed above raise the questions: Whether Hispanic students benefit from old neighborhood schools vacated by Whites who move to better new schools? Especially, do Catholic schools serve a compensatory role to provide better education for Hispanics since their neighborhood schools may be poorly equipped?

Several studies have shown that White students opt out of neighborhood public schools and enroll in private schools while the composition of minority students increases (Andrews 2002; Betts and Fairlie 2003; Fairlie and Resch 2002; Lankford, Lee, and Wyckoff 1995). Limited effort had been made to examine whether minorities also flee from neighborhood school similar to "White flight" Fairlie (2002) uses NELS:88 data to investigate "Latino flight." He finds that Latino students react to a 10% point increase in the Black composition by a rise in the probability of private school attendance. There is about an increase of 8.5% for Latino 8th graders and 17% for Latino 10th graders (Fairlie 2002). Based on 1980 and 1990 Census data, Betts and Fairlie (2003) further compare student composition by immigrants versus natives. They find no significant association between immigration and private school enrollment in primary schools, but a significant relation is found in secondary schools. On average, public schools lose one native students to private schools while they gain four immigrants.

No research has specifically reported whether Hispanic students choose Catholic schools while they flee into the private sector. Since Catholic schools share the majority of private school enrollments and half of them locate in urban areas and inner cities where there is a large proportion of Hispanics, it is likely that Catholic schools are the destinations for most Latino flight found in previous research.

However, do Hispanic students benefit from Catholic schooling? Few research that closely examines the association between Catholic schooling for Hispanics focuses on the immigrant students in Catholic schools. Louie and Holdaway (2009) employ qualitative and quantitative methods on data from the Immigrant Second Generation in Metropolitan New York Study (ISGMNY) to study how graduating from Catholic high school affects educational attainment as well as the incidence of arrest for boys and early pregnancy for girls. The authors break down immigrants into five categories- South American, Dominican, Puerto Rican, West Indian, and Chinese, to compare with native Black and White. Their findings suggest that the Catholic religion is the main reason for native Whites and Puerto Ricans to attend Catholic schools, whereas other immigrant groups consider Catholic school as a means to avoiding poor neighborhood schools. In addition, Catholic schooling does not only benefit students of all groups with high educational attainment, but also helps prevent boys from police arrests and girls from early pregnancy. The effect is especially statistically significant for low-income immigrants. However, low-income immigrants (i.e. Dominicans) are usually constrained by their lack of information about the public school system. The cost of Catholic schools also places a hurdle for their enrollment in such schools.

Louie and Holdaway's (2009) study addresses the importance of family socioeconomic status on Catholic school enrollments. However, the authors fail to demonstrate the SES effect across immigrant groups, especially for Hispanics. So it is not easy to distinguish how Catholic schooling interacts with SES and has affected academic or behavior outcomes for each immigrant group. Furthermore, it is questionable whether the findings from the New York Metropolitan area can be generalized to the nation, especially to the areas that host a large number of immigrants (i.e. Texas and California). The educational system and composition of immigrants in terms of race/ethnicity/country of origin differ by region. What school systems are available for immigrants varies from the Northeast to the South and the West. Last but not the least, aggregating Mexican with other Southern Americans as one immigrant category is a weakness since Mexicans account for 32% of all immigrants living in the U.S. (United Nations 2009).

Based on the data from South Florida, Portes and Fernandez-Kelly (2008)'s qualitative work specifically examine some Mexican second generation immigrant's schooling experience. They find that Catholic grammar schools are beneficial for Mexican second generation to catch up with other students in grades and improve their language proficiency. However, their finding is based on only two case studies in the South Florida. The generalizability problem is raised from their research.

Based on the NELS:88 data, research has found differences in social positions among Mexican and Chinese immigrant young adults and native Whites (Hao and Pong 2008). The position gap between Mexicans and Whites remains large. The authors emphasize that some structural and relational attributes of schools, such as curriculum and school programs versus teachers' interests and educators' encouragement about college, affect students' upward mobility, especially for disadvantaged students. They suggest this is where policy intervention should play a role in public schools for students at risk. However, they do not specify whether these immigrant groups differ in social position by school sector. It is unknown whether Catholic schooling is a good choice for disadvantaged immigrants' educational outcomes while they suffer in poor neighborhood schools.

In chapter 4 of this thesis, the findings (Tables 7 and 8) suggest Hispanic students benefit from Catholic schooling on mathematics achievement. Whether within the strata of propensity for Catholic schooling or within states, the Catholic school effects persist. In addition, the magnitudes of effects for Hispanics are larger than those for Blacks and Whites. Does Catholic schooling affect Hispanics differently on academic achievement across national origin and immigration status? Is there heterogeneity of effect by the propensity of attending Catholic school? What are the features accounting for the heterogeneity of effects? Drawing on the existing study, three hypotheses are to be tested: (1) The higher SES a Hispanic group has, the more participation in Catholic schools; (2) Catholic schools affect low-SES Hispanic immigrants more than high-SES ones in academic achievement, after controlling for other covariates related to students' learning; and (3) Catholic school effects differ for students with low and high propensity of attending Catholic schools. The higher the propensity, the more students benefit from Catholic schooling.

Drawing on the need for investigation of the Catholic school effect for Hispanic immigrants, the remainder of this chapter examines the effect that Catholic schools have on mathematics scores for Hispanic immigrant students only. In addition, I divide Hispanics into Mexicans and non-Mexicans to compare possible differentials in effects. Based on the full matched sample used in chapter 4, I first report summary statistics about the distribution of Mexicans, non-Mexican Hispanics, their participation in

Catholic schools, and some features that are found to explain the Catholic school effect in previous chapters. After summary statistics, three sets of models (as in the previous chapter, these are OLS, strata fixed effect, and state fixed effect) are used to measure the Catholic school effect for three Hispanic/national origin categories – overall Hispanics, Mexicans, and non-Mexican Hispanics. The school district fixed effect modeling is not available due to insufficient observations for estimating the average effect by creating more than 300 school district dummies.

Summary Statistics

Table 15 reports that Hispanic matched student sample amounts to 900 students. Among them, 49.8% are Mexicans and 50.2% are Non-Mexican Hispanics. About 5.7% of Hispanics attend Catholic schools, compared to 4.4% of Mexicans and 7.0% of Non-Mexican Hispanics. The proportion of enrollment in Catholic schools for Non-Mexicans is more than that of Mexicans. In contrast to non-Mexican Hispanics, Mexicans have lower SES, higher proportion of being Catholics, less likely to be in the school districts with public aid available for Catholic schooling, and less likely to attend schools across school district boundaries.

I further divide the sample to two groups-immigrants and natives by Hispanics, Mexicans, and non-Mexican Hispanics. Immigrants here include all foreign born and U.S. born with at least one immigrant parent (1^{st} and 2^{nd} generations). The sample demonstrates that immigrants account for 21.2% of the matched student sample, and about 9.1% of immigrants register in Catholic schools. Consistently with the existing population report, Hispanics make up the largest share of the immigrant population (37.3%). Hispanic immigrants have fewer enrollments in Catholic schools than all Hispanics (4.9% versus 5.7%).

For students of Hispanics, Mexicans, or non-Mexican Hispanics, in contrast to immigrants, natives tend to be more likely to enroll in Catholic schools, have higher mathematics scores, have higher family SES, and are more mobile to attend schools across school district boundaries. They are also less likely to be Catholics. Comparing Catholic school enrollment among Mexicans, Non-Mexican Hispanics, and all immigrants, Mexican immigrants have the lowest enrollments in Catholic schools (3.5%) in contrast to Non-Mexican (6.5%). In other words, Non-Mexican Hispanic natives are more active at Catholic schooling, followed by Non-Mexican Hispanic immigrants, Mexican natives and Mexican immigrants. Compared to non-Mexican Hispanic immigrants, Mexican immigrant students are less likely to be male and are from less affluent families. Male Mexicans may have dropped out from high schools before 12th grade. A large proportion of Hispanics are Catholics, but Mexicans contribute significantly to more Catholic affiliations than non-Mexicans (88.6% versus 71.6%). The findings from previous research suggest that the Catholic religion is the main reason dominating the decision of choosing Catholic schools (Louie and Holdaway 2009). However, this study shows Mexicans have a lower percentage of participation than non-Mexican Hispanics. It is likely that lower SES has forced most Catholic Mexicans to choose free public schools rather than Catholics schools, which charge tuition.

Examining the mobility of students to cross school district boundaries for schooling, about 15.4% of non-Mexican Hispanics opt out of their home school districts.

In contrast, Mexicans are less mobile and attend schools across school districts[8]. For Mexican immigrants, SES might have limited their school choice to neighborhood pubic schools. It is interesting that non-Mexican Hispanics tend to live in school districts where public aid is more available for Catholic schooling than Mexicans, given their higher enrollment in Catholic schools. The reason behind this phenomenon may be due to insufficient information about such public aid. The limited language proficiency for most Mexican immigrants could have played a role in their capacity to participate in both public school choices and private schools. It is also possible that their illegal status prevents them from receiving public aid.

Comparing natives and immigrants within Mexican and non-Mexican Hispanic groups, Table 21 shows that immigrants are less likely to attend Catholic schools, regardless of national origin. Immigrants of these two Hispanic groups have lower SES than natives, and are more likely to be Catholics. However, Mexican immigrants are more likely to live in school districts with public aid (23.8%) for Catholic schooling than Mexican natives (14.6%). For non-Mexican Hispanics, natives (24.1%) are more likely to live in the districts with public aid (21.0%).

[8] In the full sample (without matching), there are about 18.7% Mexicans opt out of their home school districts, compared with 21.8% of non-Mexican Hispanics. The proportions of crossing school districts in the matched sample here present opposite results between the two groups, although the difference is not much. Other indicators used to compared between the two groups are consistent with the full sample.

Table 15. The Means for Achievement and Background Variables for Hispanic Students

	Hispanics			**Mexicans**			**Non-Mexican Hispanics**			**Diff**
Variables	Native	Imm	All	Native	Imm	All	Native	Imm	All	
Proportion in the sample	0.365	0.635	-	0.333	0.667	0.498	0.396	0.604	0.502	*
Catholic school	0.072	0.049	0.057	0.063	0.035	0.044	0.078	0.065	0.070	**
12^{th} math score	44.330	42.611	43.232	44.133	42.828	43.262	44.496	42.376	43.203	
Male	0.517	0.485	0.497	0.398	0.465	0.442	0.617	0.507	0.551	+
Number of siblings	2.309	2.424	2.382	2.285	2.465	2.405	2.329	2.378	2.358	
SES	-0.031	-0.375	-0.250	-0.070	-0.549	-0.389	0.002	-0.185	-0.111	**
Catholic affiliation	0.707	0.854	0.801	0.831	0.914	0.886	0.604	0.789	0.716	*
Public aid for Catholic schooling	0.198	0.224	0.215	0.146	0.238	0.207	0.241	0.210	0.222	*
Cross school district boundaries	0.173	0.141	0.153	0.176	0.139	0.151	0.176	0.144	0.154	*
N	430	570	900	140	270	410	180	310	490	

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

Note:

1. Using *Hispanic* matched sample, from 5 imputed data
2. Design effect is controlled by taking into account school clusters and probability weighting schemes (using first follow-up student weight *f1qwt*), as well as estimating a robust standard of error.
3. *: significance comparison between Mexicans and non-Mexicans
4. The means of socioeconomic status for Mexican or Non-Mexican Catholic school students are estimated, but are not reported in the table due to the small number of cases: less or equal to 30. According to NCES regulation of the use of restricted data, parameters with such few cases should be removed from the output to avoid the danger of revealing student identifications. The result indicates that Non-Mexican Catholic school students have higher SES than Mexican Catholic school students, although the difference is not significant. Those Catholic school students, regardless of national origin, have higher SES than their other counterparts of the same national origin.
5. The differences (Diff) are comparisons between non-Mexican Hispanic and Mexican immigrants.

Catholic School Effects for Hispanic Immigrants

Nineteen models are created to estimate the Catholic school effects for Hispanic immigrants. In each model, a set of covariates including students' demographics, family background, school experience, school characteristics, and policy intervention (whether public aid is available for Catholic schooling) are controlled. This is the same set of covariates used in chapter 4 to estimate Catholic school effect. Each model is for specific racial/ethnic/nativity/national origin group. The results are presented in Table 16.

The effect for Mexican immigrants

To use native Whites as one comparison group, model 1 in Table 16 estimate Catholic school effect among native Whites and suggests marginally beneficial effect of Catholic schooling for native Whites. The effect is small (1.114) but marginally significant. Compared with native Whites, the second model finds stronger effect for immigrants of any origin. Immigrants significantly gain about 2.109 score points from Catholic schooling. Model 3 is the same model that was estimated in chapter 4 showing a significant Catholic school effect for Hispanic students' mathematics scores. In the sample with only Hispanic immigrants (model 4), there is a significant Catholic schools effect at 0.01 significance level (t=3.063). From model 3 to 4, the effect size increases slightly, implying that Catholic school effects are slightly larger for Hispanic immigrants than Hispanic natives.

Table 16. Catholic School Effect on 12th Graders' Mathematics Scores, Hispanics by Immigration, and National Origin

Models	Effect	StD	t	N
(1) Native Whites	1.114	0.592	1.882	2,920
(2) Immigrants	2.109	0.731	2.885	1,500
(3) Hispanics	2.069	0.803	2.576	900
(4) Hispanic immigrants	2.771	0.905	3.063	570
(5) Mexican	2.231	1.092	2.043	410
(6) Mexican immigrants	2.570	1.172	2.194	270
(7) Mexican natives	1.951	1.715	1.114	140
(8) Mexican immigrant_strata fixed effect	2.255	1.164	1.937	270
(8a) Mexican immigrant_1-2 quintiles	2.032	1.759	1.155	210
(8b) Mexican immigrant_3-5 quintiles[d]	3.440	1.835	1.875	60
(9) Mexican immigrant_state fixed effect	3.350	1.158	2.894	260
(10) Other non-Mexican immigrants	2.062	0.779	2.648	1,230
(11) N-M Hispanics	2.668	1.084	2.462	490
(12) N-M Hispanic immigrants	2.835	1.317	2.153	310
(13) N-M Hispanic natives	2.546	1.505	1.692	180
(14) N-M Hispanic immigrant_strata fixed effect	2.703	1.252	2.160	310
(14a) N-M Hispanic immigrant_1-2 quintiles	2.838	1.848	1.536	220
(14b) N-M Hispanic immigrant_3-5 quintiles	0.955	1.660	0.576	90
(15) N-M Hispanic immigrant_state fixed effect	2.323	1.482	1.568	300

Note:

1. The number of observation are the average of 5 imputed data for each matching group - native Whites, immigrants, and Hispanics.
2. Design effect is controlled by taking into account school clusters and probability weighting schemes (using first follow-up student weight *f1qwt*), as well as estimating a robust standard error.
3. N-M denotes non-Mexican.

Models 5-9 investigates the effects for Mexicans. .Catholic schooling positively affects Mexicans' mathematics scores (all coefficients from models 5-9 are positive), evidenced by the high t-statistics across models. The exceptions are Mexican natives and Mexican immigrants (model 7) who are less likely to enroll in Catholic schools (model 8a). Model 10 further estimates the effect among other non-Mexican immigrants. For non-Mexican immigrants, there is about 2.835 significant gain in math scores, a stronger effect than that found among immigrants as a whole (found in model 2.) The findings are consistent to the previous research by Portes and Fernandez-Kelly (2008) who reported Mexican immigrants' positive experience with Catholic schooling and their academic achievement.

The effect for non-Mexican Hispanic immigrants

The same analytic approaches apply for Non-Mexican Hispanics that show similar results. For all non-Mexican Hispanics, the average treatment effect for Catholic school students is about 2.668 and the effect is statistically significant with t statistics of 2.462 in model 11. While estimating the effect for the same group but immigrants only, the magnitude of effect in model 12 increases and the effect remains significant. It is possible that the decreasing t-statistics are due to the drop in sample size (drop about 35%, from 490 to 310). Compared with non-Mexican Hispanic immigrants, model 13 reports smaller but insignificant effect for non-Mexican Hispanic natives (2.546 score gain with t-statistics = 1.692). Models 11 to 13 seem to suggest that being immigrants is important in explaining non-Mexican Hispanics' academic achievement.

The next question is whether or not there is an effect of Catholic schooling if non-Mexican Hispanic immigrants are given the same propensity for enrolling in Catholic schools. To answer this question, a propensity score strata fixed effect model is to estimate the average effect within five strata. Model 14 demonstrates a significantly positive effect for non-Mexican Hispanic immigrants within strata. Non-Mexican Hispanic immigrants in Catholic schools perform higher in mathematics scores than their public school counterparts. The previous chapter has found the Catholic school effect is more significant for those who are least likely to attend Catholic schools. Therefore, I divide the sample into two categories – low and high propensity strata, and estimate the Catholic school effect within each category. Models 14a and 14b do not show any evidence of the heterogeneity of effects by low and high propensity score strata (with t-statistics lower than $p<0.1$ confidence level). For non-Mexican Hispanic immigrants, the Catholic school effects do not differ by the likelihood of enrolling in Catholic schools or not.

To know whether Hispanic immigrants gain more in mathematics scores within states, models 9 and 15 suggest a large Catholic school significant effect for Mexicans but not for non-Mexicans. After taking into account state variations, within the same state where students are exposed to the same state educational policy, Catholic schooling generally benefits Mexican Hispanic immigrants with a 3.350 test score gain (net effect) by not enrolling in public schools. It is meaningful to investigate the fixed effect within school districts since the quality of school districts varies a lot within the same state. By doing so, the differences of the local school system can be controlled. In addition, the evaluation of policy intervention at the school district level can be more precisely measured. However, I am not able to fit a school district fixed effect model in this sample due to insufficient observations. The same limitation exists while I try to estimate the effect for students living in the area where public aid is available for Catholic schooling. Thus such analysis is also not available.

Summary

This chapter follows the findings from previous chapters that Hispanic students benefit from Catholic schooling in their academic achievement. Research suggests that within the same racial/ethnic group, students from different countries of origin perform differently in academic achievement (Kao and Thompson 2003). Mexican immigrant students are the most disadvantaged group with lower SES and test scores. The gap between Mexicans and native Whites remains large (Hao and Pong 2008). This chapter estimates the Catholic school effects on mathematics achievement for Mexican and Non-Mexican Hispanic immigrants. The summary statistics report that Mexicans and non-Mexican Hispanics differ in the means of mathematics achievement, demographics, family background, and school experience. Mexicans achieve lower scores and are more likely to be Catholic affiliated although they have a lower proportion of Catholic school enrollment compared to non-Mexican Hispanics. Mexicans' lower SES may explain their lower propensity for attending Catholic schools and lower achievement scores. This is consistent with the research suggesting that SES is associated with racial/ethnic differences in achievement test scores (Kao and Thompson 2003) and cost determines immigrant groups' propensity for enrolling in Catholic schools (Louie and Holdaway 2009).

The estimation of the Catholic school causal effect suggests differentials between the two groups. Both Mexicans and non-Mexican Hispanics in Catholic schools have more achievement gains than their public school counterparts. However, when immigrants and natives are separately analyzed, the results suggest that neither Mexican nor non-Mexican Hispanic natives benefit from Catholic schooling.Although there is a positive Catholic school effect for Mexican immigrants as a whole, it masks the fact that Catholic schools help improve math score mainly for those Mexican immigrants who have high propensity to attend Catholic schools. The Catholic school effects for non-Mexican Hispanics are different: average achievement gains are found with or without adjustments for propensity score strata, suggesting that the Catholic school effect is independent from the propensity to attend Catholic school. Further analysis using the state fixed-effect model reports that Mexican immigrants gain from Catholic school enrollment while non-Mexican immigrants do not.

To sum, there is a large scholarship about the Catholic school effect on students' educational achievements and attainments. Many of them suggest Catholic schooling benefits low-income and minority students. However, few research studies have investigated the effect for a specific minority group, such as Hispanics. This chapter goes beyond the existing research to fill the literature gap. The result suggests that there is heterogeneity of the Catholic school effect by national origin within Hispanic immigrants. Catholic schooling especially matters for Mexican Hispanics who are generally from higher SES families than those from lower SES. Comparing effect sizes across groups, non-Mexicans tend to have higher score gains than Mexicans. What features of Catholic schools may account for such effects is still unknown. Further research is required on this perspective.

Chapter 6

EMPIRICAL RESULTS 3: MAGNET SCHOOL EFFECT

Introduction

This chapter presents the analytical results of magnet school effect on students' academic achievements. Following the same analytical approaches employed in the prior chapters, five sections of the results are discussed. The first section describes summary statistics of variables used in this study. The results of propensity score matching are presented in the second section. The third section presents the estimation of the causal effect of magnet schools using the OLS methods on a match sample. In addition, propensity-strata fixed-effect models are utilized to detect any heterogeneity in the magnet school effects. The final section summarizes the findings.

Description of Variables

This study uses a total of 50 variables. Table 17 shows that, in my sample of students from a central city school, magnet school students do not differ from those in comprehensive public schools in academic achievements. But they differ in some demographic, family background, and school characteristics. A large proportion of magnet students are Blacks, while a relatively smaller proportion of Blacks are in comprehensive public schools. Asians and Hispanics do not differ in their participation in these two types of schools. Because most magnet schools are more likely to locate in urban areas and inner cities, where host a large amount of immigrants, a series variables of race/ethnicity divided by immigration status are included to capture student characteristics. Among these variables, the second-generation Hispanics are more likely to attend magnet schools than attend comprehensive public schools, but the third-generation Hispanics tend to attend comprehensive public schools (marginally significant).

Table 17. Descriptive Statistics for the Full Study Sample before Matching

Variables	Overall Mean	Overall SD	Magnet Mean	Comprehensive public Mean	Diff
Outcome variables:					
12th-grade math IRT score	44.23	14.89	45.87	43.71	
10th-grade reading IRT score	26.88	9.33	28.81	26.29	
Magnet school student	0.236	0.425	-	-	
Prior math score -10th grade	39.22	13.58	41.09	38.64	
Demographics & family background					
Asian	0.18	0.37	0.20	0.18	
Black	0.27	0.44	0.39	0.24	**
Hispanic	0.21	0.42	0.22	0.21	
Other race	0.05	0.23	0.08	0.04	+
Asian_1st generation	0.08	0.26	0.07	0.08	
Asian_2nd generation	0.10	0.28	0.12	0.09	
Asian_3rd generation	0.01	0.07	0.01	0	
Hispanic_1st generation	0.08	0.27	0.06	0.08	
Hispanic_2nd generation	0.08	0.28	0.12	0.07	*
Hispanic_3rd generation	0.05	0.24	0.04	0.06	+
Black_3rd generation	0.24	0.42	0.35	0.20	**
Others	0.13	0.35	0.12	0.13	
Male	0.48	0.50	0.49	0.47	
Age	18.34	0.65	18.22	18.38	+
English as native language	0.71	0.45	0.68	0.72	
Number of siblings	2.71	1.64	2.76	2.69	**
Step parent	0.16	0.38	0.13	0.16	*
Single parent	0.28	0.45	0.24	0.29	
No parent	0.05	0.23	0.08	0.05	*
Socioeconomic status	-0.17	0.74	-0.12	-0.19	
Mother does not work	0.26	0.43	0.29	0.25	+
Mother works part time	0.17	0.38	0.12	0.18	**
Northeast	0.10	0.30	0	0.13	
Midwest	0.18	0.38	0.19	0.18	

Table 17. (Continued)

Variables	Overall Mean	SD	Magnet Mean	Comprehensive public Mean	Diff
West	0.32	0.47	0.38	0.30	
Neighborhood segregation	0.44	0.21	0.40	0.45	*
Neighborhood crime: moderate	0.14	0.34	0.18	0.13	*
Neighborhood crime: high	0.04	0.18	0.04	0.03	
Poverty rate	0.17	0.09	0.20	0.16	*
The state mandate open enrollment	0.68	0.46	0.57	0.71	
Student's school experience					
Ever repeated grade	0.08	0.31	0.08	0.08	
Attend general program	0.37	0.49	0.33	0.39	
Attend vocational program	0.10	0.32	0.12	0.10	
Cross school district boundaries	0.11	0.01	0.10	0.12	
School characteristics					
School mean math score	33.65	5.97	35.13	33.20	
% in ESL program	0.08	0.09	0.07	0.08	
% receive free-reduced lunch	0.39	0.21	0.47	0.37	*
% living in linguistic isolated neighborhood	0.25	0.20	0.32	0.23	+
% school minority	0.61	0.28	0.80	0.55	**
% out-of-field teaching	0.04	0.16	0	0.05	
% certified teachers	0.94	0.14	0.88	0.96	
School offers vocational program	0.91	0.92	0.89	0.92	
Number of students	**1,560**		**350**	**1,210**	

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

Note:

1. Reference categories for race, family composition, mother working status, urbanicity, region, neighborhood crime, and school program attended are white, 2-parent family, mother has full-time work, suburban, south, low neighborhood crime, and college preparatory program.
2. The sample is weighted with first follow-up weight (*f1qwt*) and takes into account sampling design that students are nested within schools.
3. There are around 80 schools and 60 school districts in this sample.
4. Dependent variables are not imputed. Thus the number of observations for math and reading scores is fewer than 1,560.
5. Interaction terms of race/ethnicity by percent school minority are estimated, and only Black*% school minority is statistically significant. These variables are not listed on the table.
6. The estimates are from five imputed data.

Compared with their comprehensive public school counterparts, magnet school students tend to live in families with a greater number of siblings, and no parent accompanied. Native Blacks and 2nd generation Hispanics have higher proportion in magnet schools. Furthermore, they are more likely to live in the less segregated neighborhoods (zipcodes) with higher neighborhood poverty rate and moderate crime in central cities. As to school characteristics, the magnet schools also accommodate more of racial/ethnic minority and low income students. About 80% of magnet school students are minorities, and among them, the majority is Black (about 33%).

Generally, the summary statistics from the main sample show no difference in both math and reading test scores between students of magnet and comprehensive public schools, but differences in student background and school characteristics. Given the fact that magnet schools attract more minority students from disadvantaged backgrounds, can magnet schools benefit their students?

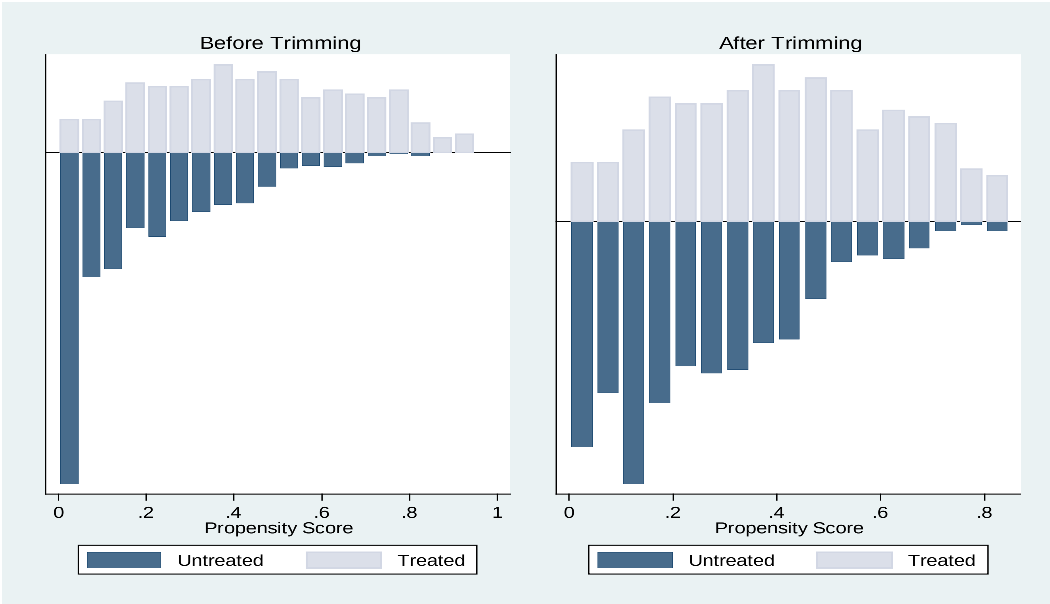
Sample from Propensity Score Matching

To examine whether there is a causal effect of magnet schooling on achievements, the rest of the analysis relies on the matched sample from the propensity score matching method. First, a total of 50 covariates are used to estimate a logistic regression model that predicts the odds of attending magnet schools. The logistic regression output is reported in Table C2 in the Appendix. Based on the predicted propensity scores, I make sure that there is balance between the sample of magnet and comprehensive public students. Finally, the sample is stratified into five propensity-score strata, which is classified by the quintiles of students' propensity scores.

As discussed on page 87 in chapter 3, a caliper match with 1% distance in propensity score is used to obtain matched comprehensive public school students (untreated or control group. For every magnet school students in the magnet sample, 5 closest matched public school students are kept. The closest matched students have propensity scores within 1% distance from the corresponding propensity score of the magnet school students. For example, a magnet student A with propensity score 0.50 is matched to comprehensive public school students with propensity scores ranged from 0.49 to 0.51 (i.e., 0.50 $\pm$ 1%). Those public students who are matched to student A can also be matched to other magnet school students as long as their propensity score is within the 1% distance. On the other hand, if a treated case (magnet school student) whose propensity score is larger than the propensity scores of other untreated by more than 1%, this is considered no match or poor match. The treated case no or poor match, therefore, is dropped from the sample.

Figure 3 demonstrates the change of samples before and after unmatched or dropping poorly matched cases. On the left side of Figure 3, before trimming the sample, there are more comprehensive public school students (untreated) with low propensity scores, compared with relatively fewer untreated cases with high propensity scores. After poor matches are dropped from the sample and replacement for matching is allowed, there are relatively more public school students matched to magnet school students. This is shown in Figure3 (right-hand side). The change is more significant for students with propensity scores between around 0.17 and 0.5. Furthermore, on the right tail of the right figure, the magnet school students who have high propensity scores are dropped from the sample due to no or poorly matched treated cases.

Figure 3. The Distribution of Propensity Scores for Magnet School Attendance



To precisely know the balance feature of the matched sample, Table 17 shows the summary statistics of propensity scores for students in the magnet and public comprehensive schools across five strata. The mean and standard deviation within each stratum are approximately the same for magnet (treated) and comprehensive public (control) students. This suggests that the magnet-versus-public matches achieved an adequate balance. Students in the same strata are alike in terms of the covariates (e.g. student demographics, family background, and interaction terms) controlled in the logistic regression model. Students in the higher strata are more likely to attend magnet schools, and vice versa. It is reasonable to observe fewer comprehensive public school students in highest propensity stratum (stratum 5) and more public students in lowest propensity stratum, in contrast to magnet school students. To sum up, the results in Figure 3 and Table 18 both show the matched sample achieves balance between treated and untreated students.

Table 18. Balance of Propensity Score, Main Match Sample (Magnet)

	Magnet			Comprehensive Public		
	Mean	**Std**	**N**	**Mean**	**Std**	**N**
Stratum1	0.114	0.058	50	0.093	0.060	260
Stratum2	0.270	0.039	50	0.268	0.040	130
Stratum3	0.393	0.031	50	0.394	0.032	80
Stratum4	0.533	0.049	60	0.525	0.048	60
Stratum5	0.721	0.064	50	0.719	0.072	20

Note: The number of observation is the average of 5 imputed data. The matched sample size (without missing test scores) is 810 students, including 260 magnet school students and 540 assigned public school students.

After a matched sample is created, the rest of analysis is based on this sample. Before employing further statistical models to estimate the causal effect of magnet school, it is worthy to observe the features of students who are remained in the matched sample. Table 19 shows the descriptive statistics of the matched sample. Compared with Table 16, the sample before matching, the sample size decreases from about 1,560 students, 80 schools, and 60 school districts to be around 810 students in 50 schools and 40 school districts. After matching, magnet school and comprehensive public students but they still do not achieve differently in their mathematics and reading scores. However, they become more alike in demographics and background characteristics. Magnet schools tend to serve more native Black students and students living in poor neighborhoods. There are some variations in some school features. One explanation is that the matching is based on student variables that represent variations before school selection. In other words, the sample is not matched on school variables, but on student variables (except outcome variables). Students of magnet and comprehensive public schools become more like, in terms of their prior-school-selection characteristics. This sample is thus considered a good match sample.

Table 19. Descriptive Statistics from the Magnet School Student Matched Sample

Variables	Overall Mean	Overall SD	Magnet Mean	Comprehensive public Mean	Diff
Outcome variables:					
12th-grade math IRT score	43.68	14.87	45.85	42.65	
10th-grade reading IRT score	26.54	9.33	28.85	25.45	
Demographics & family background					
Asian	0.20	0.38	0.19	0.20	
Black	0.33	0.33	0.39	0.30	+
Hispanic	0.21	0.41	0.22	0.21	
Other race	0.06	0.25	0.08	0.05	
Asian_1st generation	0.08	0.26	0.07	0.09	
Asian_2nd generation	0.11	0.31	0.12	0.11	
Asian_3rd generation	0.01	0.06	0.01	0.01	
Hispanic_1st generation	0.08	0.26	0.06	0.09	
Hispanic_2nd generation	0.08	0.29	0.11	0.07	
Hispanic_3rd generation	0.05	0.22	0.04	0.05	
Black_3rd generation	0.30	0.45	0.35	0.27	+
Others	0.11	0.32	0.12	0.10	
Male	0.47	0.50	0.48	0.47	
Age	18.30	0.62	18.23	18.34	
English as native language	0.70	0.45	0.69	0.71	
Number of siblings	2.78	1.64	2.75	2.80	
Step parent	0.15	0.36	0.13	0.16	+
Single parent	0.27	0.45	0.24	0.29	
No parent	0.06	0.25	0.07	0.05	
Socioeconomic status	-0.18	0.74	-0.11	-0.21	
Mother does not work	0.28	0.44	0.29	0.27	
Mother works part time	0.15	0.36	0.12	0.17	+
Northeast	0	0	0	0	
Midwest	0.20	0.40	0.18	0.22	
West	0.36	0.48	0.38	0.36	
Neighborhood segregation	0.41	0.21	0.41	0.41	
Poverty rate	0.17	0.09	0.20	0.16	+
Neighborhood crime: moderate	0.14	0.35	0.17	0.13	
Neighborhood crime: high	0.04	0.19	0.05	0.04	
Student's school experience					
Ever repeated grade	0.08	0.29	0.08	0.08	
Attend general program	0.34	0.48	0.33	0.35	
Attend vocational program	0.11	0.32	0.12	0.11	
Cross school district	0.11	0.01	0.11	0.11	
School characteristics					
School mean math score	33.53	5.95	35.16	32.76	
% in ESL program	8.35	9.22	7.36	9.03	
% receive free-reduced lunch	38.78	20.19	46.17	35.65	

Table 19. (Continued)

Variables	Overall Mean	Overall SD	Magnet Mean	Comprehensive public Mean	Diff
% living in linguistic isolated neighborhood	26.33	20.19	30.91	23.05	
% school minority	65.25	25.18	80.42	57.69	**
% out-of-field teaching	2.33	8.28	0.00	2.11	
% certified teachers	93.01	15	87.65	95.41	
School offers vocational program	0.94	0.23	0.89	0.96	**
Number of students	**810**		**270**	**540**	

** $p<0.01$, * $p<0.05$, + $p<0.1$

Note:

1. Reference categories for race, family composition, mother working status, urbanicity, region, neighborhood crime, and school program attended are white, 2-parent family, mother has full-time work, suburban, south, low neighborhood crime, and college preparatory program.
2. The sample is weighted with first follow-up weight (*f1qwt*) and takes into account sampling design that students are nested within schools.
3. There are around 50 schools and 40 school districts from this sample.
4. Interaction terms of race/ethnicity by percent school minority are estimated, and only Black*% school minority is statistically significant. These variables are not listed on the table.
5. The estimates are from five imputed data.

The differences in schools are expected since there are differentials between magnet and comprehensive public schools. In Table 19, magnet schools are found to have a higher percentage of minority (non-white) students and are less likely to provide vocational programs than comprehensive public schools. Since most magnet schools carry the mission to balance school racial/ethnic composition, it is predictable for them to have higher proportion of minority students. This is especially true in central cities that host many minority students. In addition, some magnet schools have special themes, such as art and career academy, while most comprehensive public schools offer vocational programs for their students. On average, comprehensive public schools have more vocational programs available is expected.

OLS and Fixed-Effect Estimates with Match Sample

This section first presents the average treatment effect for the treated (ATT) to examine whether magnet schools benefit their students with achievement gains. Many researches on school choices concern the effects for low income and minority students. That is, they expect there is heterogeneity of school effects. Strata-fixed effect models are conducted to investigate the heterogeneity effect. In the last part of this section, state and school district fixed effect models are implemented to measure magnet effects at the policy level.

Average treatment effect for the treated (ATT)

After balancing the matched sample, I use OLS regression models and fixed-effect modeling (FE) to estimate the average magnet school effect for the magnet school students (ATT). The OLS and fixed effect modeling correspond to the equation (5) and (6) addressed in chapter 3, respectively. Table 20 shows the results on 12th grade mathematics scores. The first model presents the main effect of magnet school, where only the effect of dummy variable-magnet schooling, is estimated. The coefficients and t-statistics show that the main effects are positive but statistically insignificant (models 1). After taking account other covariates that are associated with students' academic achievements, models 2 reports insignificant magnet school effects.

Constraining the sample by propensity score strata to measure the heterogeneity of effect, the two-tail t statistics are consistently below 1.64 ($p<0.1$) across models 3-8 and 13-18. This reveals that magnet school students do not perform differently in mathematics scores. The propensity strata are grouped into two categories- low (1-3 quintiles) and high propensity (4-5 quintiles). Models 9 and 10 show there is no evidence indicating heterogeneity of the magnet school effect on math scores by high or low scores. For students with similar propensity of attending magnet schools, magnet school students do not benefit from magnet schooling in math score.

Table 20. Magnet School Effect on Mathematics Achievements

	Magnet school effect	StdE	t	N
Dep var: 12th –grade math				
1: Main effect (without covariates)	0.648	1.743	0.372	810
2: 1+ 10th-grade score + demographics + background + school experience	-0.555	0.788	-0.704	810
3: Strata fixed effect	-0.167	0.791	-0.211	810
4: Stratum 1: 1st quintile	-1.374	1.083	-1.269	310
5: Stratum 2: 2nd quintile	-0.101	1.201	-0.084	180
6: Stratum 3: 3rd quintile	0.427	1.249	0.342	130
7: Stratum 4: 4th quintile	1.024	1.337	0.766	120
8: Stratum 5: 5th quintile	-0.594	1.83	-0.325	70
9: 1st – 3rd quintiles	-0.583	0.816	-0.715	620
10: 4th – 5th quintiles	0.645	1.074	0.6	190

Note:

1. The numbers of observations presented here are rounded to 10 digits according to the NCES regulation of the use of restricted data.
2. The number of observations is the average of observations per model from 5 imputed data. The match sample size after dropping missing math scores is 1,070 students, including 330 magnet school students and 740 public school students.
3. Design effect is controlled by taking into account school clusters and probability weighting scheme (using first follow-up student weight *f1qwt* for the models, as well as estimating robust standard error.

The findings above consistently demonstrate no effect of magnet schooling on math achievement. The results echo what Gamoran (1996) has found from the NELS:88 data. His results suggest significant effect of magnet schools on reading, but not on mathematics. I have estimated the same analyses on 10th grade reading scores. The results are reported in Appendix Table C3. A comparison between the results from this study and Gamoran's are in Appendix Table C4. Nonetheless, it should be reminded that the significant effect in reading should be conservatively interpreted due to the lack of prior reading score. It is possible that after controlling for prior reading scores, the marginal effect disappears.

Magnet school effect at the policy level

The analyses in the previous subsection focus on the individual level analysis. Tables 17 and 19 show that about 11% of magnet school students and 11% of comprehensive public school students attend schools across school district boundaries. In either full sample before matching or matched sample, as their peers in comprehensive public schools, most magnet students attend schools in their home school districts. In an attempt to understand to what extent the magnet school effect should be considered at the policy level, I estimate the magnet effect using models with state and school district fixed effects. The results in Table 21 do not show the magnet effect in any model. The absolute values of two-tailed t-statistics are all below significance level ($p<0.1$). Within states or school districts, magnet schooling seems not to favor their students with better achievement scores than their counterparts from comprehensive public schools. The results from Tables 17, 19 to 21 present that no differences in mathematics scores between students of magnet and comprehensive public schools are reported, no matter from the descriptive analysis on both full and matched sample or from models in both individual and policy levels.

Table 21. State and School District Fixed-Effect Analysis on Achievement Scores

	Magnet school effect	StdE	t
Dep var: 12th –grade math			
State fixed effect	0.096	0.833	0.116
District fixed effect	0.039	1.435	0.027
Strata 1-3	0.697	1.901	0.367
Strata 4-5	-3.910	3.075	-1.272

Note:

1. The numbers of observations presented here are rounded to 10 digits according to the NCES regulation of the use of restricted data.
2. From five imputed datasets.
3. Design effect is controlled by taking into account school clusters and probability weighting scheme (using first follow-up student weight *f1qwt* for the models, as well as estimating robust standard error.

Summary

This chapter estimates the causal effect of magnet schools on academic achievement using a national high school sample with state-of-the-art statistical method- the propensity score matching. The results in previous subsections show that magnet schools serve large proportions of minority students. Blacks and Second-generation Hispanics are more likely to attend magnet schools in contrast to comprehensive public schools. In central cities, students from the two types of public schools do not differ in their family socioeconomic status. This study does not find a positive magnet effect for 12^{th} graders in mathematics. This is similar to a previous study that uses NELS:88 for magnet effect estimation (Gamoran 1996).

Magnet school is a public school choice plan implemented within or across school districts. It is part of the open enrollment policy. Such schools can draw students from the same school district, and sometimes across school district boundaries. For magnet schools that only allow for intra-district admissions, to estimate magnet school effect within school district is meaningful. By controlling for school district variation, the net magnet school effect could be investigated. Given the fact that some magnet schools are inter-district plan within state, there is also a need of magnet effect with states. The results from previous section show no significant differences in mathematics scores within school districts and states.

If magnet schooling does not significantly improve achievements, why are magnet schools persistently popular? Is it a choice to pursue educational excellence or equity? Further discussion will be addressed in the final chapter of discussion and conclusion.

Chapter 7

DISCUSSION AND CONCLUSION

Introduction

This final chapter is divided into four sections. First, an overview addresses the motivation, empirical questions, main findings, and contributions of the dissertation. The subsequent section returns to the research hypotheses proposed in the previous chapter. The third section discusses hypothesis testing, policy implications, limitations, and avenues for future studies. The final section presents the overall conclusion of the dissertation.

Overview

The expansion of school choice reflects its educational and social value for families in contemporary American society. Educational excellence is the major consequence that the public expect from making various school choices, while social equality is an implicit outcome. Through more choices in the educational market, students across all social backgrounds are more likely to be provided equal opportunity to learn and therefore improve their educational outcomes. However, as we have seen, school choices do not benefit everyone equally. The literature has shown mixed effects of each type of school choice on academic achievement. Even for the same choice, the effects vary for participants from different demographic and social backgrounds.

This study investigates school choice effects on academic achievement with two focuses. First, I explore the disparity of school effects across demographic and social backgrounds as well as the propensity of participating in school choices. Second, this dissertation goes further to examine school choice effects at the policy level. By investigating the effects of two school choices- Catholic and magnet schools, which serve the majority population of private school and public school of choice, respectively, the fundamental questions underlying this study were: (1) Is there a causal effect of Catholic/magnet school on students' academic achievement? (2) If an effect exists, is there disparity of the effect across groups? And (3) Is the effect statistically significant at the policy level, if there is an average effect?

By addressing the shortcomings in the literature, more can be understood about inconsistent school choice effects. First, most critique about school choice study lies on the lack of controlling for selection bias. Since school selection is a process affected by family backgrounds and school circumstances. That is, school choice is not randomly assigned to students. Without taking into account the prior-selection features, one cannot claim net effect of a school choice. To accommodate selection bias, this study employs a quasi-experimental method- propensity score matching, to investigate Catholic/magnet school effects.

Second, researchers using different samples find different results. The majority of scholarship on magnet school effects are based on data sets from local school districts. The problem about generalizability is thus raised. This study uses a national student sample to address this problem.

Third, the literature has been neglecting the significance of the school choice effect at the policy level. Under a decentralized education system, the U.S. educational policies are implemented differently across local school systems, school districts, and states.

Therefore, these policy authorities may play an important role in shaping students' learning. This dissertation makes an effort to obtain more robust results by controlling for the variation at the policy level through statistical models with state and school district fixed effects.

Prior research found heterogeneity in the effect of Catholic schools on academic achievements (Morgan 2001). Students who are least likely to enroll in Catholic schools gain most from Catholic schooling. Such students are more likely to be minorities and from low-income families. The minority groups include non-native-White racial/ethnic groups and immigrants. One previous study suggests that Catholic schools are beneficial for immigrants in academic attainment and avoiding behavioral problems (Portes and Fernandex 2008). Also, disparity in academic attainment is found in students from different national origins (Hao and Pong 2008). However, no research specifically examined whether Catholic schooling benefits a certain racial/ethnic/national origin group more than the others. In addition to estimating Catholic school effects for various racial/ethnic groups, this study also analyzed immigrant students, particularly Mexican students, who comprise the majority of the growth for the U.S. immigrant populations.

Adopting multiple data sources, I have conducted a nationwide investigation on Catholic and magnet school effects. Several major findings are summarized below.

Catholic school effects

First, by replicating Morgan's (2001) study with a more recent nationally representative dataset - ELS:2002, I found consistent results with Morgan's study in mathematics test scores. Students who are least likely to attend Catholic schools benefit most from Catholic schooling. Given similar propensity, among students with lower propensity, Catholic school students are more likely than their public school peers to be from higher SES and two-parent families, be affiliated with the Catholic church, and be less likely to repeat a grade. However, students who are most likely to attend Catholic schools are more alike, in terms of their academic performance and backgrounds, regardless of their Catholic or public school affiliation.

Second, the heterogeneity in the average treatment effect is found to significantly vary by race/ethnicity and nativity. The effects are especially statistically significant for Hispanic and White students, who have low propensity of attending Catholic schools. However, there are no significant effects for Black students. Compared with non-Mexican Hispanics, Mexican students have lower math scores and are more likely to be affiliated with the Catholics church, although they have lower proportion of Catholic school enrollment. Catholic schooling benefits both Mexicans and non-Mexican Hispanics. The effect is especially large for non-Mexican Hispanics who are generally from higher SES families. In addition, Catholic school effects are larger among immigrants than natives. For Mexican immigrants who are more likely to attend Catholic schools, such schooling is beneficial to their large math score gains. However, this is not the case for Mexican natives.

Third, in the policy-level analyses, three analytical approaches were conducted to estimate Catholic school effects on mathematics achievements. I first analyzed the state fixed-effect in the full match sample, and secondly I used a within-district match sample to estimate the Catholic school effect within school districts. Last but not least, I analyzed the treatment effect by whether or not public aid (e.g. voucher or tax credit) is available for students to attend Catholic schools in students' school districts. The results suggest an overall positive effect of Catholic schooling within states. This effect is strong and statistically significant for White and Hispanic students, but not for Black students

Fourth, for students with similar propensity to choose Catholic schooling within the same districts, mathematics outcomes are similar regardless of whether they are attending public or Catholic schools. The only exception is that there is a positive Catholic school effect within the districts where public aid for Catholic schooling is available. In the school districts with public aid, Catholic school students are less selective in terms of family background, thus the Catholic school effect is more obvious. Policies supporting Catholic schooling may therefore have a positive effect on Catholic school students' learning, especially for minority and low-income students.

One might question the reliability of the district match sample, which shrinks substantially from the full sample. In a separate analysis presented in Table A3 in the Appendix, I created another match sample for public and Catholic school students across school districts. The sample size increased, but the results were consistent with the within-district match sample. Because school choice policies are implemented at local school districts, and parents choosing schools first consider schools available within their districts, I argue that matching students within districts is more appropriate.

Fifth, I found that students who moved across school district boundaries to attend Catholic schools did not choose more affluent school districts. This may in part be due to the fact that many (about 43%) Catholic schools that offer secondary education are located in urban and inner cities serving less affluent populations (McDonald and Schultz 2010). There are large proportions of Catholic schools located in the regions of the

Mideast, Great Lakes, and West/Far West, where there are high Hispanics enrollments. This also explains why the school districts in which the district crossers attended Catholic schools tend to have a higher percentage of students with limited English proficiency (LEP).

However, students do not move for less attractive school districts characteristics. They move to the school districts where students generally perform better in test scores than their sending districts. Catholic school students who move have higher math achievement than public school students in both their districts of residence and destination districts, but perform similarly to their Catholic school peers who came originally from the receiving districts. The benefits of academic achievement appear to be the main force that pushes students to move across school district boundaries.

Magnet school effect

Finally, this study found no significant magnet effects for 12th graders in mathematics. This result is similar to that of Gamoran (1996) who used NELS:88 data and found no magnet school effects on mathematics achievement. However, the estimation of reading scores from this study does not echo Gamoran's finding in reading achievement. The ELS:2002 only provides base-year reading score without any further follow-up measurement, while reading scores for base-year and first-follow-up are both available in NELS:88 data. Without controlling for prior scores, the result in reading achievement in this study should be interpreted cautiously.

Miscellaneous findings

Miscellaneous findings about the mechanisms of Catholic school effects and the school effects on reading scores are presented in the Appendix Tables A4 and A5. The effects are stronger for Hispanics than for Whites and Blacks. White students who are in lower propensity strata gain more in reading scores than other whites with high propensity. On the contrary, there is a Catholic school effect among Black students with higher propensity scores but not among Black students with lower propensity scores. It should be noted that Black students in the match reading sample are disproportionately in the lower propensity strata. The results for Blacks in high propensity score strata may not be nationally representative.

The analyses for the mechanisms through which Catholic schooling affects students' mathematics achievement are presented in Appendix B. Several mechanisms are worth noting. Being male students, and having higher prior scores and higher SES are related to higher mathematics achievement, whereas being Black and older has a negative association with math achievement. In addition, higher parental education is also associated with higher test scores. These are consistent with prior research. However, contrary to the previous literature, parental involvement and parental networking do not matter for mathematics scores. Except for the number of science courses taken since high school, no other measures of students' schooling experience accounts for the main effect of Catholic schools. As to school-level measures, only the average mathematics score within schools is marginally associated with individual students' mathematics scores.

This section has provided an overview of this dissertation and has summarized the major findings above. A discussion on this study's limitations is followed in the next section.

Limitations

There are several differences between Morgan (2001) and this study. Morgan used the base-year and first follow-up mathematics and reading scores from NELS:88 to estimate the Catholic school effects. However, ELS:2002 does not measure reading achievement in the first follow-up survey. The base-year reading score for ELS sample is only in the base-year (10^{th} grade), thus I can only estimate the Catholic school effect without adding prior reading score as a covariate.

Insufficient observations prevent this study from studying some smaller minority groups. In the analyses of effect disparity between national origins within Hispanics, the numbers of observations drop for either Mexicans or non-Mexicans. This makes it impossible to estimate the disparity of effects within school districts. There are also too few Asian students in the matched sample to study school effects for Asians.

In addition, it is important to study Catholic school effects for immigrants by generational status, especially 1^{st} and 2^{nd} generations. For example, the 2^{nd} generation Hispanics are U.S. born and thus eligible to receive financial aid for schooling, while some of these in the 1^{st} generation may be illegal immigrants who cannot receive financial aid and so are unable to attend college. Therefore, the effect of financial aid for immigrants students to attend Catholic schools may vary by generation status. The insufficient number of cases for estimating the Catholic school effects on academic achievement for Hispanic immigrants by generation is another limitation of this study.

Another limitation to the matching is the need for more pre-treatment covariates that are associated with school selection before high schools. Previous research has found several factors to be related to parents' school selection, including prior parental involvement, proximity to schools, and the quality of schools in surrounding neighborhoods. Unfortunately, ELS:2002 collected data for these variables while students were already enrolled in high schools. Little is known about a student's learning, school life, and school choices before his/her current school selection. I can only rely on information on 10th graders, while making the assumption that students' SES and family composition do not change from 10th to 12th grade, and thus are not affected by schooling in the 12th grade. Data that provide more direct information about school selection are preferred.

Applying the propensity score matching method on survey data allows us to estimate the Catholic school effect for students of Catholic schools based on a counterfactual inference. It is not an estimation to find out whether Catholic students perform differently if they are placed in neighborhood public schools. It is also unknown whether current public school students can benefit from Catholic schooling if they were in Catholic schools. Research with experimental designs using local school district data are more able to resolve these puzzles, although such research also faces the challenge about generalizability.

Another limitation of this study is that I compare students of Catholic schools with all public school students. There is no variable in ELS:2002 that directly shows whether public students' current schools are their assigned or chosen schools. The Catholic school effect might be more robust if I had matched Catholic students to those in their assigned neighborhood schools. If I had done so, I would have been able to replicate previous research (Gamoran 1996) that found a positive Catholic school effect on math scores by comparing students of Catholic and comprehensive public schools. However, aggregating public school students allows me to replicate the sample that Morgan (2001) obtains to detect if there is continuity of Catholic school effect.

The empirical results generally show no magnet school effect on mathematics. The differential admission methods may play a significant role in explaining the lack of significant magnet effect. As previously discussed, almost half of magnet schools today have adopted competitive admission criteria. It is possible that students in selective magnet schools gain little or lose out in achievement. Students in lottery-admission magnets actually gain more. The magnet effects estimated from the two groups thus offset each other. As Gamoran (1996) pointed out, it is better to categorize magnet schools by type, which is difficult to do with national data because of the small magnet sample.

In an exploratory analysis not presented here, I used five ELS variables from school administrative surveys to gauge the selectivity of magnet schools. These are variables indicating whether magnet school students are "assigned from particular areas to achieve desired racial or ethnic composition in the school", are "admitted to this school based on their achievement entrance tests, auditions, or other criteria," are "admitted to this school based on a lottery or random selection," and "admittance is determined on a first-come first-serve basis." However, the variables are not mutually exclusive. That is, a magnet school may adopt multiple methods to admit students. It is difficult to distinguish which schools are more selective of their students.

Another limitation of this study is the possibility of unobserved variables. Although propensity score matching reduces selection bias, it may still suffer from unobserved confounders. To estimate propensity score, I include the covariates that are related to parental selection for Catholic schools according to previous research (Morgan 2001). However, there may be some confounders that are related to selection into Catholic schools that I was not able to control in my estimation logit model. It is possible that selection bias is not completely removed by using this method.

Policy Implications

Several policy implications can be drawn from the empirical findings. First, within a large school district that serves a large body of minority and low-income students, making Catholic schooling more available for those students is a way to improve student learning. Large school districts are usually locate in metropolitan areas and have a substantial proportion of inner-city students. While Catholic schools are more available in such areas, policies that use public funds to encourage minority students' attendance are important.Two relevant school choice policies should be considered. One is to make voucher programs, scholarships, and tax credits more available for those low-income and minority households. The other one is to transform Catholic schools that face closure into charter schools. In the last two years, some inner-city Catholic schools in Indianapolis, Washington D.C., and Brooklyn and Queens in New York City came under the spot light for their transformations into publicly-funded charter schools. Those Catholic schools are on the closure list because of decreasing enrolment and financial support from the Roman Catholic church or other sponsors. However, they tend to provide a positive impact on the neighborhoods by providing quality education. Keeping these schools through public funds, but retaining the school's autonomy, may be a good strategy to improve disadvantaged students' academic achievement in urban neighborhoods.

Second, it is essential to make Catholic schooling more accessible for students who would like to participate in quality schools across school district boundaries. Crossing school district boundaries for schooling often means that students need to travel a farer distance than going to their neighborhood public schools. The transportation cost is especially a concern for low-income households. Therefore, funds to subsidize school busing or other transportation means could create incentives for low-income families to choose Catholic schools farer away from home.

Third, the information about quality school choices should be distributed to as many families as possible. The lack of information about what school alternatives are available constrains parents' selection for those schools. The information is often stratified by SES. Higher SES families are more knowledgeable about school information for their offspring (Hamilton & Guin 2005). In addition, compared with affluent native Whites, immigrant families who live in the linguistic isolated neighborhoods are less informed about schools due to limited English proficiency. The effort to inform and educate those disadvantaged families about school choice information through the media, such as

Spanish brochure and TV broadcasting, could be helpful for recruiting disadvantaged students from such neighborhoods.

Fourth, learning from Catholic school experience can benefit academic achievement for public school students. Requesting public funding to support private schools, especially religious schools, is usually controversial and faces more challenges. A more doable way is to provide more science courses and encourage students to take those courses.

With respect to the magnet school effect, the second and third policy implications described above are also applicable to the policy formation for magnet schooling. The main point to keep in mind is that even magnet schooling continuously does not significantly improve achievements, it is still an important school alternative that carry a mission of school diversity and equity. With its persistent popularity and growing enrolments, more magnet school research is needed to better inform policy discussions. It is important that magnet school are of equal standing in terms of mathematics achievement with other public schools, given the fact that their student body is largely minority and school programs are vocational oriented. Previous research has reported lower achievement for schools with high percentage of minority and students who are in vocational tracks have lower performance. Therefore, quality magnet schools may still provide a superior schooling for disadvantaged students to their defecting public schools.

This study was initiated in an attempt to answer the fundamental questions of whether there are causal effects of Catholic and magnet schools, and what mechanisms could account for such effects. Previous efforts have been made to investigate the causal effect of Catholic/magnet schools. Although less information about magnet school effect is available from this study, the empirical findings still inform several policy implications.

Not only did this dissertation gauge the causal effects of Catholic/magnet schools, it also confirmed the heterogeneity in these effects across groups of students with different demographic characteristics, social backgrounds, and propensities of participating in school choices. In addition, this study unraveled school effects at the policy level – state and school district, and thus contributed to the existing school choice literature.

Bibliography

Allison, P. 2002. *Missing Data*. Thousand Oaks, CA: Sage.
Allison, Paul D. 2005. *Fixed Effects Regression Methods for Longitudinal Data Using Sas*. Cary, NC: SAS Institute Inc.
Altonji, Joseph G., Todd E. Elder, and Christopher R. Taber. 2002. "An Evaluation of Instrumental Variable Strategies for Estimating the Effects of Catholic Schools." NBER, Cambridge, MA.
Altonji, Joseph G., Todd E. Elder, and Christopher R. Taber. 2005. "Selection on Observed and Unobserved Variables: Assessing the Effectiveness of Catholic Schools." *Journal of Political Economy* 113:151-182.
Andrews, K. T. 2002. "Movement-Countermovement Dynamics and the Emergence of New Institutions: The Case of "White Flight" Schools in Mississippi." *Social Forces* 80:911-936.
Andre-Bechely, Lois. 2007. "Finding Space and Managing Distance: Public School Choice in an Urban California District." *Urban Studies* 44:1355-1376.
Andrews, K. T. 2002. "Movement-Countermovement Dynamics and the Emergence of New Institutions: The Case of "White Flight" Schools in Mississippi." *Social Forces* 80:911-936.
Angrist, J., E. Bettinger, E. Bloom, E. King, and M. Kremer. 2002. "Vouchers for Private Schooling in Colombia: Evidence from a Randomized Natural Experiment." *The American Economic Review* 92:1535-1558.
Anselin, L. 1995. "Local Indicators of Spatial Association - LISA." *Geographical Analysis* 27:93-115.
Ascher, Carol and Edwina Branch-Smith. 2005. "Precarious Space: Majority Black Suburbs and Their Public Schools." *Teacher College Record* 107:1956-1973.
Astin, Alexander W. 1992. "Educational "Choice": Its Appeal May be Illusory." *Sociology of Education* 65:255-260.
Barrow, Lisa. 2005. "Private School Location and Neighborhood Characteristics." *Economics of Education Review* 25:633-645.
Bayer, Patrick, Fernando Ferreira, and Robert McMillan. 2007. "A Unified Framework for Measuring Preferences for Schools and Neighborhoods." National Bureau of Economic Research.
Bayer, Patrick and Robert McMillan. 2005. "Choice and Competition in Local Education Markets." National Bureau of Economic Research.
Bayer, Patrick, Fernando Ferreira, and Robert McMillan. 2007. "A Unified Framework for Measuring Preferences for Schools and Neighborhoods." National Bureau of Economic Research.
Berends, Mark, Caroline Watral, Bettie Teasley, and Anna Nicotera. 2006. "Charter School Effects on Achievement: Where We are and Where We're Going." in *National Center on School Choice conference*. Nashville, TN: National Center on School Choice.
Betts, J. 2005. "The Economic Theory of School Choice." Pp. 14-39 in *Getting Choice Right*, edited by J. Betts and T. Loveless. Washington, DC: Brookings Institution Press.

Betts, Julian R. and Robert W. Fairlie. 2003. "Does immigration induce `native flight' from public schools into private schools?" *JOurnal of Public Economics* 87:987-1012.

Bifulco, Robert and Helen F. Ladd. 2006. "School Choice, Racial Segregation and Test-Score Gaps: Evidence from North Carolina's Charter School Program." in *Annual Meeting of Allied Social Science Associations*.

Briggs, Xavier de Souza. 1997. "Moving Up versus Moving Out: Neighborhood Effects in Housing Mobility." *Housing Policy Debates* 8:195-234.

—. 2003. "Bridging Networks, Social Capital, and Racial Segregation in America." John F. Kennedy School of Government, Harvard University.

Brooks-Gunn, J., G. Duncan, and J. L. Aber. 1997. *Neighborhood poverty-context and consequences for children.* New York: Russel Sage Foundation.

Brown, Lawrence A. and Su-Yeul Chung. 2006. "Spatial Segregation, Segregation Indices and the Geographical Perspective." *Population, Space and Place* 12:125-143.

Bryk, Anthony, Valerie Lee, and Peter Holland. 1993. *Catholic Schools and the Common Good*. Boston: Harvard University Press.

Buddin, R., J. J. Cordes, and Kirby S. 1998. "School Choice in California: Who Chooses Private Schools?" *Journal of Urban Economics* 44:110-134.

Burgess, Simon and Adam Briggs. 2006. "School Assignments, School Choice and Social Mobility." The Centre for Market and Public Organisation, University of Bristol.

Butler, Tim and Chris Hamnett. 2007. "The Geography of Education: Introduction." *Urban Studies* 44:1161-1174.

Card, David and Alan Krueger. 1996. "School Resources and Student Outcomes: An Overview of the Literature and New Evidence from North and South Carolina." National Bureau of Economic Research.

Card, David, Alexandre Mas, and Jesse Rothstein. 2007. "Tipping and the Dynamic of Segregation." National Bureau of Economic Research.

Card, David and Jesse Rothstein. 2006. "Racial Segregation and the Black-White Test Score Gap." National Bureau of Economic Research.

Catterall, James S. 1992. "Theory and Practice of Family Choice in Education: Taking Stock." *Economics of Education Review* 10:407-416.

Charles, Camille Z. 2000. "Residential Segregation in Los Angeles." Pp. 167-219 in *Prismatic Metropolis:Inequality in Los Angeles*, edited by L. Bobo, M. L. Oliver, J. H. J. Jr., and A. V. Jr. New York: Russell Sage Foundation.

—. 2003. "The Dynamics of Racial Residential Segregation." *Annual Review of Sociology* 29:167-207.

Christenson, Bruce, Marian Eaton, Michael S. Garet, Luke C. Miller, Hiroyuki Hikawa, and Phyllis DuBois. 2003. "Evaluation of the Magnet Schools Assistance Program, 1998 Grantees." edited by U. S. Department of Education, Office of the Under Secretary. Washington, D.C.

Chubb, John and Terry Moe. 1990. *Politics, Markets, and America's Schools*. New Haven: Yale University Press.

Clark, R. L. 1992. "Neighborhood Effects on Dropping Out of School among Teenage Boys." Urban Institute, Washington, DC.

Cochran, W. G. . 1968. "The Effectiveness of Adjustment by Subclassification in Removing Bias in Observational Studies." *Biometrics* 24:205-213.
Cloward, RIchard A. and Lloyd E. Ohlin. 1960. *Delinquency and Opportunity: A Theory of Delinquent Gangs*. Glencoe, Ill: The Free Press.
Cobb, C. and G. Glass. 1999. "Ethnic Segregation in Arizona Charter Schools." in *Education Policy Analysis Archives*, vol. 7.
Coleman, James. 1966. "Equality of Educational Opportunity." US Office of Education, Washington, D.C.
—. 1990. *Foundations of Social Theory*. Cambridge, MA: Harvard University Press.
Coleman, James S. and T. Hoffer. 1987. *Public and Private Schools: The Impact of Communities*. NY: Basic Books.
Coleman, James S., Thomas Hoffer, and Sally Kilgore. 1982. *High school achievement: Public, Catholic, and private schools compared*. New York.
Coleman, James S. 1988. "Social Capital in the Creation of Human Capital." *American Journal of Sociology* 94:95-120.
—. 1992. "Some Points on Choice in Education." *Sociology of Education* 65:260-262.
Coleman, James S. and T. Hoffer. 1987. *Public and Private Schools: The Impact of Communities*. NY: Basic Books.
Cradock, A., I. Kawachi, G. A. Colditz, C. Hannon, S. Melly, J. Wiecha, and S. Gortmaker. 2005. "Playground Safety and Access in Boston Neighborhoods." *American Journal of Preventive Medicine* 28:357-363.
Crane, J. 1991. "The Epidemic Theory of Ghettos and Neighborhood Effects on Dropping Out and Teenage Childbearing." *American Journal of Sociology* 96:1226-59.
Cullen, Julie B., Brian A. Jacob, and Steven D. Levitt. 2005. "The Impact of School Choice on Student Outcomes: an Analysis of the Chicago Public Schools." *Journal of Public Economics* 89.
Cutler, David M., Edward L. Glaeser, and Jacob Vigdor. 2007. "When Are Ghettos Bad? Lessons from Immigrant Segregation in the United States." National Bureau of Economic Research.
Dee, Thomas S., Wei Ha, and Brian A. Jacob. 2006. "The Effects of School Size on Parental Involvement and Social Capital: Evidence from the ELS: 2002." Pp. 78-97 in *Brookings Papers on Education Policy: 2006/2007*.
DeLuca, Stefanie 2007. "All Over the Map: Explaining Educational Outcomes of the Moving to Opportunity Program." *Education Next*, pp. 29-36.
Ellen, Ingrid Gould and Margery Austin Turner. 1997. "Does Neighborhood Matter? Assessing Recent Evidence." *Housing Policy Debate* 8:883-866.
Emerson, Michael O., George Yancey, and Karen J. Chai. 2001. "Does Race Matter in Residential Segregation? Exploring The Preferences of White Americans." *American sociological review* 66:922-935.
Entwisle, Doris R., Karl L. Alexander, and Linda S. Olson. 1997. *Children, Schools and Inequality*. Boulder, CO: Wastview press.
Epstein, J. 2001. *School, Family, and Community Partnerships: Preparing Educators and Improving Schools*. Boulder, Colorado: Westview Press.

Evans, William N. and Roberst M. Schwab. 1995. "Finishing high school and starting college: Do Catholic schools make a difference?" *Quarterly Journal of Economics* 110:947-974.

Fairlie, Robert W. 2002. "Private Schools and "Latino Flight" from Black Schoolchildren." *Demography* 39:655-674.

Farkas, George. 2003. "Cognitive Skills and Noncognitive Traits and Behaviors in Stratification Process." *Annual Review of Sociology* 29.

Figlio, David N. and Maurice E. Lucas. 2000. "What's in a Grade? School Report Cards and House Prices." in *NBER working paper*.

Fong, Eric and Kumiko Shibuya. 2005. "Multiethnic Cities in North America." *Annual Review of Sociology* 31:285-304.

Frank F. Furstenberg, Jr. and Mary Elizabeth Hughes. 1997. "The Influences of Neighborhoods on Children's Development: A Theoretical Perspective and a Research Agenda." in *Neighborhood Poverty: Policy Implications in Studying Neighborhoods*, edited by J. Brooks-Gunn, G. J. Duncan, and J. L. Aber. New York: Russell Sage Foundation.

Figlio, David N. and Maurice E. Lucas. 2000. "What's in a Grade? School Report Cards and House Prices." in *NBER working paper*.

Frey, William H. and Reynolds Farley. 1996. "Latino, Asian, and Black Segregation in U.S. Metropolitan Areas: Are Multiethnic Metros Different?" *Demography* 33:35-50.

Fry, Richard. 2006. "The Changing Landscape of American Public Education: New Students, New Schools." Pew Hispanic Center, Washington, DC.

Fry, Richard. 2007. "The Changing Racial and Ethnic Composition of U.S. Public Schools." Pew Hispanic Center, Washington, DC.

Fry, Richard and Felisa Gonzales. 2008. "One-in-Five and Growing Fast: A Profile of Hispanic Public School Students." Pew Hispanic Center, Washington, DC.

Furstenberg, Frank F. and Mary E. Hughes. 1997. "The Influence of Neighborhoods on Children's Development: A Theoretical Perspective and a Research Agenda." in *Indicators of Children's Well-Being*, edited by R. M. Hauser, B. V. Brown, and W. R. Prosser. New York: Russell Sage Foundation.

Gamoran, Adam. 1987. "The Stratification of High School Learning Opportunities." *Sociology of Education* 60:135-155.

Gamoran, A. 1996. "Student achievement in public magnet, public comprehensive, and private city high schools." *Educational Evaluation and Policy Analysis* 18:1-18.

Garibaldi, Antoine M. 1997. "Four Decades of Progress and Decline: An Assessment of African American Educational Attainment" *The Journal of Negro Education*." *66* 2:105-120.

Goldberger, Arthur R. and Glen G. Cain. 1982. "The causal analysis of cognitive outcomes in the Coleman, Hoffer and Kilgore Report." *Sociology of Education* 55:103-22.

Goldring, Ellen and Kristie J. Rowley. 2006. "The Public-Private Decision about School Choice." in *Annual Meeting of the American Educational Research Association*. San Francisco, California: National Research and Development Center on School Choice.

Greeley, Andrew. 1982. *Catholic high schools and minority students*. New Brunswick: Transaction Books.

Grodsky, Eric, John Robert Warren, and Erika Felts. 2008. "Testing and Social Stratification in American Education." *Annual Review of Sociology* 34:385-404.

Hamilton, L. and K. Guin. 2005. "Understanding How Families Choose Schools." in *Getting Choice Right*, edited by J. Betts and T. Loveless. Washington, DC: The Brookings Institute.

Hanushek, E. A. 1996. "School resources and student performance." Pp. 43-73 in *Does money matter? The effect of school resources on student achievement and adult success*, edited by G. Burtless. washington D.C.: Brookings Institution.

Hanushek, E. A., John F. Kain, Jacob M. Markman, and Steven G. Rivkin. 2003. "Does Peer Ability Affect Student Achievement?" *Journal of Applied Econometrics* 18.

Hanushek, Eric A., John F. Kain, and Steven G. Rivkin. 2004. "Disruption versus Tiebout Improvement: the Costs and Benefits of Switching Schools." *Journal of Public Economics* 88:1721-1746.

Hao, Lingxin and Suet-ling Pong. 2008. "The Role of School in the Upward Mobility of Disadvantaged Immigrants' Children." *The ANNALS of the American Academy of Political and Social Science* 620:62-89.

Harding, Daivid J. 2003. "Counterfactual Models of Neighborhood Effects: The Effect of Neighborhood Poverty on Dropping Out and Teenage Pregnancy." *American Journal of Sociology* 109:676-719.

Hassel, Bryan. 1998. "Governmance and Educational Equality." in *Learning from School Choice*, edited by P. Peterson and B. Hassel. Washington D. C.: Brookings Institute Press.

Hastings, Justine S., Thomas J. Kane, and Douglas O. Staiger. 2006a, "Parental Preferences and School Competition: Evidence from a Public School Choice Program", Retrieved (http://aida.econ.yale.edu/~jh529/Hastings_Kane_Staiger_QualityCompetition.pdf).

Hastings, Justine S., Thoman J. Kane, and Douglas O. Staiger. 2006b. "Preferences and Heterogeneous Treatment Effects in A Public School Choice Lottery." National Bureau of Economic Research.

Hallinan, Maureen T. 1992. "The organization of students for instruction in middle school." *Sociology of Education* 65:114-27.

Hastings, Justine S., Richard Van Weelden, and Jeffrey Weinstein. 2007. "Preferences, Information, and Parental Choice Behavior in Public School Choice." National Bureau of Economic Research.

Hastings, Justine S. and Jeffrey Weinstein. 2007. "No Child Left Nehind: Estimating the Impact on Choices and Student Outcomes." National Bureau of Economic Research.

Heckman, J. J. 1979. "Sample selection bias as a specification error." *Econometrica* 47:153-161.

Henig, J. R. 1995. "Race and Choice in Montgomery County, Maryland, Magnet Schools." *Teachers College Record* 96:729-734.

Henig, Jeffrey. 1996. "The Local Dynamics of Choice: Ethnic Preferences and Institutional Responses." in *Who Chooses? Who Loses? Culture, Institutions, and* *the Unequal Effects of School Choice*, edited by B. Fuller, R. Elmore, and G. Orfield. New York: Teacher College Press.

Helling, Amy and David S. Sawicki. 2003. "Race and Residential Accessibility to Shopping and Services." *Housing Policy Debate* 14:69-101.

Henig, J. R. 1995. "Race and Choice in Montgomery County, Maryland, Magnet Schools." *Teachers College Record* 96:729-734.

Henig, J. R. and S.D. Sugarman. 1999. "The nature and extent of school choice." in *School choice and social controversy: Politics, policy, and law*, edited by S. D. Sugarman and F. R. Kemerer. Washington, DC: Brookings.

Hensher, DA, JM Rose, and WH Greene. 2005. *Applied Choice Analysis*: Cambridge University Press.

Hill, P. T., G. E. Foster, and T. Gendler. 1990. "High schools with character." The RAND Corporation, Santa Monica.

Hoffer, T., Andrew M. Greeley, and J.S. Coleman. 1985. "Achievement growth in public and Catholic schools." *Sociology of education* 58:74-97.

Hong, G. and S. W. Raudenbush. 2005. "Effects of Kindergarten Retention Policy on Children's Cognitive Growth in Reading and Mathematics." *Educational Evaluation and Policy Analysis* 27:205-224.

Hoxby, C. M. 1994. "Do private schools provide competition for public schools?" National Bureau of Economic Research.

—. 2000. "Does Competition among public schools benefit students and taxpayers?" *american economic review* 90:1209-1238.

Hoxby, Caroline M. 1998 What do America’s “traditional” forms of school choice teach us about school choice reforms? FRBNY Economic Policy Review

Hoxby, Caroline M. 2003. "School Choice and School Productivity: Could Public School Be a Tide that Lifts All Boats?" in *The Economics of School Choice*, edited by C. M. Hoxby. Chicago: The University of Chicago Press.

Hoxby, C. M. 2004. "A Straightforward Comparison of Charter Schools and Regular PUblic Schools in the United States."

Hoxby, Caroline M. and Gretchen Weingarth. 2005. “Taking Race Out of the Equation: School Reassignment and The Structure of Peer Effects.” Department of Economics, Harvard University.

Huerta, L. A., M-F. Gonzalez, and C. d'Entrement. 2006. "Cyber and home school charter schools: Adopting policy to new forms of public schooling " *Peabody Journal of Education* 81:103-139.

Iceland, J. 2004. "Beyond Black and White - Metropolitan Residential Segregation in Multiethnic America." *Social Science Research* 33:498-520.

Ingels, Steven J., Daniel J. Pratt, James E. Rogers, Peter H. Siegel, and Ellen S. Stutts. 2005. "Education Longitudinal Study of 2002: Base-Year to First Follow-up Data File Documentation (NCES 2006–344)." edited by U. S. D. o. Education. Washington, DC: National Center for Education Statistics.

Jargowsky, Paul A. 1996. *Poverty and Place: Ghettos, Barrios, and the American City*. New York: Russell Sage.

Jencks, Christopher and Susan Mayer. 1990. "The Social Consequences of Growing up in a Poor Neighborhood." in *Inner-City Poverty in the United States*, edited by L. E. Lynn and M. G. H. McGeary. Washington, D.C.: National Academy Press.

Kao, Grace. 1995. "Asian-Americans as Model Minorities? A look at their academic performance." *American Journal of Education* 103:121-159.
—. 2002. "Ethnic Differences in Parents' Educational Aspirations." *Schooling and Social Capital in Diverse Cultures* 13:85-103.
Kao, Grace and Jennifer S. Thompson. 2003. "Racial and Ethnic Stratification in Educational Achievement and Attainment." *Annual Review of Sociology* 103:417-442.
Kleitz, B., G. R. Weiher, K. Tedin, and R. Matland. 2000. "Choice, Charter Schools, and Household Preferences." *Social Science Quarterly* 81:846-849.
Kelly, Sean. 2009. "The black-white gap in mathematics course taking." *Sociology of Education* 82:47-69.
King, Gary, James Honaker, Anne Joseph, and Kenneth Scheve. 2001. "Analyzing Incomplete Political Science Data: An Alternative Algorithm for Multiple Imputation." *American Political Science Review Vol. 95, No. 1 March 2001* 95:49-69.
Lankford, H., E. S. Lee, and J. Wyckoff. 1995. "An Analysis of Elementary and Secondary School Choice." *Journal of Urban Economics* 38:235-251.
Lankford, Hamilton and James Wyckoff. 1992. "Primary and Secondary School Choice Among Public and Religious Alternatives." *Economics of Education Review* 11:317-37.
—. 2001. "Who Would Be Left Behind by Enhanced Private School Choice?" *Journal of Urban Economics* 50:288-312.
—. 2006. "The effect of school choice and residential location on the racial segregation of students." Pp. 185-239 in *Improving School Accountability: Check-Ups or Choice*, vol. 14, *Advances in Applied Microeconomics*, edited by T. J. Gronberg and D. W. Jansen: Elsevier.
Lauen, Douglas L. 2007. "Contextual Explanations of School Choice." *Sociology of Education* 80:179-209.
Lavy, Victor. 2006. "From Forced Busing to Free Choice in Public Schools: Quasi-Experimental Evidence of Individual and General Effects." National Bureau of Economic Research.
Lee, Barrett A., R. S. Oropesa, and James W. Kanan. 1994. "Neighborhood Context and Residential Mobility." *Demography* 31:249-270.
Lee, Barrett A., Sean F. Reardon, Glenn Firebaugh, Chad R. Farrell, Stephen A. Matthews, and David O'Sullivan. 2007. "Beyond the Census Tract: Patterns and Determinants of Racial Residential Segregation at Multiple Scales." Population Research Institute, Pennsylvania State University.
Lee, Valerie E., Robert G. Croninger, and Julia B. Smith. 1994. "Parental Choie of Schools and Social Stratification in Education: The Paradox of Detroit." *Educational Evaluation and Policy Analysis* 16:434-457.
Lee, Valerie E., Julia B. Smith, and Robert G. Croninger. 1997. "How High School Organization Influences the Equitable Distribution of Learning in Mathematics and Science." *Sociology of Education* 70.
Levin, Henry M. 1992. "The Economics of Educational Choice." *Economics of Education Review* 11.

Levin, Henry R. 2009. "An Economic Perspective on School Choice." in *Handbook of Research on School Choice*, edited by M. Berends, M. G. Springer, D. Ballou, and H. J. Walberg. New York: Routledge.
Little, R.J.A. and Rubin, D.B. 1987. *Statistical Analysis with Missing Data*. New York: J. Wiley & Sons.
Lobo, Arun P., Ronald J. Flores, and Joseph J. Salvo. 2002. "The Impact of Hispanic Growth on the Racial/Ethnic Composition of New York City Neighborhoods." *Urban Affairs Review* 37:703-727.
Logan, John, B. Stults, and R. Farley. 2004. "Segregation of Minorities in the Metropolis: Two Decades of Change." *Demography* 41:1-22.
Logan, John R. 2001. "The New Ethnic Enclaves in America's Suburbs." Lewis Mumford Center for Comparative Urban and Regional Research.
Lopez, Gerardo R., Jay D. Scribner, and Kanya Mahitivanichcha. 2001. "Redefining parental involvement: Lessons from high-performing migrant-impacted schools." *American Educational Research Journal* 38:253-288.
Louie, Vivian and Jennifer Holdaway. 2009. "Catholic Schools and Immigrant Students: A New Generation." *Teachers College Record* 111:783-816.
Lucas, Samual R. 1999. *Tracking inequality*. New York: Teachers College Press.
Manski, Caharles F. 1992. "Educational Choice (Vouchers) and Social Mobility." *Economics of Education Review* 11.
Massey, D. 1985. "Ethnic Residential Segregation: A Theoretical Synthesis and Empirical Review." *Sociology and Social Research* 69: 315-50.
Massey, D. and N. A. Denton. 1989. "Hypersegregation in US metropolitan areas: Black and Hispanic segregation along five dimensions." *Demography* 26:373-391.
Massey, Douglass S. and Nancy A. Denton. 1993. *American Apartheid: Segregation and the Making of the Underclass*. Cambridge, Mass: Harvard University Press.
Massey, Douglas S. and Eric Fong. 1990. "Segregation and Neighborhood Quality: Blacks, Hispanics, and Asians in the San Francisco Metropolitan Area." *Social Forces* 69:15-32.
McArdle, Nancy. 2002. "Race, Place, and Opportunity: Racial Change and Segregation in the San Diego Metropolitan Area, 1990-2000."
McDonald, Dale and Margaret M. Schultz. 2008. "Annual Statistical Report on Schools, Enrollment, and Staffing: United States Catholic Elementary and Secondary Schools 2007-2008." National Catholic Educational Association, Washington, D.C.
McMillan, C. B. 1980. *Magnet Schools: An Approach to Voluntary Desegregation.* Bloomington, IN: Phi Delta Kappa.
Meyer, Peter. 2007. "Can Catholic Schools Be Saved?" *Education Next*, pp. 13-20.
Moe, Terry. 1995. "School Choice and the Creaming Problem." in *Midwest Approach to School Reform*, edited by T. A. Downs and W. A. Testa. Chicago: Federal Reserve of Chicago.
Moe, Terry M. 2001. *Schools, Vouchers, and the American Public*. Washington, D.C.: The Brookings Institution.
Morgan, Stephen L. and Aage B. Sørensen. 1999. "Parental Networks, Social Closure, and Mathematics Learning: A Test of Coleman's Social Capital Explanation of School Effects." *American Sociological Review* 64:661-681.

Morgan, Stephen L. 2001. "Counterfactuals, Causal Effect Heterogeneity, and the Catholic School Effect on Learning " *Sociology of Education* 74:341-74.

Morgan, Stephen L. and Daivid J. Harding. 2006. "Matching Estimates of Causal Effects: Prospects and Pitfalls in Theory and Practice." *Sociological Methods & Research* 35:3-60.

Morgan, Stephen L. and Christopher Winship. 2007. *Counterfactuals and Causal Inference: Methods and Principles for Social Research*. New York: Cambridge University Press.

Murnane, R. J., S. Newstead, and R. J. Olsen. 1985. "Comparing Public and Private Schools: The Puzzling Role of Selectivity Bias." *Journal of business and statistics* 3:23-35.

Murnane, R. J., J. B. Willett, and Randal Olsen. 1985. "Comparing public and private schools: the puzzling role of selectivity bias." *Journal of economics and business statistics* 3:23-35.

Nawata, Kazumitsu. 1993. "A Note on the Estimation of Models with Sample-Selection Biases." *Economics Letters* 42:15-24.

Neal, Derek. 1997. "The Effects of Catholic Secondary Schooling on Educational Achievement." *Journal of Labor Economics* 15:99-123.

Noell, Jay. 1982. "Public and Catholic schools: a reanalysis of public and private schools." *Sociology of Education* 55:123-132.

Olsen, R.J. 1982. "Distributional tests for selectivity bias and a more robust likelihood estimator." *International Economic Review* 23:223-240.

Olson, Lynn 2006. "A Decade of Effort." *Quality Counts*, Jaunary 5, 2006, pp. 8-10, 12,14,16, 18-21.

Orfield, G., S. E Eaton, and E. R. Jones. 1996. *Dismantling Desegregation: The Quiet Reversal of Brown v. Board of Education*. New York:: New Press.

Orfield, G. and J. T. Yun. 1999. "Resegregation in American Schools." Civil Right Project, Harvard University, Cambridge, MA.

Orfield, Gary. 2001. "Schools More Separate: Consequences of A Decade of Resegregation." Harvard University, Cambridge, Massachusetts.

—. 2004. "Losing Our Future: Minority Youth Left Out." in *Dropouts in America: Confronting the Graduation Rate Crisis*, edited by G. Orfield. Cambridge, Massachusetts: Harvard Education Press.

Patacchini, Eleonora and Yves Zenou. 2007. "Intergenerational Education Transmission: Neighborhood Quality and/or Parents' Involvement." IZA.

Pew Hispanic Center tabulations of 2008 American Community Survey. 2008, "Statistical Portrait of Hispanics in the United States, 2008", (http://pewhispanic.org/factsheets/factsheet.php?FactsheetID=58).

Plank, S., K. Schiller, B. Schneider, and James S. Coleman. 1993. "Effects of Choice in Education." in *School Choice: Examining the Evidence*, edited by E. Rasell and R. Rothstein. Washington, D. C.: Economic Policy Institute.

Pong, Suet-ling and Aaron Pallas. 2001. "Class Size and Eight-Grade Math Achievement in the United States and Abroad." *Education Policy Analysis Archives* 23:251-273.

Portes, Alejandro and Patricia Fernandex-Kelly. 2008. "No Margin for Error: Educational and Occupational Achievement among Disadvantaged Children of Immigrants."

The ANNALS of the American Academy of Political and Social Science 620:12-36.

Powell, L. M., S. Slater, F. J. Chaloupka, and D. Harper. 2006. "Availability of Physical Activity-related Facilities and Neighborhood Demographic and Sociodemographic Characteristics: A National Study." *American Journal of Public Health* 96:1676–80.

Quillian, Lincoln. 1999. "Migration Patterns and the Growth of High-Poverty Neighborhoods, 1970-1990." *American Journal of Scociology* 105:1-37.

Raudenbush, S. W. and A. S. Bryk. 2002. *Hierarchical Linear Models: Applications and Data Analysis Methods*. Thousand Oaks: Sage Publications.

Raywid, Mary Anne. 1985. "Family Choice Arrangements in Public Schools: A Review of the Literature." *Review of Educational Research* 55:435-467.

Reardon, SF, JT Yun, and M Kurlaender. 2006. "Implications of Income-Based School Assignment Policies for Racial School Segregation " *Educational Evaluation and Policy Analysis* 28:49-75.

Reardon, Sean F. and Glenn Firebaugh. 2002. "Measures of MultiGroup Segregation." *Sociological Methodology* 32:33-67.

Reardon, Sean F. and John T. Yun. 2001. "Suburban Racial Change and Suburban School Segregation, 1987-95." *Sociology of Education* 74:79-101.

Reardon, Sean F., John T. Yun, and Tamela M. Eitle. 2000. "The Changing Structure of School Segregation: Measurement and Evidence of Multiracial Metropolitan-Area School Segregation, 1989-1995." *Demography* 37:351-364.

Reback, Randall. 2006. "Demand (and Supply) in an Inter-District Public School Choice Program." BARNARD COLLEGE ECONOMICS DEPT. WORKING PAPER SERIES.

Rivkin, Steven G., Eric A. Hanushek, and John F. Kain. 2005. "Teachers, Schools, and Academic Achievement." *Econometrica* 73:417-458.

Rooney, R., W. Hussar, M. G. Planty, S. P. Choy, G. Hampden-Thompson, S. Provasnik, and M.A. Fox. 2006. "The Condition of Education." U.S. Department of Education, National Center for Education Statistics, Washington, DC.

Rosenbaum, Paul R. and Donald B. Rubin. 1983a. "Accessing Sensitivity to an Unobserved Covariate in an Observational Study with Binary Outcome." *Journal of the Royal Statistical Society* 45:212-18.

—. 1983b. "The Central Role of the Propensity Score in Observational Studies for Causal Effects." *Biometrika* 70:41-55.

—. 1984. "Reducing Bias in Observational Studies Using Subclassification on the Propensity Score." *Journal of the American Statistical Association* 79:516-524.

Rubenstein, Ross, Amy Ellen Schwartz, Leanna Stiefel, and Hella Bel Hadj Amor. 2007. "From Districts to Schools: The Distribution of Resources Across Schools in Big City School District." *Economics of Education Review* 26:532-545.

Rubin, D. 1986. "Statistical Matching Using File Concatenation with Adjusted Weights and Multiple Imputations." *Journal of Business and Economic Statistics* 4:87-94.

Rubin, D.B. 1987. *Multiple Imputation for Nonresponse in Surveys*. J. Wiley & Sons, New York.

Rubin, Donald. 1977. "1977formalizing Subjective Notions About the Effect of Nonrespondents in Sample Surveys." *Journal of the American Statistical Association* 72:538-43.
Sampson, Robert J. and Lydia Bean. 2006. "Cultural Mechanisms and Killing Fields: A Revised Theory of Community-Level Racial Inequality." in *The Many Colors of Crime: Inequalities of Race, Ethnicity, and Crime in America*, edited by R. D. Peterson, L. J. Krivo, and J. Hagan. New York: New York University Press.
Sampson, Robert J., Jeffrey D. Morenoff, and Felton Earls. 1999. "Beyond Social Capital: Spatial Dynamics of Collective Efficacy for Children." *American sociological review* 64:633-660.
Sampson, Robert J., Stephen W. Raudenbush, and Felton Earls. 1997. "Neighborhoods and Violent Crime: A Multilevel Study of Collective Efficacy." *Science* 277:918-924.
Sander, William and Anthony Krautmann. 1995. "Catholic Schools, Dropout Rates, and Educational Attainment." *Economic inquiry* 33:217-233.
Saporito, Salvatore. 2003. "Private Choices, Public Consequences: Magnet School Choice and Segregation by Race and Poverty." *Social Problems* 50:181-203.
Saporito, Salvatore and Annette Lareau. 1999. "School Selection as a Process: The Multiple Dimensions of Race in Framing Educational Choice." *Social Problems* 46:418-439.
Saporito, Salvatore and Deenesh Sohoni. 2006. "Coloring Outside the Lines: Racial Segregation in Public Schools and Their Attendance Boundaries." *Sociology of Education* 79:81-105.
Schafer, Joseph L. . 1997. *Analysis of Incomplete Multivariate Data*. London: Chapman and Hall.
Schneider, Barbara, Kathryn Schiller, and James S. Coleman. 1996. "Public School Choice: Some Evidence From the National Education Longitudinal Study of 1988." *Educational Evaluation and Policy Analysis* 18:19-29.
Schneider, Barbara, Adam E. Wyse, and Venessa Keesler. 2006. "Is Small Really Better? Testing Some Assumptions about High School Size." Pp. 15-47 in *Brookings Papers on Education Policy: 2006/2007*.
Schneider, Mark and Jack Buckley. 2002. "What do Parents Want from Schools? Evidence from the Internet." *Educational Evaluation and Policy Analysis* 24:133-144.
Schneider, Mark, P. Teske, and M. Marschall. 2000. *Choosing Schools: Consumer Choice and the Quality of American Schools*. Princeton: Princeton University Press.
Schneider, M., P. Teske, M. Marschall, and C. Roch. 1998. "Shopping for schools: In the Land of the Blind, the One-Eyed Parent May Be Enough." *American Journal of Political Science* 42:769-793.
Schneider, Mark, P. Teske, C. Roth, and M. Marschall. 1997. "Networks to Nowhere: Segregation and Startification in Networks of Information about Schools." *American Journal of Political Science* 41:1201.
Shaw, Clifford and Henry D. McKay. 1942. *Juvenile Delinquency and Urban Areas*. Chicago: University of Chicago Press.
Small, Mario Luis and Katherine Newman. 2001. "Urban Poverty After The Truly

Disadvantaged: The Rediscovery of the Family, Neighborhood, and Culture." *Annual Review of Sociology* 27:23-45.
Smock, Pamela J. and Franklin D. Wilson. 1991. "Desegregation and the Stability of White Enrollments: A School-Level Analysis, 1968-84." *Sociology of Education* 64:278-292.
Snyder, Thomas D. . 2008. "Mini-Digest of Education Statistics, 2007 (NCES 2008-023). ." edited by I. o. E. S. National Center for Education Statistics, U.S. Department of Education.
Snyder, T.D., and Dillow, S.A. 2010. "Digest of Education Statistics 2009" (NCES 2010-013).
National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC.
South, S. J., E. P. Baumer, and A. Lutz. 2003. "Interpreting Community Effects on Youth Educational Attainment." *Youth and Society* 35:3-36.
Taub, Richard P., D. Garth Taylor, and Jan D. Dunham. 1984. "A Revised Theory of Racial Tipping." Pp. 143-166 in *Paths of Neighborhood Change*. Chicago: The University of Chicago Press.
Teske, Paul and Mark Schneider. 2001. "What Research Can Tell Policymakers About School Choice?" *Journal of Policy Analysis and Management* 20:609-31.
Theil, H. 1972. *Statistical Decomposition Analysis*. Amsterdam: North-Holland.
Tice, Peter, Daniel Princiotta, and Stacey Bielick. 2006. "Trends in the Use of School Choice: 1993 to 2003." U.S. Department of Education, National Center for Education Statistics.
Tiebout, Charles M. 1956. "A Pure Theory of Locational Expenditures." *The Journal of Political Economy* 64:416-424.
Tiggs, Leann M., Irene Browne, and Gary P. Green. 1998. "Social Isolation of the Urban Poor: Race, Class, and Neighborhood Effects on Social Resources." *The Sociological Quarterly* 39:53-77.
U.S. Department of Education, NCES. 2006. "The Condition of Education 2006." Washington, DC: U.S. government printing office.
U.S. Department of Education, NCES. 2007. "The Condition of Education 2007." Washington, DC: U.S. government printing office.
United Nations, Department of Economic and Social Affairs, Population Division. 2009. "International Migration Report 2006: A Global Assessment."
Vigdor, Jacob and Jens Ludwig. 2007. "Segregation and the Black-White Test Score Gap." National Bureau of Economic Research.
Warren, JR. . 1996. "Educational Inequality among White and Mexican-Origin Adolescents in the American Southwest: 1990." *Sociology of Education* 69:142-158.
Wassmer, Robert W. 2002. "An Economic View of Some Causes of Urban Spatial Segregation and its Costs and Benefits." Graduate Program in Public Policy and Administration, California State University.
Welch, Susan, Lee Sigelman, Timothy Bledsoe, and Michael Combs. 2001. *Race and Place: Race Relations in An American City*. New York: Cambridge University Press.
Wells, Amy Stuart 1993. "The Sociology of School Choice: Why Some Win and Others

Lose in the Educational Marketplace." in *School Choice: Examining the Evidence*, edited by E. Rassell and R. Rothstein. Washington, D. C.: Economic Policy Institute.
Willms, D. 1985. "Catholic-school effects on acade-mic achievement: New evidence from the High School and Beyond follow-up study. ." *Sociology of Education* 58:98-114.
Wilson, Franklin D. 1985. "The Impact of School Desegregation Programs on White Public-School Enrollment, 1968-1976." *Sociology of Education* 58:137-153.
Wilson, Franklin D. and Karl E. Taeuber. 1978. "Residential and School Segregation: Some Tests of Their Association." in *The Demography of Racial and Ethnic Groups*, edited by W. P. Frisbie and F. D. Bean. New York: Academic Press.
Wilson, William Julius. 1987. *The Truly Disadvantaged: The Inner-City, the Underclass, and Public Policy*. Chicago: University of Chicago Press.
Winship, Christopher and Stephen L. Morgan. 1999. "The Estimation of Causal Effects from Observational Data." *Annual Review of Sociology* 25:659-706.
Witte, John F. 1992. "Private Schools versus public school achievement." *Economics of Education Review* 11:371-394.
Witte, John F. 1996a. "Who Benefits from the Milwaukee Choice Program?" Pp. 25-49 in *Who Chooses? Who Loses? Culture, Institutions, and the Unequal Efefcts of School Choice*, edited by B. Fuller, R. Elmore, and G. Orfield. New York: Teacher College Press.
—. 1996b. "School Choice and Student Performance." Pp. 149-175 in *Holding Schools Accountable*, edited by H. F. Ladd. Washington, DC: The Brookings Institution.
—. 2000. *The Market Approach to Education: An Analysis of America's First Voucher Program*. Princeton, N.J.: Princeton University Press.
Wolf, Patrick J. 2009. "Lost Opportunities." *Education Next*.

Woessmann, L. 2003. "Schooling resources, educational institutions, and student performance: The international evidence.". *Oxford Bulletin of Economics and Statistics* 65:117-170.
Woessmann, Ludger and Martin R. West. 2002. "Class-Size Effects in School Systems Around the World: Evidence from Between-Grade Variation in TIMSS." in *IZA-Discussion Paper Series*, vol. 485: IZA.
Yinger, John. 1995. "The impact of Housing Discrimination on Education, Employment, and Poverty." Pp. 135-158 in *Closed Doors, Opportunities Lost*. New York: Russell Sage Foundation.
Zenk, S. N., A. J. Schulz, B. A. Israel, S. A. James, S. Bao, and M. L. Wilson. 2005. "Neighborhood Racil Composition, Neighborhood Poverty, and the Spatial Accessibility of Supermarkets in Metropolitan Detroit." *American Journal of Public Health* 95:660-667.
Zhou, Min. 2000. "Social Capital in Chinatown: The Role of Community-Based Organizations and Families in the Adaption of the Younger Generation." in *Contemporary Asian America: a multidisciplinary reader*, edited by M. Zhou and J. V. Gatewood. New York: New York University Press.
Zhou, L. 2009. "Revenues and Expenditures for Public Elementary and Secondary School Districts: School Year 2006-07 (Fisical Year)." National Center for

Education Statistics, Institute of Education Sciences, U.S. Department of Education, Washington, DC.

Appendix A

Table A1. Descriptive Statistics for Variables, full main sample (with missingnesses)

Variables	Mean	SD	Min	Max	N
Outcome variable: 12th-grade math score	49.18	15.23	15.2	81.31	9240
Previous academic performance					
10th-grade math score	43.97	14.01	13.87	82.03	9240
Catholic school participation	0.04	0.01	0	1	9240
Demographics & family background					
White	0.57	0.01	0	1	9240
Asian	0.04	0.00	0	1	9240
Black	0.16	0.01	0	1	9240
Hispanic	0.18	0.01	0	1	9240
Other race	0.05	0.01	0	1	9240
Male	0.49	0.50	0	1	9240
Age	18.35	0.55	16.92	21.03	9220
Immigrant	0.29	0.46	0	1	8170
English as native language	0.81	0.39	0	1	9240
Number of siblings	2.26	1.51	0	6	7650
Step parent	0.14	0.35	0	1	9240
Single parent	0.21	0.40	0	1	9240
No parent	0.04	0.19	0	1	9240
Socioeconomic status	0.06	0.74	-2.11	1.81	9240
Mother does not work	0.24	0.43	0	1	8760
Mother works part time	0.18	0.38	0	1	8760
Catholic affiliation	0.42	0.49	0	1	7530
Urban	0.38	0.49	0	1	9240
Northeast	0.20	0.40	0	1	9240
Midwest	0.25	0.44	0	1	9240
West	0.22	0.41	0	1	9240
Neighborhood segregation	0.57	0.24	0.04	0.99	8850
Neighborhood crime: moderate	0.10	0.31	0	1	7610
Neighborhood crime: high	0.02	0.13	0	1	7610
# public schools within 2 miles	1.12	1.73	0	16	8850
Private schools in the residential county/city receiving state fund	0.21	0.41	0	1	9240
Poverty rate	12.24	8.74	0	59.95	8850
Student's school experience					
Ever repeated grade	0.08	0.26	0	1	9240
Attend general program	0.33	0.47	0	1	8690
Attend vocational program	0.10	0.30	0	1	8690
School characteristics					

Table A1. (continued)

Variables	Mean	SD	Min	Max	N
School offers vocational program	0.78	0.41	0	1	8080
School mean score	37.82	6.30	21.36	56.77	9240
% out-of-field teaching	4.41	16.57	0	100	7530
% in ESL program	4.07	8.39	0	100	7460
% receive free-reduced lunch	29.95	20.86	0	96.2	7030
% living in linguistic isolated neighborhood	20.94	19.30	0	100	8850
% school minority	37.45	31.23	0.58	100	9050
% certified teachers	93.60	14.82	2	100	8990
School district characteristics:					
% in academic program	82.27	25.08	0	100	8280
% in dropout remedial program	19.75	25.54	0	100	5650
% in drug prevention program	45.39	34.98	0	100	7510
% in ESL program	4.17	7.13	0	71	8120
% receive free-reduced lunch	30.87	20.55	0	96.2	7590
% living in linguistic isolated neighborhood	20.95	17.80	2.94	90.34	9200
% school minority	37.33	29.20	0.58	100	9120
School district mean score	37.82	5.72	21.67	56.62	9240
% out-of-field teaching	4.42	15.88	0	100	8130
% certified teachers	93.51	13.46	2	100	9090
% in vocational program	47.41	32.49	0	100	7160
SES composition	0.06	0.39	-0.99	1.08	9240
Poverty rate	12.26	6.89	1.63	38.61	9200
Percent dropout	6.89	8.91	0	59.00	9180
% White	61.70	26.91	0	99.73	9180
% Black	18.63	19.63	0	94.82	9180
% Limited English Proficiency	25.10	62.16	0	25.42	8390

Note:

1. Reference categories for race, family composition, mother working status, urbanicity, region, neighborhood crime, and school program attended are white, two-parent family, mother has full-time work, suburban, south, low neighborhood crime, and college preparatory program.
2. The sample is weighted with the first follow-up weight (f1qwt) and takes into account sampling design that students are nested within schools.
3. Interaction terms are not listed in the table.

Table A2. Logistic Regression for the Estimation of the Propensity Score

	Coef.	Robust SE	z	P>|z|	[95% Conf. Interval]	
Previous academic performance						
10th -grade math score	0.01	0.00	3.45	0.00	0.01	0.02
Demographics & family background						
Asian	0.71	0.70	1.02	0.31	-0.65	2.07
Black	0.15	0.35	0.42	0.68	-0.54	0.83
Hispanic	0.22	0.40	0.56	0.58	-0.56	1.01
Other race	0.95	0.42	2.24	0.03	0.12	1.78
Male	0.16	0.08	2.10	0.04	0.01	0.32
Age	-0.11	0.08	-1.42	0.16	-0.26	0.04
Immigrant	-0.25	0.17	-1.5	0.13	-0.57	0.08
English as native language	0.93	0.16	5.78	0.00	0.61	1.24
Number of siblings	-0.03	0.04	-0.67	0.50	-0.11	0.05
Step parent	-0.50	0.13	-3.76	0.00	-0.76	-0.24
Single parent	-0.25	0.11	-2.26	0.02	-0.46	-0.03
No parent	-0.13	0.24	-0.55	0.59	-0.61	0.34
Socioeconomic status	0.51	0.12	4.09	0.00	0.26	0.75
Mother does not work	0.44	0.12	3.73	0.00	0.21	0.67
Mother works part time	0.15	0.12	1.29	0.20	-0.08	0.38
Catholic affiliation	2.41	0.11	21.59	0.00	2.19	2.63
Urban	0.45	0.26	1.72	0.09	-0.06	0.97
Northeast	0.38	0.12	3.12	0.00	0.14	0.62
Midwest	0.08	0.12	0.73	0.47	-0.14	0.31
West	-0.44	0.13	-3.29	0.00	-0.70	-0.18
Neighborhood segregation	-0.40	0.38	-1.05	0.30	-1.14	0.35
Neighborhood crime: moderate	0.25	0.14	1.74	0.08	-0.31	0.53
Neighborhood crime: high	0.60	0.29	2.04	0.04	0.02	1.17
# public schools within 6 miles	0.04	0.01	6.24	0.00	0.03	0.05
Public aid available for Catholic schooling	0.03	0.09	0.30	0.76	-0.16	0.21
Poverty rate	2.45	1.64	1.49	0.14	-0.76	5.66
Interaction terms						
Black * immigrant	0.46	0.34	1.35	0.18	-0.21	1.14
Asian * immigrant	0.08	0.54	0.16	0.88	-0.97	1.14
Hispanic * immigrant	0.17	0.27	0.64	0.52	-0.35	0.70
Other race * immigrant	-0.07	0.43	-0.17	0.86	-0.91	0.76
Black * SES	0.13	0.20	0.66	0.51	-0.25	0.51
Asian * SES	0.26	0.22	1.17	0.24	-0.18	0.70
Hispanic * SES	1.04	0.17	6.21	0.00	0.71	1.36
Other race * SES	-0.10	0.29	-0.32	0.75	-0.67	0.48
Black * mother no work	-0.06	0.33	-0.20	0.84	-0.70	0.57
Asian * mother no work	0.40	0.39	1.03	0.30	-0.36	1.16
Hispanic * mother no work	-0.25	0.26	-0.97	0.33	-0.77	0.26
Other race * mother no work	0.09	0.48	0.19	0.85	-0.85	1.03
Black * mother works PT	0.67	0.35	1.89	0.06	-0.02	1.36

Table A2. (continued)

Asian * mother works PT	-0.36	0.48	-0.74	0.46	-1.30	0.59
Hispanic * mother works PT	-0.12	0.30	-0.39	0.70	-0.70	0.47
Other race * mother works PT	-0.66	0.61	-1.08	0.28	-1.86	0.54
Black * # siblings	-0.18	0.08	-2.18	0.03	-0.33	-0.02
Asian * # siblings	-0.34	0.15	-2.27	0.02	-0.64	-0.05
Hispanic * # siblings	-0.32	0.09	-3.61	0.00	-0.49	-0.15
Other race * # siblings	-0.24	0.13	-1.83	0.07	-0.49	0.02
# siblings * SES|	0.05	0.05	1.17	0.24	-0.04	0.14
Black * Catholic Affiliation	-0.81	0.29	-2.79	0.01	-1.38	-0.24
Asian * Catholic Affiliation	-0.82	0.36	-2.28	0.02	-1.52	-0.12
Hispanic * Catholic Affiliation	-0.11	0.35	-0.3	0.77	-0.80	0.59
Other race * Catholic Affiliation	-0.50	0.40	-1.23	0.22	-1.29	0.30
Urban * neighborhood seg	1.91	0.40	4.72	0.00	1.12	2.70
Black*urban*neighborhood seg	0.51	0.58	0.88	0.38	-0.63	1.65
Asian*urban*neighborhood seg	0.80	0.67	1.19	0.24	-0.52	2.12
Hispanic*urban*neighborhood seg	0.53	0.46	1.16	0.25	-0.37	1.42
Other*urban * neighborhood seg	0.28	0.64	0.44	0.66	-0.97	1.53
Segregation * Poverty	-9.88	2.84	-3.48	0.00	-15.43	-4.30
Urban* # public schools in 6 miles	-0.01	0.01	-0.98	0.51	-0.02	0.01

The Number of observations = 9,240
Wald chi2(64) = 1396.05
Prob > chi2 = 0.0000
Log pseudolikelihood = -1462.6719
Pseudo R2 = 0.3045

Table A3. Catholic School Effect on Mathematics Achievement for 12th -Grade Catholic School Students *Cross School District* Sample

	Catholic school effect	StdE	t	N
Main effect + 10th-grade score + (demographics & background)	1.051	0.586	1.792	3,800
School district fixed effect	0.984	0.722	1.362	3,610
School district fixed effect:				
Stratum 1: 1st quintile	1.293	1.018	1.271	2,020
Stratum 2: 2nd quintile	1.448	1.144	1.265	890
Stratum 3: 3rd quintile	-1.137	2.258	-0.503	320
Stratum 4: 4th quintile	-7.169	4.61	-1.555	220
Stratum 5: 5th quintile	2.278	2.198	1.036	170
1st – 2nd quintiles	1.254	0.787	1.593	2,900
3rd – 5th quintiles	-0.841	1.354	-0.621	710
With public aid for Catholic Schooling	1.967	0.995	1.976	810
Without public aid for Catholic schooling	0.514	0.809	0.636	2,800

Note:

1. The number of observation is the average of 5 imputed data. The match sample includes 3,800 students, including 720 Catholic school students and 3,800 public school students.
2. Design effect is controlled by taking into account school clusters and probability weighting scheme (using first follow-up student weight *f1qwt*), as well as estimating robust standard error.

Table A4. Catholic School Effect on Reading Achievement for 10th -Grade Catholic School Students

	Catholic school effect	StdE	t	N
Main effect	3.364	0.731	4.604	6,120
Full model	1.229	0.655	1.811	6,120
Strata fixed effect	1.271	0.651	1.954	6,120
Stratum 1: 1st quintile	1.748	0.893	1.956	2,810
Stratum 2: 2nd quintile	1.76	0.828	2.126	1,460
Stratum 3: 3rd quintile	1.176	0.86	1.367	860
Stratum 4: 4th quintile	0.338	0.98	0.345	570
Stratum 5: 5th quintile	0.432	1.05	0.412	430
1st – 2nd quintiles	1.8	0.71	2.536	4,270
3rd – 5th quintiles	1.541	0.663	0.325	1,850
State fixed effect	1.657	0.685	2.42	5,920

Table A5. Catholic School Effect on Reading Achievement for 10th -Grade Catholic School Students, by Race/Ethnicity

	Catholic school effect	StdE	t	N
White Students				
Main effect	2.142	0.755	2.836	3,500
Full model	0.885	0.684	1.294	3,500
Strata fixed effect	0.880	0.679	1.296	3,500
1st – 2nd quintiles	1.260	0.790	1.595	2,150
3rd – 5th quintiles	0.072	0.717	1.494	1,350
State fixed effect	1.369	0.732	1.869	3,360
Blake Students				
Main effect	3.633	1.258	2.889	760
Full model	1.948	1.308	1.490	760
Strata fixed effect	2.113	1.311	1.611	760
1st – 2nd quintiles	0.978	1.385	0.706	710
3rd – 5th quintiles	1.802	1.398	1.289	60
State fixed effect	2.925	1.297	2.255	750
Hispanic Students				
Main effect	5.201	0.921	5.646	880
Full model	2.368	0.984	2.406	880
Strata fixed effect	2.73	0.983	2.776	880
1st – 2nd quintiles	3.826	1.157	3.306	650
3rd – 5th quintiles	3.506	1.027	3.415	230
State fixed effect	2.517	1.089	2.312	860

Appendix B

EMPIRICAL RESULTS:

THE MECHANISMS OF THE CATHOLIC SCHOOL EFFECT

Introduction

The previous chapter focuses on the examination of causal effect of Catholic schools on students' academic achievement. The average effect is positive and marginally significant. The effect is more statistically significant for students with low propensity of Catholic schooling. These results in general indicate beneficial functioning of Catholic schooling. However, they do not answer the question *why Catholic schools matter*. The mechanisms through which Catholic schooling benefits students is another key question for policymakers and researchers. Therefore, the next step is to explore what factors account for the Catholic school effects.

Borrowing the approach that Berends and colleagues (2010) use to find out the mechanisms of the charter school effect on students' mathematics achievement, this study employs Hierarchical Linear Modeling (HLM) to estimate these mechanisms suggested by the prior literature. The following section presents the results from HLM, and the summary of the findings.

HLM Estimates with Main Match Sample

In the existing education research, indicators of students' ability, family backgrounds, and school features are often used to investigate the variation of students' academic outcomes. Students' ability is measured by either test scores or grades. This study thus use 10th grade test score to measure a student's existing ability that predict his/her test score in 12th grade. Among family background characteristics, parental SES presents a strong predictor that is associated with students' test score (Kao and Thompson 2003). Since SES to certain degree determines the probability of attending private schools which charge tuition for most students, controlling for parental SES to estimate net Catholic school effect is important.

As addressed in the existing literature, institutional structure and the concept of *community* within Catholic schools may account for the Catholic school effects on students' academic outcomes. Catholic schools have higher autonomy than comprehensive public schools and they develop school universal curricula for students to learn. Within such schools, most of time students are constrained to take academic courses and be placed in the college preparatory program. Students and staffs within Catholic schools also share the same norm to make a commitment to such a norm. The characteristics of the *common* school, such as course taking, academic track, and shared norm, contribute to Catholic school effects (Bryk et al., 1993; Gamoran 1996). This study uses the variables of student school experience- number of science and mathematics course taken as well as program placement, to measure this concept.

The common theme also forms certain social ties between parents and students and among parents of students (Coleman & Hoffer 1987). Parental involvement and parental social networks are the two measures discovered that influences the Catholic school effect. The more parental involvement and social network, the higher academic outcomes students achieve. Therefore, these two variables are taken into account in the following analysis.

Six models are implemented to explore significant mechanisms in Table B1. Model 1 is the main effect model, with the purpose of being a base model to compare the changes in variation. Models 2 estimates Catholic school effect by controlling for 10th grade math score and family SES. Following this model, parental education expectation, involvement, and social networks are added into model 3. The association of variables measuring students' school experience, such as program placement and academic courses taking, are estimated in model 4. With the consideration of the other individual characteristics, the other student covariates are controlled in model5. In the final model, the relevant school-level covariates are controlled to explain the main effect of Catholic schools on mathematics scores. These models are based on the full matched sample as shown in the prior chapter. The result from the HLM analysis presents some significant association between student and school characteristics with 12th graders' mathematics achievement scores.

Model 2 shows that students' prior test scores and parental SES are significant predictors of 12th grader's mathematics achievement. These two variables also explain a large proportion of Catholic school effects. From model 1 to 2, the Catholic school effect drops about 75%, from 5.35 to 1.30. The variance component dramatically decreases. The two variables explain about 96% of variation (from 47.337 to 1.688). However, they do not completely explain Catholic school effect, which still remains significant. Other than parental SES, the other measures of parental influence on students' schooling are presented on model 3. Parents who expect their children only to finish high school or less than college are negatively associated with students' mathematics scores, whereas those who expect obtaining degree from graduate schools are positively associated with students' higher scores. Different from what prior research has suggested, this model reports that parental involvement and network do not play an important role in students' mathematics achievement. In this model, Catholic school effect drops a little but still significant. Comparing the variance components between models 2 and 3, the variation does not change much. This set of parental variables does not explain too much variation in test scores.

Model 4 controls for students' program placement and course taking. The results from this model show no much difference from previous model in terms of changes in variance component and Catholic school effect. Among these new controlled variables, only the number of science courses taken in high school is significantly positive to mathematics score. Ironically, number of mathematics courses taken is not a significant covariate to mathematics score. It might be due to collinearity between number of math and science courses.

Before proceeding to the model with school-level covariates, the other indicators of students' demographics and background features are included in model 5. Most of those covariates are not associated with mathematics achievement, except for positive association for males and negative association for Blacks and older student age. These variables explain about 15% of the association between SES and math scores, and again Catholic school effect decreases but remain significant and the variance component does not change much.

As to the level-2 school covariates, the last model in model 6 reports that only school average math score is marginally related to students' achievement. Other school variables do not present association with achievement score. However, after controlling school covariates, Catholic school effect become insignificant to mathematics achievement. In other words, these variables account for the Catholic school effect found in model 5. The only significant but marginal school feature is school average math score. This might be due to collimearity problem with the control of prior math score in the same model, since school average math score is an aggregated score calculated from 10th graders' IRT scores by schools. The lack of school level measures that are significantly associated with achievement but explain the Catholic school effect seem to suggest there are other unobserved school features that account for Catholic school effect. More objective school level measures that could predict students' academic outcome are demanded for future research. The variance component in the final model decreases by about 15% from model5. This implies that this model effectively explains some variation in mathematics scores among schools by holding school characteristics constant.

Table B1. Multilevel Analysis on the Mechanisms of Catholic School Effect

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	50.061**	7.495**	8.414**	8.703**	17.631**	18.028 **
	(0.543)	(0.433)	(0.424)	(0.474)	(4.781)	(4.798)
Catholic school participation	5.350**	1.302**	1.159**	1.113**	0.998**	0.608
	(0.882)	(0.248)	(0.244)	(0.242)	(0.264)	(0.443)
10th – grade Math score		0.941**	0.924**	0.918**	0.902**	0.890 **
		(0.009)	(0.008)	(0.009)	(0.010)	(0.010)
Demographics & family background						
SES		1.333**	1.186**	1.174**	0.986**	0.894 **
		(0.225)	(0.229)	(0.231)	(0.231)	(0.226)
Asian					0.427	0.368

			(0.774)	(0.756)
Black			-0.960*	-0.887 *
			(0.396)	(0.442)
Hispanic			-0.532	-0.484
			(0.568)	(0.561)
Other race			0.168	0.154
			(0.673)	(0.656)
Male			0.780**	0.808 **
			(0.237)	(0.236)
Age			-0.467*	-0.475 +
			(0.266)	(0.268)
Immigrant			-0.122	-0.147
			(0.575)	(0.584)
English as native language			0.447	0.442
			(0.641)	(0.633)
#siblings			-0.080	-0.074
			(0.093)	(0.093)
Step parent			-0.486	-0.470
			(0.420)	(0.423)
Single parent			-0.970	-0.375
			(0.336)	(0.335)
No parent			-0.871	-0.785
			(0.771)	(0.777)
Mother does not work			0.141	0.149
			(0.350)	(0.349)
Mother works part time			0.452	0.429
			(0.318)	(0.314)
Catholic affiliation			-0.122	-0.121
			(0.287)	(0.288)
Northeast			0.311	0.279
			(0.393)	(0.371)
Midwest			-0.018	0.023
			(0.335)	(0.334)
West			0.148	0.166
			(0.392)	(0.392)
Parental educational expectation				
<High school	-0.918	-0.311	-0.962	-0.920
	(2.230)	(2.200)	(2.206)	(2.190)
High School	-2.544**	-2.318**	-2.448**	-2.435 **

			(0.578)	(0.555)	(0.565)	(0.567)
< College			-1.611**	-1.510**	-1.638**	-1.648 **
			(0.500)	(0.478)	(0.476)	(0.467)
Graduate school			0.646*	0.629*	0.793**	0.807 **
			(0.251)	(0.248)	(0.258)	(0.257)
Parental involvement			-0.290	-0.321	-0.342	-0.343
			(0.317)	(0.320)	(0.328)	(0.326)
Parental network			0.081	0.071	0.059	0.054
			(0.233)	(0.237)	(0.256)	(0.258)
Schooling experience						
Ever been retained a grade				-0.808	-0.526	-0.530
				(0.565)	(0.619)	(0.628)
Attend general program				-0.242	-0.298	-0.294
				(0.301)	(0.307)	(0.311)
Attend vocational program				-0.731	-0.855	-0.809
				(0.695)	(0.689)	(0.684)
Number of science courses				0.038**	0.035*	0.035 *
				(0.014)	(0.014)	(0.014)
Number of math courses				0.001	0.002	0.003
				(0.013)	(0.013)	(0.012)
School characteristics						
%Students in vocational program						-0.024
						(0.343)
School average math score						0.065 +
						(0.034)
% Free-reduce price lunch						-0.640
						(1.120)
% Minority						0.538
						(0.819)
% Certified teachers						-0.278
						(0.981)
% Out-of-field teaching						-0.477
						(0.645)
School climate						0.074
						(0.186)
Urban school						0.242
						(0.295)
Variance component	47.337**	1.688**	1.679**	1.636**	1.649**	1.483 **

** $p<0.01$, * $p<0.05$, + $p<0.1$
Note:

1. The analysis is weighted by using first follow-up student weight *f1qwt*; standard errors are in parentheses.
2. The reference groups are White, two-parent, mother working full time, South, and college graduates.

Summary

This analysis briefly explains what accounts for the average Catholic school effect on students' academic achievement. The association between mathematics achievement and some covariates is consistent with prior research, while there are also some inconsistencies. After controlling for student (level 1) and school (level 2) covariates, the Catholic school effect becomes insignificant with 90% of effect size drops. Among those covariates, 10^{th} grade math scores, male, family socioeconomic status, and the number of science courses taken since high school are positively associated with students' 12^{th} grade math scores. Students whose parents expect them to receive education less than college achieve lower test scores than parents with college educational expectation. Expecting children to have graduate school degrees is positively related to students' mathematics achievement. However, being a Black student and being an older student are negatively related to mathematics achievement.

The inconsistent findings from the previous research are that parental involvement and parental networking do not matter for mathematics scores. Except for the number of science courses taken since high school, no other measure of students' schooling experience accounts for the main effect of Catholic schools. As to school measures, only the average mathematics score is marginally associated with students' mathematics scores. The analysis of including school-level measures also reveals the weakness of these measures. Almost no school covariates are significant mechanisms to account for Catholic school effect, although the effect disappears after controlling for school variations. This suggests further research on more precise school-level measures are needed in considering what school features are important for Catholic school effects.

Appendix C

Table C1. The Comparison of Magnet School Samples from Three Data Sets

	% magnet schools	Definition of magnet high school	Definition of central city
NELS:88 first follow-up, magnet schools in central cities (Gamoran)	1.8%	Stand-alone magnet, from two variables: “F1c4b”: public magnet school (including schools within magnet programs, schools within a school); and “f1c73q3”: currently using schools-within-a-school with their own administrative staffs such as alternative or magnet school programs	From Quality Education Data: (1) Central cities have at least 50,000 residents; at least 40% of resident workers are employed locally; and at least 75 jobs exist in the central city for every 100 residents who work; (2) Central cities are also those with population is at least 250000 or if they contain 100000 or more workers; (3) QED counts an area as a central city of an SMA if it contains 15000 residents and is the largest city in an urbanized area and persons commute in rather than out for work
CCD:01-02 Magnet schools in central cities (This study)	7.7%	Variables “magnet01”=1 & “level01”=3=high school Magnet01: Magnet school, “Regardless of the source of funding, a magnet school or program is a special school or program designed to attract students of different racial/ethnic background for the purpose of reducing, preventing, or eliminating racial isolation and/or to provide an academic or social focus on a particular theme.”	From variable “locale”=1 or 2: 1 = Large City - A central city of Consolidated Metropolitan Statistical Area (CMSA) with the city having a population greater than or equal to 250,000. 2 = Mid-size City - A central city of a CMSA or Metropolitan Statistical Area (MSA), with the city having a population less than 250,000.
ELS:2002,	10.21%	Variable bya03b=1	From variable “urban”=1

magnet schools in urban areas		Public magnet school (e.g., whole school, magnet program, school within a school)	**Urbanicity (or metropolitan status):** The ELS:2002 school sample was stratified by metropolitan status or urbanicity, in accordance with the following three locale codes: (1) Urban: the school is in a large or mid-size central city; (2) Suburban: the school is in a large or small town or is on the urban fringe of a large or mid-size city; and (3) Rural: the school is in a rural area. Locale indicators were taken from the Common Core of Data (CCD) for public schools and the Private School Survey (PSS) for private schools. (from *Education Longitudinal Study of 2002: Base-Year to First Follow-up Data File Documentation*, page E-19)

Note:
The exact % distribution of magnet schools among high schools at national level in year 2001-2002 is unknown because there is no report for this information. The only way I can think of is to use CCD 89-90 file to calculate the approximate proportion.

Table C2. Logistic Regression for the Estimation of the Propensity Score for Attending Magnet School

	Coef.	Robust Std. E.	z	P>|z|	[95% Conf.	Interval]
Black	2.150	1.610	1.34	0.182	-1.006	5.306
Asian	0.499	1.349	0.37	0.711	-2.145	3.143
Other race	2.688	1.790	1.5	0.133	-0.820	6.195
Male	-0.058	0.194	-0.3	0.764	-0.438	0.322
Age	-0.707	0.187	-3.78	0	-1.074	-0.341
Asian_1st gen	0.896	1.597	0.56	0.575	-2.234	4.026
Asian_2nd gen	1.156	1.601	0.72	0.47	-1.983	4.295
Hispanic_1st gen	0.959	1.705	0.56	0.574	-2.383	4.301
Hispanic_2nd gen	2.296	1.580	1.45	0.146	-0.801	5.393
Hispanic_3rd gen	1.256	0.948	1.32	0.185	-0.602	3.113
Black_3rd gen	-1.319	1.430	-0.92	0.356	-4.122	1.484
Others	-1.425	1.249	-1.14	0.254	-3.873	1.023
English as native language	-0.237	0.328	-0.72	0.47	-0.881	0.407
Number of siblings	0.012	0.079	0.16	0.875	-0.142	0.166
Midwest	0.302	0.250	1.21	0.228	-0.189	0.792
West	-0.181	0.301	-0.6	0.548	-0.770	0.409
SES	1.372	0.497	2.76	0.006	0.397	2.346
Step parent	-0.506	0.294	-1.72	0.086	-1.083	0.071
Single parent	-0.264	0.247	-1.07	0.285	-0.749	0.220
No parent	0.561	0.414	1.35	0.175	-0.251	1.374
Mother does not work	0.109	0.579	0.19	0.85	-1.025	1.244
Mother works part time	-0.952	0.772	-1.23	0.217	-2.465	0.561
Segregated neighborhood	-2.079	1.247	-1.67	0.095	-4.523	0.365
Neighborhood poverty rate	5.066	1.196	4.24	0	2.722	7.410
%neighborhood linguistic isolation	4.187	0.813	5.15	0	2.595	5.780
Neighborhood crime_mederate	0.164	0.261	0.63	0.53	-0.347	0.675
Neighborhood crime_high	0.211	0.509	0.42	0.678	-0.786	1.208
Open enrollment is available	-1.089	0.221	-4.92	0	-1.522	-0.655
Black*immigrant	0.341	0.655	0.52	0.603	-0.943	1.625
Asian*immigrant	-1.613	1.834	-0.88	0.379	-5.208	1.982
Hispanic*immigrant	-0.615	1.353	-0.45	0.649	-3.267	2.036
Other race*immigrant	-0.886	0.894	-0.99	0.322	-2.638	0.866
Black*SES	-1.305	0.559	-2.33	0.02	-2.400	-0.209
Asian*SES	-0.992	0.585	-1.7	0.09	-2.139	0.155
Hispanic*SES	-1.166	0.565	-2.07	0.039	-2.273	-0.060
Other race*SES	-1.190	0.683	-1.74	0.082	-2.529	0.149
Black*mother not work	-0.059	0.681	-0.09	0.931	-1.394	1.276

Asian*mother not work	0.056	0.737	0.08	0.94	-1.388	1.499
Hispanic* mother not work	0.603	0.720	0.84	0.402	-0.807	2.014
Other race*mother not work	1.992	1.148	1.74	0.083	-0.258	4.242
Black*mother works part time	0.282	0.897	0.31	0.753	-1.476	2.040
Asian*mother works part time	1.428	1.054	1.35	0.176	-0.638	3.494
Hispanic*mother works part time	0.589	0.942	0.63	0.532	-1.257	2.435
Other race*mother works part time	1.415	1.168	1.21	0.226	-0.873	3.704
Asian*#siblings	0.176	0.134	1.31	0.19	-0.087	0.439
Hispanic*#siblings	-0.087	0.160	-0.54	0.587	-0.400	0.226
Other race*#siblings	-0.180	0.233	-0.77	0.439	-0.636	0.276
#siblings*segregation	0.053	0.086	0.62	0.537	-0.116	0.222
Black*Urban*Segregation	3.173	1.416	2.24	0.025	0.398	5.948
Asian*urban*segregation	1.222	2.157	0.57	0.571	-3.006	5.449
Hispanic*urban*segregation	-0.970	1.775	-0.55	0.585	-4.450	2.509
Other race*urban*segregation	1.646	2.252	0.73	0.465	-2.767	6.060
Ever repeated grade	0.221	0.414	0.53	0.593	-0.591	1.034

Note:

1. The following variables are dropped from the model due to collinearity: Hispanics, Asian 3rd generation, urban_seggregated, suburban*number of public schools in 2 miles. The region-northeast is dropped due to incomplete estimation of likelihood
2. Number of observation: 1080
3. Wald Chi2=178.59; Prob> chi2 =0.000; Log pseudo likelihood=-424.84118; Pseudo R2= 0.2806

Table C3. Magnet School Effect on Reading Test Score

	Magnet school effect	StdE	t	N
Dep var: 10th –grade reading				
1: Main effect	1.283	1.328	0.966	1,070
2: 1 + demographics + background+ school experience	0.229	0.985	0.232	1,070
3: Strata fixed effect	0.159	0.886	0.179	1,070
4: Stratum 1: 1st quintile	-0.724	1.644	-0.440	460
5: Stratum 2: 2nd quintile	1.152	1.505	0.101	230
6: Stratum 3: 3rd quintile	3.998	2.522	1.585	190
7: Stratum 4: 4th quintile	0.023	3.503	0.006	140
8: Stratum 5: 5th quintile	2.647	2.781	0.952	60
9: 1st – 3rd quintiles	1.35	1.45	0.931	870
10: 4th – 5th quintiles	3.304	1.709	1.934	200
11: State fixed effect	2.002	1.278	1.566	1,070
12: District fixed effect	0.017	2.216	0.008	1,070
12a: Strata 1-3	-1.410	3.545	-0.398	870
12b: Strata 4-5	4.123	3.709	1.112	200

Note:

1. The number of observations is the average of observations per model from 5 imputed data.
2. The numbers of observations presented here are rounded to 10 digits according to the NCES regulation of the use of restricted data.
3. The sample size for analyses on reading score is about 1,360 students, with 350 magnet students versus 1,010 comprehensive public students.
4. Design effect is controlled by taking into account school clusters and probability weighting scheme (using the base-year student weight *bystuwt*), as well as estimating robust standard error.

Table C4. The Comparison of Magnet School Analytical Samples

	Gamoran 1996	**This study**
Sample	NELS: 88, BY & F1	ELS: 02, BY & F1
Grade	8th, 10th	10th, 12th
Identifying magnet schools	Stand-alone magnet	Magnet schools identified by CCD
Identifying central city schools	Using the classification from the Quality Education Data (QED)	Common Core of Data (CCD) identifies school locations that are central cities. (locale01=="1" or locale01=="2")
Analytical models		
Dependent variables:	Grade 10 achievement: IRT scores of math, reading, science, and social studies	Grade 12 math IRT score, Grade 10 reading IRT score
Independent variables:		
Background	Y	Y
School context:		
School racial/ethnic & SES composition	Y	Y
% in single-parent family	Y	N
Academic climate	Y	Y
Student social bounding	Y	Y
Academic course taking	Y	Y
N	35 magnet schools attended by 323 students; 213 comprehensive public schools attended by 2,240 students	A matched sample, with about 20 magnet schools attended by 350 students versus 60 comprehensive public schools attended by 1210 comprehensive public students
Methods	(1) HLM: remove bias from clustering (2) 2-stage Heckman procedure to adjust for selection bias: use multinomial logit	(1) Propensity score matching method (2) For the estimation of the effect on 12th graders' math achievement, controlling for

	to estimate the odds of attending different type of schools; OLS to estimate school effects - control for prior test scores (8th grade) - use test scores for multiple subjects	10th grader's math score (There is no prior reading score for 10th graders) (3) Heckman selection procedure
Results (Magnet effects):		
Math	No effect	No effect
Reading	Positive effect	Marginally positive effect for those with lower propensity of attending magnet schools
Science	No effect	N/A
Social studies	Positive effect	N/A

VITA

Wen-Chun Chen

EDUCATION

- **Doctor of Philosophy** in Educational Theory and Policy & Comparative and International Education (dual title), Minor: Demography • Pennsylvania State University, College of Education, 2011.
- **Bachelor of Science** in Management Information Systems • National ChengChi University, School of Business, Taipei, Taiwan, 2000.

HONORS/AWARDS

- American Education Research Association Dissertation Grant, 2008-2009.
- Alumni Society Graduate Student Research Initiation Grant, Pennsylvania State University, 2008-2009.

SCHOLARLY CONTRIBUTIONS

Publications

- Pong, Suet-ling, Jamie Johnson, and Vivien W. Chen. 2010 "Authoritarian Parenting and Asian School Performance: Insights from the U.S. and Taiwan." International Journal of Behavioral Development 34:62-72.
- Pong, Suet-ling and Vivien W. Chen. 2010 "Co-resident Grandparents and Grandchildren's Academic Performance in Taiwan" Journal of Comparative Family Studies 41(1).

Conference Presentations /Working Papers

- Chen, Vivien W. "The Effects of Catholic Schools on Mathematic Achievement in 12th Grade: School District Variations" An invited presentation for the 2010 AERA Grantee Conference, Washington D.C.
- Chen, Vivien W. "The Effect of Catholic School on 12th-Grade Mathematic Achievement" To present at the 2009 annual meeting of the American Education Research Association, San Diego, CA.
- Chen, Vivien W., Suet-ling Pong, and Tse-Chuan Yang, " School Availability and Choice." 2008 Annual Meeting of the Population Association of America, New Orleans, LA.
- Suet-ling Pong and Vivien W. Chen. "Coresidence with Grandparents and Grandchildren's Educational Achievement and Expectation: The Case of Taiwan." 2007 Annual Meeting of the Population Association of American, New York, NY.

PROFESSIONAL TRAININGS

- AERA Institute on Statistical Analysis for Education Policy, Washington D.C., May 2010.
- Geographically Weighted Regression Workshop, the Pennsylvania State University, University Park, PA., June 2008.
- Social Science and Biomedical Institutional Review Boards (IRB) Basic Training on the Protection of Human Participants, The Pennsylvania State University, University Park, PA., Summer 2005.