DISSERTATION

SCHOOL CHOICE IMPACTS WITHN A LOCAL SCHOOL DISTRICT

Submitted by

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ABSTRACT

SCHOOL CHOICE IMPACTS WITHN A LOCAL SCHOOL DISTRICT

In the mid 1990's, changes in Colorado state law and local school district policy resulted in the opening of magnet and charter schools within a school district in Northern Colorado. Parents now had multiple school choice options that were independent of school assignment based on residency. I use student level data to analyze school choice impacts within the district as they unfolded over time.

I test first if there are student achievement gains that can be attributed to school choice. In theory, when parents can better match the needs of their children to the offerings at different schools, student achievement should increase. Using multilevel modeling I find little evidence that school choice yields achievement gains compared to residential based school choice, but do find that some schools that offered differentiated curriculums yielded gains. The negative impacts on student achievement attributed to low family income and from when students change schools explain much of the variation in test scores.

I next examine how local public schools may compete for students once parents are given expanded school choice rights. Economic theory suggests that competition for students would force lower performing schools to improve or risk losing their students to higher achieving schools. I test to see if the choices that parents make to attend schools outside their neighborhoods are influenced by prior year academic achievement, the income and ethnic composition of a school and changes in the size of a local school's attendance zone. I find that shrinking attendance zones preceded students choicing into other schools, motivating schools to compete for students. Past performance matters as well, but so does the composition of the

student body and how representative the student body is of the community that surrounds the school. Parents show preferences to associate with families with similar incomes and ethnic background.

Finally, I study how school choice impacts housing decisions. If school choice breaks the link between residency and local schooling then house prices should reflect this change. Parents would be less willing to pay a premium to live near a higher performing school and should receive less of a discount to purchase a home near a lower performing school. Using prices paid by cohorts of home buyers that subsequently placed their children into district schools, I find support for the hypothesis that the house price-school quality link evaporates with school choice and that changes in housing valuations can be modeled as a function of the number of families choicing into and out of school attendance zones. Prices appear to be moving towards an equilibrium whereby local school quality and distance to the assigned school no longer contribute value to the price of a home.

ACKNOWLEDGEMENTS

I would like to express my thanks, love and appreciation to my wife Ellen for her support of my decision to abandon our retirement plans in pursuit of a PhD in Economics. I know this wasn't part of our life plan but as it unfolded it lead us in new and exciting directions. I also want to express my love for our daughter Sara whose personal commitment to and love of learning is an inspiration to me.

I would further like to thank Dr. Harvey Cutler whose introductory class in econometrics inspired me to focus my graduate program on empirical research and analysis and who chose me to assist him in a research project that allowed me to further develop my data gathering and analysis techniques. Dr. Cutler challenged me throughout this dissertation to more fully develop, test and interpret my research questions. Without his help my dissertation would have certainly become lost in the woods.

Throughout my academic life I have been fortunate in meeting teachers who took an interest in me and helped direct me in ways that profoundly changed my life. Mr. Marvin Pasch rescued me from the freshman wrestling team at Ridgewood High School and got me involved in academic debate. Dr. Ted Jackson offered me a scholarship to Illinois State University that helped me attend college. Dr. Ralph Webb at Purdue University told me that I had the talent to be a very successful graduate student but only if I applied myself in ways I had never done before. Dr. Chuen-mai Fan at Colorado State University taught me to "push the pencil" and got me through my first class in micro theory, the most difficult hurdle I faced in my PhD program.

Finally, I want to acknowledge the love and support I always received from my parents, Mr. Joseph F. Chisesi and the late Joan M. Chisesi, and also from my mother-in-law, the late Ruth O'Connor.

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Chapter One

Introduction

Most American children are educated in public schools. In Colorado, the right to a free education is guaranteed under the state Constitution[1] and one hundred and seventy six accredited school districts provide kindergarten through twelfth grade schooling. Parents now have great discretion about what school to send their children to, though some choices have only recently been made available. Increasing choice means many public schools are no longer local monopolists. They can be seen to be monopolistic competitors, where location advantages and product differentiation play a role in establishing and maintaining market share. Schools don't compete on price but compete in ways that are important to families.

Increased accountability came along with new options for school choice. Content standards specified what students should learn and yearly tests measured their progress. Report cards were mailed home to parents with information about their child, the progress of all children at their child's school, and the progress of other schools close by.

School choice and accountability have left their mark on a school district in northern Colorado, which is the subject of my research. Within a five year period beginning in1995, five new schools opened that any district student could enroll in, regardless of residence. Some schools adopted new curriculums, differentiating them from other schools. In this dissertation I look at the impacts that arose from school choice. I first address how school choice impacts both the level of and growth in student achievement. I explore how schools compete for students and identify what motivates competition. Finally, I analyze how school choice impacts housing

[1] The Education Clause of the Colorado State Constitution directs the General Assembly to "establish and maintain a thorough and uniform system of free public schools throughout the state, wherein all residents of the state, between the ages of six and twenty-one years, may be educated gratuitously". See Article IX, Section 2 available at www.colorado.gov/dpa/doit/archives/history/constitution/index.htm

prices within the district's borders, affecting decisions about where to live and where to go to school.

Addressing each impact requires a unique literature review. Economists address student achievement as forms of education production functions where inputs to learning are identified and measured. Inputs are multilayered, with contributions coming from the community, the school, the classroom, the family and the student. Analyzing the role of competition requires an understanding of market structures and the motivations of actors in the market, who maximize certain objectives. Literature evaluating competition in communities with histories of school choice forms a foundation for predicting events in this district and in interpreting my later results. The house price literature is centered on hedonic modeling of public goods, in a Tiebout choice framework. Researchers have used innovate strategies to identify school quality and house price relationships, which I detail. The four chapters that follow address these unique literatures and present my research questions and results.

In chapter two, I survey the landscape of the school district under study. I summarize the institutional changes that occurred starting in 1995 and identify how they enabled and expanded school choice. I also present, in some detail, the data that the local district provided me for this research, as I frequently make references to it in the remaining three chapters. I profile the district from the mid 1990's through 2006 and represent it in terms of school hierarchies. Income and achievement hierarchies existed in the early days of school choice and in the years that followed. I compare our district to one in a neighboring state, where school choice options exceed those available here, and find the same type of hierarchies. In these districts, school choice options haven’t flattened school hierarchies.

Student achievement is addressed in chapter three. I test to see if school choice, school type, school resources and student inputs affect achievement on standardized tests. I find no relationship between school choice and achievement, except that student in magnets schools, who initially underperform compared to other students, catch up by 2005. Students in some specialized schools perform at a higher level than other students. Income, gender, and ethnicity play the large roles in determining levels of achievement, regardless of school type and school choice. I also find that students who change schools in elementary grades suffer achievement losses. It is important for a student to stay in the same school to achieve success, regardless of school type.

Competition between schools is the focus of chapter four. I review work from Caroline Hoxby who has published extensively in this area. Hoxby (2002) argues that when a public school is exposed to competition, it becomes more efficient in production, benefitting its students. School choice becomes the rising tide that lifts all boats. I test for competition effects by looking at school and parent behavior. I calculate the percent of students attending a school that live in other school areas and use that as a measure of a school's competiveness. I find that competition for students is driven by school supply shocks. The district opened new magnet and charter schools without adjusting attendance areas. Schools had to compete for students or risk closure. Test score gains help draw students in. I find evidence that parents change their willingness to attend some schools as the income and ethnic composition changes at a school.

In the last chapter, I consider the relationship between house prices and school quality. A large body of research suggests that parents will pay more for a home located near higher performing schools. Several researchers argue that school choice works to weaken this relationship. The intuition behind this is that when parents are able to cross school district borders to attend higher performing schools, the prices of houses in "receiving" districts start to fall, while prices in "sending" districts start to rise. I test to see if the same adjustment process occurs when households cross school area boundaries within a single district. I create a unique sample of housing sales by matching student addresses to county real estate records, identifying buyer cohorts across multiple time periods. These buyers soon placed their young children in kindergarten and first grade at district elementary schools. I find that in the early days of school choice a positive relationship existed between house prices and local school quality, but dissipates in the years following the opening of district magnet and charter schools. House prices are also impacted by the flow of students into and out of local schools, mirroring the effect found in earlier research that examined inter district migration.

My research reveals that school choice and school accountability have impacted the local district. While student improvement is not directly linked to school choice, growth in learning is enhanced in some cases. Schools respond to declining attendance areas by competing for students, driven by loss of local monopoly power. Schools are differentiated in type of instruction and parents have shown preferences for school types. Homebuyers understand that school choice lowers the premium they had historically paid to have their children attend better schools, yielding welfare gains for homeowners in those areas where fewer families choose to attend the local school.

References

Hoxby, C.M. (2003). "School Choice and School Productivity: Could School Choice Be a Tide that Lifts All Boats?", In C. M. Hoxby (Ed.), The Economics of School Choice (pp.286-341). Chicago: University of Chicago Press.

Chapter Two

The School Choice Landscape

Markets are shaped by rules. So when the rules change, the markets change too. In Colorado, rule changes that challenged local school monopolies were instituted in the mid 1990's. These rules allowed charter schools to be organized at both the local and state level. In addition, in the district that I study in this dissertation, the local school board broke from its own historical rule and opened three elementary schools that were not designated to serve residents of the local neighborhood. These were magnet schools open to all students in the district. Parents became more active in searching for and selecting schools. The choices they made have had an impact on the composition of schools.

In this chapter, I briefly review the history of rule changes that enabled school choice. I also place school choice in the context of an evolving standards based education system with a clear focus on accountability. Our local school system has been changing for almost twenty years, and I compare where it was in the early days of school choice to where it moved to. I use this comparison as an opportunity to overview and highlight the data that was made available to me for this dissertation, and finally to explore the reasons for and nature of school achievement hierarchies.

Instituting Choice

In 1995, the State of Colorado adopted a set of standards for K-12 education. These standards were written to cover a broad array of disciplines from reading, writing, and math, to visual arts and foreign languages.[2] The general form these standards take is to first state a rational for why a discipline should be studied, then to broadly define performance outcomes for the discipline,

[2] A full description of all K-12 standards in original and revised form is available from the Colorado Department of Education on-line at http://www.cde.state.co.us/cdeassess/UAS/index.html

and finally to present model content. Model content standards are expressed at grade levels, with clusters at K-4, 5-8, and 9-12. For example, the Reading and Writing Standard states that students in Colorado "shall become fluent readers, writers, and speakers; be able to communicate effectively, concisely, coherently, and imaginatively; recognize the power of language and use that power ethically and creatively; and be at ease communicating in an increasingly technological world" (CDE 2012). Six overarching content standards express what a student should be able to know or accomplish in this subject area. Each of these six content areas is further refined by grade level. Sub-standards by grade level give further structure to a standard.

Each school district's board of education is required to certify that its curriculum meets content standards as specified. Compliance is monitored by the Department of Education.

In addition to requiring curriculum alignment with state standards, school districts were required to administer standardized tests to students beginning in the spring of 1997. These tests, known as CSAP (Colorado Standards Assessment Program) were first administered to 4th grade students in reading. A writing test soon followed, and by 2000 tests in math and science had been added. Eventually, students in grades 3-10 were being tested in reading, writing, math and science.

CSAP's were designed to measure learning as specified in the 1995 Model Content Standards. Results from tests are released in the fall of each school year. The Department of Education also requires that parents receive copies of school test results. A report card indicating how well the child's school performed in the aggregate was eventually developed and mailed to parents. This report card included performance information about the school and about schools closest in proximity to the parent's residence.

In 1995 the State Legislature passed a bill authorizing the establishment of charter schools in Colorado. Charter schools were to be authorized by local school districts. These schools are granted waivers from standard district policy and can be autonomous from district supervision. Per-student funding flows from the district to the school. A separate school licensing group, the Charter School Institute was established in 2004. It is an organizational arm of the Colorado State Board of Education and is authorized to license schools without the approval of a local school district school board.[3]

In 1998 the first charter school opened in the district as a K-6 school. A second opened in 2001 as a K-12 school. A third school opened a few years later, having applied to the Charter Institute for a license, bypassing the local district. Funding, however, still flows from the local district to the school.

In the fall of 1993, the local board of education approved the opening of three new elementary schools. These schools were theme centered rather than neighborhood centered. They had open enrollment meaning that any parent, regardless of residential location, could enroll their children if space was available. Over subscriptions would be managed through waiting lists. One school was a bilingual school where English and Spanish would be taught in an immersion environment. A second school opened that featured an experiential, hands-on approach to learning, with the school labeling itself as a center for creative learning. The third school adopted E.D Hirsch's core curriculum,[4] which focuses on skills-based education and character development. All three schools offered school management policies, opportunities for parental involvement, and curriculum and instructional practices that differed from established district

[3] A description of the Charter School Institute is available at http://www.csi.state.co.us/.
[4] Information on E.D Hirsch and the Core Knowledge Foundation can be found at http://www.coreknowledge.org/ed-hirsch-jr

schools. They were required, however, to demonstrate that their unique approaches to learning were compliant with state content standards.

By 2003, the district included three magnet schools and three charter schools at the elementary school level. Over this same time period, three district schools asked for and received permission from the central district administration to adopt the Hirsch curriculum in their buildings. These three schools have assigned attendance areas serving neighborhood students as well as a students who choice into them. By the final year of my study, approximately two thousand of the district's roughly twelve thousand kindergarten through sixth grade students were in schools that actively employed the Hirsch curriculum. Just under two hundred students were at the school for creative learning, and approximately three hundred and fifty were enrolled in the bilingual program.

Several other schools asked the district for permission and funding to implement the International Baccalaureate (IB) primary years curriculum in their schools. By 2006, three elementary schools were IB certified [5]. Two IB middle year programs and a high school diploma program were also certified.

By 2006 the local school district had changed considerably from the early 1990's. Changes had been made to curriculum at all grade levels. Teacher training in standards based education was occurring across the district and within each school building. Teachers and students were making time each spring for mandated state performance tests. Parents were receiving report cards not just on the performance of their student, but on the performance of all students at their child's school and at schools close by. Parents retained the right to send their child to their local school, but now also had a right to choose from six open enrollment schools that featured various

[5] Information on IB programming and certification is available at http://www.ibo.org/

approaches to teaching state mandated content standards. Additionally, parents could choose to send their children to any other neighborhood school that had space available.

Proprietary Data

In 2007, I approached the school district with a request for access to data to research issues related to school choice. In August 2008, the district granted my request and Colorado State University approved Human Subjects Protocol 08-592H which has been renewed annually since then.

I received data records on individual students for school years 1997-98 through 2006-07. Each yearly record was essentially the same. Test score data, however, was not available at the student level for years 1997 and 1998. Each data record provided was formatted as follows:

Student Number
District ID
Student Address (number, street, city, zip code)
Gender
Ethnicity
Free and Reduced Lunch program status
English as Second Language status
Assigned Elementary, Junior, and Senior High School
Actual school attended
Grade
Colorado Student Assessment Program test results for tests administered to the student that year
American College Testing Services test results for any ACT test administered that year

There are two student identifiers with each record since the district was in the process of transitioning from its own district numbering system to a new numbering system. The format for the new number was proscribed by the Colorado Department of Education.

Students are identified ethnically as being White (not Hispanic), Hispanic, Black, Asian/Pacific Islander, or American Indian. Students are identified as being eligible to receive a free or reduced lunch. I use the acronym FRED for this classification.

CSAP tests have been previously described.[6] Students received a numerical score with each test. The score is a scaled score. In a given subject, a proficient test taker would need to meet or exceed a certain threshold score. Academic growth can be measured over the years by looking at changes in the index score. Four proficiency levels are recognized on the scale. The lowest level of achievement is labeled *Unsatisfactory*, then *Partially Proficient*, *Proficient*, and finally *Advanced*. I use both the student index score and an aggregate measure of overall proficiency in the research that follows and identify the form used where appropriate.

The ACT test is given to all high school students in their junior year. The score earned on this test can be used by students applying to university in lieu of taking the exam at a separate ACT sponsored setting.

There were some limitations to the data that restricted some of the analysis I attempted. The dataset had omitted CSAP scores for large numbers of students in school years 2003 and 2004. All other fields in the record were intact but these scores ended up being un-retrievable. I also lack test score data for charter school students. I have records for students who attended the first charter school from 1998 to 2001, but these student test scores were never part of the district's data base and so were not available to me. After 2001, as part of a contract negotiation, the district stopped keeping any records of these students. I face a similar issue with the second charter school that opened. The district did not keep records for this school in some years but did in others. I address these limitations when appropriate in specific sections of the dissertation.

School Hierarchies

Most children who attend public schools in the U.S. attend a school where a local residency requirement is in place. Since families are free to choose where they live, the allocation of

[6] **See** Colorado Revised Statute 22-7-409 for information regarding testing mandates, implementation schedules, language requirements and issues regarding students with disabilities (CDE, 2011)

schooling through housing is a form of school choice. Hoxby (2000) claims it to be the primary way that parents express a choice in schooling (Hoxby, 2000). Residential selection also determines the quality and expenditure on public goods, including education. This is known as the Tiebout process and "is still the most powerful force in American schooling" (Hoxby, 2000, p. 2).

Tiebout sorting has yielded school districts highly segregated by income and ability. Even within districts, school hierarchies emerge where better performing schools are found in higher income neighborhoods. The depth of these hierarchies is startling. A recent report from the Brookings Institute claims that nationwide, the average low-income student attends a school that scores in the 42nd percentile on state examinations while the average middle/high-income student attends a school that scores in the 61st percentile. Large gaps also exist between Black, Hispanic, and White students (Rothwell, 2011).

Performance hierarchies are linked to house prices. The same Brookings report found that in the country's 100 largest metropolitan areas, housing costs are on average 2.4 times higher for homes near high performance schools compared to homes near low performing schools. They estimated the dollar impact of this to be $11,000 per year. Test score gaps based on house price differentials ranged between 15% and 26% on standardized tests.

Epple and Romano (1998, 2003) provide a theoretical foundation that predicts school composition and school quality as a function of school choice design. They model a school voucher plan, an open enrollment public school system and a closed enrollment residence based system. They demonstrate that, as ability and income become linked, wealthier families outbid less wealthy families for housing in the best school areas when a school system is residency based. An ability hierarchy is formed. In a voucher system, wealthier families outbid others and pay higher tuitions. Private schools are motivated to offer scholarships to high achieving students from low-income households so some lower income students have access to higher performing schools, but the motivation for this is to increase the quality of the school's peer group, which further attracts wealthier families. Both residency based and voucher systems produce schools segregated by ability and income, and peer effects are the dynamic motivating school selection in either model.

The only model that predicts equal outcomes across schools is a frictionless public school system with full school choice. Epple and Romano make strong assumptions to support this claim. They suggest, for example, that schools face no capacity constraints. It also assumes an indifference to residence, so that the price of an addition unit of housing equalizes across the district. Frictions are important in the model as they represent costs that families absorb to use school choice. In a model with frictions families absorb costs up to the point where they are equal to the cost for an additional unit of housing. Frictions limit choices. A district can reduce friction (costs) by offering transportation to all students, for example.

I organize the district data to test if performance hierarchies existed in the early days of school choice and in the years that followed. In this district, school choice faces frictions. Transportation is only provided to those attending their local school. The only exception I am aware of was for transporting monolingual Hispanic students to the bilingual school to balance population of native English and Spanish speaking students at the school.

I look first for hierarchies using CSAP test performance from 1997 to 2006. The data indicates that schools were stratified by test score performance. The following figures reflect this stratification. Figure 2.1 displays the percent of 4th grade students at each school scoring proficient or advanced on CSAP reading tests in the school year 1996-97. These percents are displayed on the Y-axis. Ordering is from highest to lowest. The highest performing school in 1997 had just over 80% of students proficient or advanced on the test. The lowest scoring school had 40% proficient or advanced.

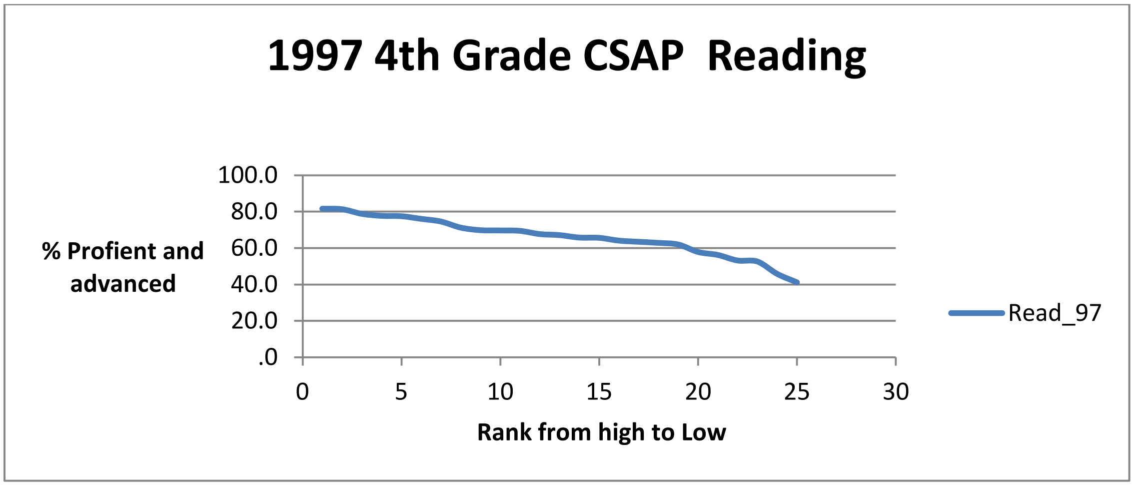

Figure 2.1 1997 4th grade CSAP reading % percent proficient or advanced

Figure 2.2 displays test results for 2006. By now, two charter schools had opened in addition to the three magnet schools that opened in 1995. Two new elementary schools were built in neighborhoods in the southeast part of the urban community. As the figure reveals, one school had very high scores, with 97% of 4th graders proficient or advanced in reading. The lowest performing school saw 55% pass the test. The spread from high to low remained the same as in 1997, but all schools saw increases in scores.

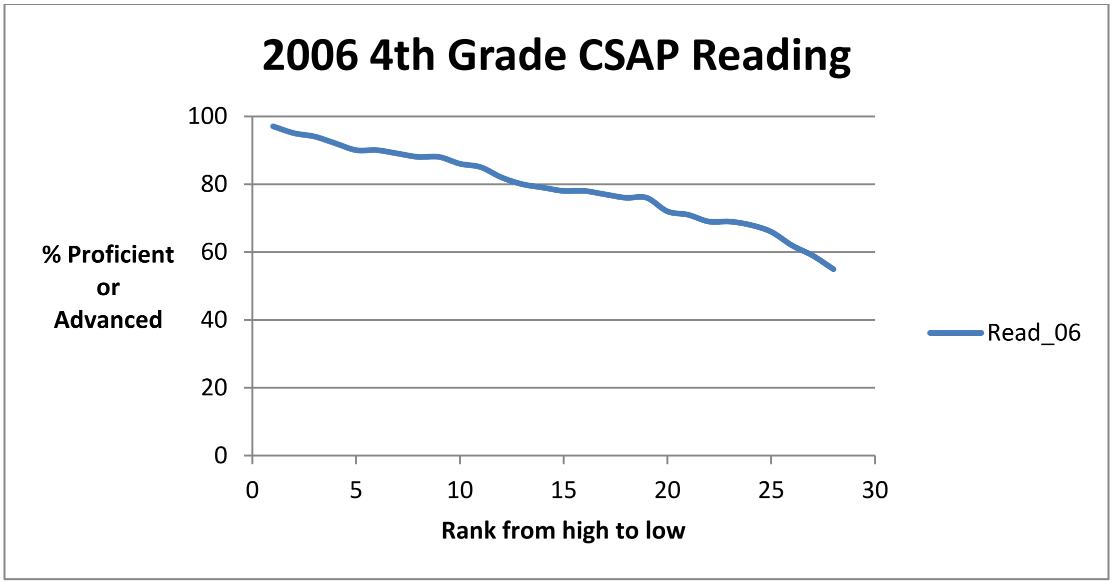

Figure 2.2 2006 4th grade CSAP reading % proficient or advanced

The figures reveal that achievement hierarchies existed in 1997, the first year that the district administered standardized state tests. Nine years later a hierarchy still exists.

I also rank schools based on the percent of students who are in the free and reduced lunch program. Figure 2.3 displays rankings for the 1997 school year.

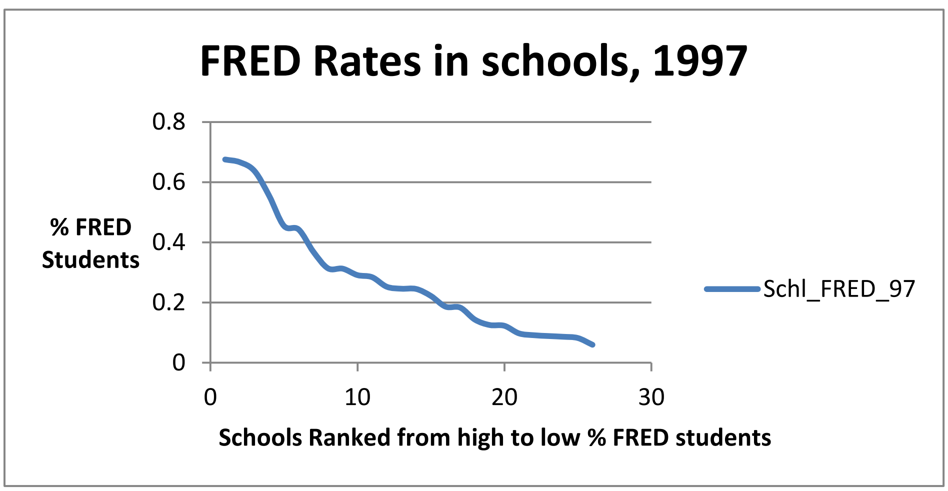

Figure 2.3 Schools ranked by FRED rates, 1997

The largest FRED percent rate at a school was 79%. A number of schools had FRED rates between 20 and 30% while the district average was 24%. Schools with low populations of FRED students had populations of around 10%.

Figure 2.4 displays FRED rates for 2006. This data includes the FRED rates at the district charter and new elementary schools that opened after 1997.

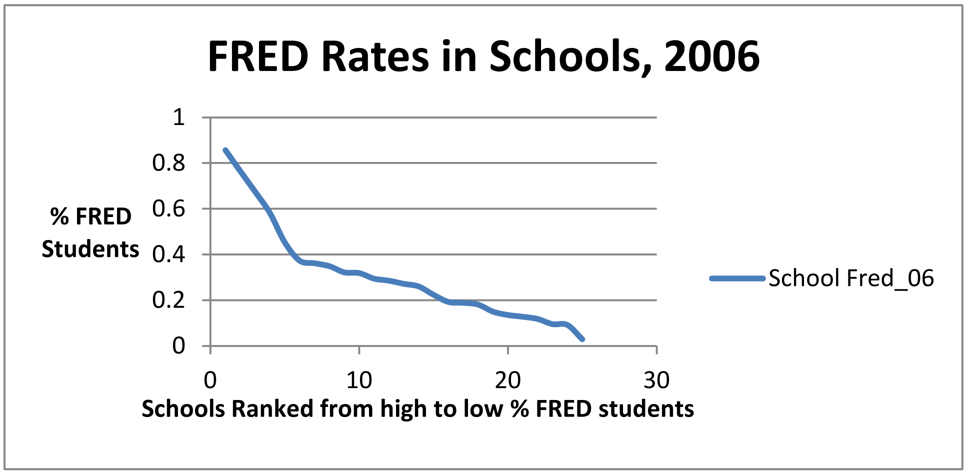

Figure 2.4 Schools ranked by FRED rates, 2006

By 2006, one school had a FRED rate of 85%. A number of schools had FRED rates close to the district average, which was 25%. Schools with very low rates now had 5% or less percent of students on free or reduced lunch. Both sets of graphs reveal school hierarchies in the local district. This was true as magnet schools were first being introduced into the district and after additional charter schools and new neighborhood schools entered the market.

If all families have equal access to school choice, then achievement and income hierarchies should not exist. Parents can choose the peer group that they want their children to be a part of. But as school choice in this district faces frictions, it's likely that lower income families make less use of school choice as any costs disproportionately impact them. I test to see if use of school choice is differentiated by income, as measured by free and reduced lunch rates.

To understand school choice at the aggregate level across the district, I first graph the percent of students attending their assigned elementary school, delineating between K-6 elementary students and students just entering grades K-1. I consider K-1 students to be early entrants to the education system. Their school choice behavior should be a leading indicator of future levels of school choice. I further delineate by type of choice made. Parents can either choose a magnet/charter school or another neighborhood school. Figure 2.5. displays these values.

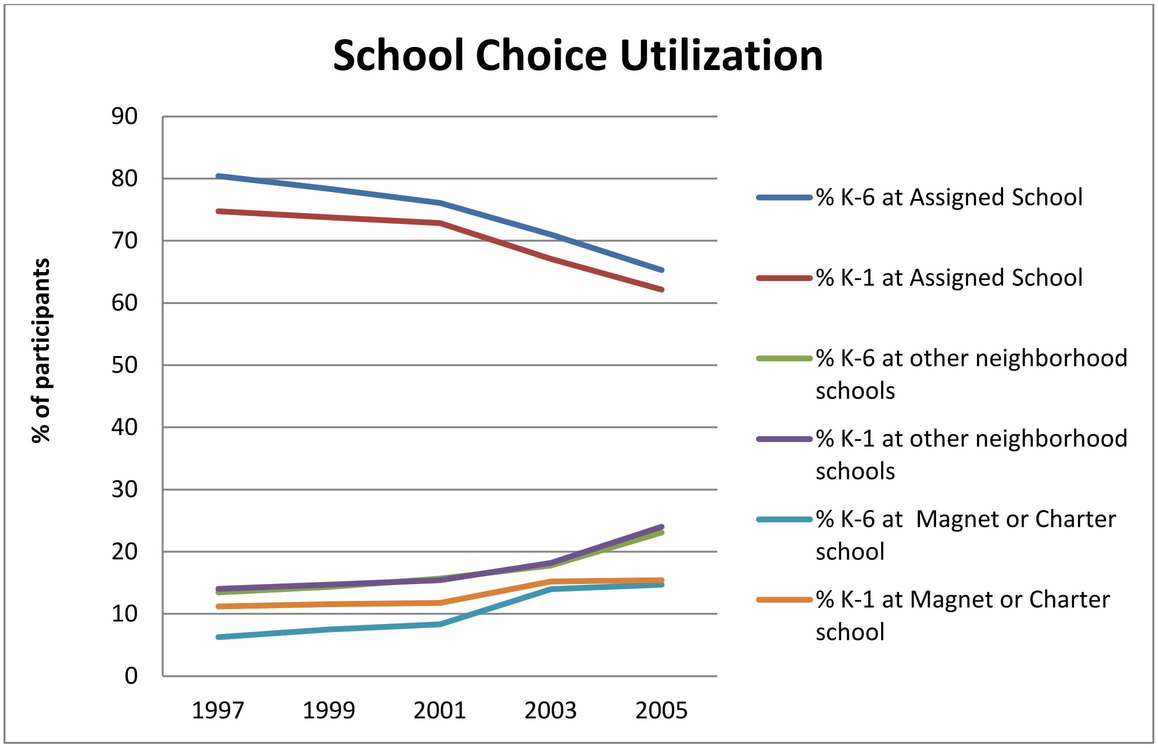

Figure 2.5 School Choice Participation Rates

From figure 2.5 it is clear that overall attendance at neighborhood schools declined from 1997 to 2005 and the percent of K-1 students not attending neighborhoods schools exceeded the overall rate. The lower half of the graph represents the delineation by choice type. There is an increase in the percent of students' choicing into other neighborhood schools. This may reflect excess capacity that existed after new neighborhood schools opened, giving parents more options to choose from. Choice rates at magnet/charter schools flatten out as these schools become fully subscribed and no new schools open.

I tabulate the number of free and reduced lunch students who participate in school choice. In 1997, almost 24% of K-6 students had free and reduced lunch status. Just under 24% of all those students using school choice were FRED students. By 2006, 28% of students had FRED status and of all students in the district using school choice, 30% were FRED students. School choice is widely used by lower income families.

A difference emerges, though, when looking at the choices FRED students make. Most FRED students who use school choice attend another neighborhoods school, not a magnet or charter school. In 1997, 25% of students at magnet schools were FRED students, mirroring their proportion in the total school district population. Most of these students attended the bilingual magnet school where FRED rates exceeded 50%. By 2006, FRED rates had decreased at magnet schools, including charters, with the exception of the bilingual school. The average FRED rate for magnet/charter schools was 6.8% while the overall district average was 25%. Participation in school choice is widespread but the type of choice is income dependent.

In chapters three and four I use regression tools to explore the relationships between school choice and academic achievement. In this section, I use a simple tabulation to represent this relationship. As families had information from both CSAP test results and school report cards, they could compare school quality at their assigned school and at other schools they have an interest in. I look to determine if there is any relationship between the difference in the average test score at the neighborhood school and the average score of the school the family chose to attend.

For the 1997-98 school year 21% of elementary school students chose not to attend their neighborhood school. Sixty two percent of those that choiced out attended a school where 4th grade reading scores were higher than at their assigned school. I call this action a "choice up". Delineating by choice type, of those who attended a magnet school, 66% chose a school with higher test scores. Of those who chose another neighborhood school, 59% choiced up. Interestingly, parents would have made their choice decision after the first CSAP results were released in September of 1997. I suggest that these school choice decisions were made on expectations of student performance at other schools.

Two years later, in the 1999-2000 school year, 23% of students choiced out of their assigned schools, an increase over 1997-98. Of those making a choice 72.5%, choiced up. Differentiating again by choice type, 95% of magnet school and charter parents choiced up. In 1999-2000, virtually all parents making this choice chose a school where the average test score for that year was greater than the test score of the school they were assigned to attend. FRED parents generally choice up too. In 1999, 65% of FRED families that choiced out made a choice up.

Overall, I conclude that in these early years of school choice, parents first based choice decisions on expectations of performance differences in schools. As more test information became available, parents recognized real differences in schools and acted on that information. For magnet and charter school parents in particular, the vast majority of parents chose a school where 4th grade average reading performance was higher than the 4th grade average reading performance in their assigned schools.

This active participation in school choice occurred in a district where families needed to provide their own transportation to attend another school. I discovered that there was a school district in a neighboring state that more fully incorporates school choice into their district, including providing transportation. I end this chapter with a look at the Natrona County School District, in Casper Wyoming, and their experience with school choice.

Natrona County Schools implemented a district wide school choice program in 2002. Every school is a school of choice and all parents have to choose. There is no default option to attend a neighborhood school. This district serves a school population roughly 60% the size of the district under study. Per-capita income is lower in the Wyoming district, but free and reduced lunch rate populations are similar.

Flicek (2007) reports on the impacts that abolition of school assignment areas had on school composition and performance. Prior to 2002, school choice was an option for parents and the district had opened several magnet schools. Adopting a full open enrollment policy came only as a result of conflict over plans to close several schools and build new ones. Rather than redraw school boundaries to accommodate the new schools, the district decided to discarded boundaries altogether. The district offered transportation for students to all schools, making this system relatively frictionless in terms of transportation costs, as defined by Epple and Romano (1998).

Flicek categorized students by how far they traveled to school. Students were *near attenders* if they traveled no further than a distance equal to that of the school that was the second closet to their home. They were *far attenders* if they traveled a greater distance. Schools were *neighborhood schools* if at least 60% of students who attended were *near attenders* and *magnet schools* if at least 75% of the population were *far attenders*. A student attended *another neighborhood school* if he traveled far, but most of his classmates did not. Schools in both the neighborhood and another neighborhood type were Title 1 eligible [7].

Flicek's analysis showed that approximately half of the students chose a school that was either the first or second closest to their home. Flicek then tested to see if parental income correlated with the decision to travel farther to a school. Two broad income levels were identified, based on the free and reduced lunch rate status of the household.

Of those who traveled far to attend a neighborhood school, free and reduced lunch students had participation rates very similar to other students. In magnet schools, however, free and reduced lunch students were underrepresented. Magnet school attendees who traveled far were

[7] A school with at least 45% of students on free and reduced lunch is classified as Title 1 in this district.

less likely to be free and reduced lunch students. Magnet schools featured curriculums that differed from the standard district curriculum. Lower income parents were not willing to travel far to attend these schools, but would travel far to attend schools that offered the standard district curriculum.

The social economic status at a school was altered by the new school choice program. For magnet schools, the social economic status increased, as there were now increased numbers of students not on free and reduced lunch. At neighborhood schools, far attenders were more likely to be free and reduced lunch students than the population that lived closest to the school. This lowered the social economic status of the school from its pre-school choice distribution.

Flicek also examined school performance. Using pre and post standardized tests, Flicek describes a performance hierarchy in levels of achievement. Title 1 schools scored lowest, neighborhood schools scored in the middle and magnet schools scored the highest. Test scores at schools that attracted more FRED students saw scores decrease. In magnet schools, where free and reduced lunch students were underrepresented, achievement levels increased. The sorting decisions that households made raised average achievement levels in one set of schools and lowered them in others. Those who traveled farther to attend a magnet school raised the school average, while those that traveled farther to attend a neighborhood school lowered its score.

Growth measures showed that students in magnet schools had less growth than students at other schools. Flicek concludes:

> If the valued outcome for parents... of far attenders... in choosing a magnet school was increased achievement growth, then parents of these students would have been better served by choosing either Title I or neighborhood schools rather than by choosing magnet schools. None of the school types studied had both (a) high achievement growth and (b) high peer status (i.e., both socioeconomic and achievement) (p.30).

The key observation from the Wyoming experience is that given choices, parents sorted schools into a performance hierarchy, the hierarchy didn't emerge from student growth. Parents also sorted by income. This result contradicts the prediction from Epple and Romano that performance hierarchies dissolve under conditions of frictionless school choice. Theory and practice were not aligned in Wyoming.

While there are differences between the Wyoming district and the district under study, some similarities are apparent. In Wyoming 50% of students chose a school close to home. In the district under study 60% attend their neighborhood school. The preference to attend the local school is revealed to be present in just over half of families. Participation in magnet schools also follows a similar pattern. In both districts, lower income families were less likely to choose these schools.

School hierarchies exist in districts both with and without school choice. Lower income families use school choice, but make different choices than higher income families. School choice is wide spread, with families willing to look at alternatives to their neighborhood school. In the following three chapters, I look more closely at school choice and student outcomes, at choice patterns across schools, and finally how school choice may impact housing decisions and the price that families are willing to pay for school quality.

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Chapter Three

School Choice and Achievement

Are students better off if their parents can choose which school they attend? From a policy perspective, if school choice improves school quality, then families would see welfare gains from private allocative efficiencies (Hoxby, 2000). In this chapter I look at student achievement during the time when options for and the use of school choice expanded for local residents. I test if the choices parents made impact student performance. I isolate the impacts of family income, gender and ethnicity on achievement and test if these are mitigated by school choice.

Economists view learning as human capital acquisition. One way to model this is through the production function framework, where acquisition of human capital is a function of inputs. These are multilayered and consist of student, family, school and community inputs that individually and collectively produce human capital. An example is the impact of one's peers. A peer's human capital acquisition is a function of their own innate ability and the school, family and community inputs that follow. His impact on others rounds out the peer effect.

If human capital acquisition is a function of multilayered inputs then school choice may be a channel through which the input mix at a school is altered such that individual student achievement is maximized for all students. Parents could select schools where resources best compliment their child's abilities and whose peers best compliment both the schools resources and the abilities of the child.

Education researchers address similar issues in what is known as school effectiveness research, or SER. Their interests are in processes within schools that yield differential student outcomes. A goal of the research is to identify best practices for schools when confronted with different sets of challenges. School leadership, teacher training, curriculum and allocation of school resources are examples of variables in SER models, though school choice is not normally a part of an SER model (Luyten, Visscher and Witziers, 2005).

If school choice leads to better matching then researches should be able to test for differences in student learning when the parent's preference for school choice can be identified. I test this by using a panel data analysis of student performance in reading and writing. Independent variables are collected at the school, family and student level and are used to identify the contributions these inputs make to learning.

I am interested in studying school choice impacts as they unfold over time. It's unrealistic to suggest that changes in choice options and school practices would have immediate impacts. Parents may make the wrong match with a school, and need to time for that decision to unwind. Information about schools builds up over time and each year, parents know more about schools, which guides their selection. Schools may make changes to meet the needs of their new students, but change is not immediate as staff training and resources need to be acquired.

My results indicate that in 1999, parents choosing new magnets schools, in particular, saw their children underperform other district students. But when I look at how these students scored two years later this gap disappeared. Performance differences at other school types emerge, such as in schools offering the IB curriculum.

Anticipating that processes evolve over time I study a student cohort that completed 6th grade in 2005. These students will have spent all seven of their elementary school years in district schools, but not all will have attended the same school. I find that differences in school type are still important, but that choice, as a variable, has little relation to academic achievement.

A final and related question is if student growth, not the level of student achievement, is improved by school choice. I study an additional student cohort that took CSAP reading examinations for four consecutive years and identify an average growth rate. Results indicate that school type and school choice matter in student growth. Students attending magnet schools show increased growth.

The organization of this chapter proceeds as follows. I first review school production function literature, both theoretical and empirical. I summarize critiques from the empirical work that raise important research challenges important for me to address. I outline a methodology for gathering and modeling the data. Results from a series of models are presented and I follow that with a discussion with respect to my research questions and the literature review. I conclude with a discussion of extensions that could be made to improve the analysis.

Education Production Functions

Todd and Wolpin (2003) review research from both the child development and economics of education literature and present a model of student level achievement where human capital acquisition is cumulative, with cognitive achievement measured over different time periods. The child's initial level of cognitive achievement is a function of ability and family inputs, which in the pre-school period are a function of varying family resources. Parents make decisions about residential location and school type as the child prepares for schooling. Once a child starts school, families make decisions each year about the school, considering the child's achievement, the level of school resources available for the next school year and their family resources. Estimating their model involves measuring student achievement and accounting for differences in family and school resources over the different school periods.

Hanushek (1979) gives a general form education production function where student achievement is a function of innate ability, family background, peer influences, school inputs and time. School inputs include class size, expenditure per student, technology, teacher training and teacher experience. Hanushek also brings peer effect into the education production function.

A peer effect is the impact of the overall ability of a class on student performance. It can be viewed as an externality, the effect one person has on another. In different settings these effects can take on different forms, such as envy, competition or compliance. Checchi (2006) suggests that peer effects work at an aggregate level in a school, and most particularly at the classroom level.

Checchi notes that peer effects can be complement or substitute inputs. If increased learning occurs only when "there is a generalized increase in the quality of all students" (p. 85), then the peer effect between two students is a complement. But if the ability of a "better endowed" student at least partially compensates for the performance level achieved by lower endowed students then peer effects are substitutes.

Researchers studying peer effects have reported mixed results. Hoxby (2000) suggests the possibility that no peer effects exist since estimation techniques to identify them are seriously flawed by self selection and endogeneity questions. She notes that most research follows what is known as the "baseline" peer effect model, where achievement for person Y is a function of a constant, the mean achievement level of a cohort and the contribution of other variables. The baseline model doesn't address selection issues, however. Additionally, specifications assume linear peer effects, so that a gain to one student is equally offset by a loss to another.

Hoxby designed a methodology to compare grade cohorts in Texas elementary schools over multiple years. She argued that changes across cohorts reflected idiosyncratic differences in groups, not self or planned group selection effects. She found peer group effects due to gender and ethnicity.

Hoxby argued that grade level was the appropriate cohort to measure peer effects. Other studies use classroom cohorts. Burke and Sass (2011) use a longitudinal data set from Florida schools and study classroom peer effects. They suggest that classroom effects are stronger than grade level effects but find that peer effects overall are small and are reduced when teacher level fixed effects are modeled.

Carrell, Fullerton and West (2009) study group level peer effects by looking at cohorts of Air Force Academy cadets that are randomly assigned in their freshmen year. These cadets train, dine, study and exercise together and have limited interaction with other cadets. They find that a 100 point increase in the cohort's average verbal SAT entrance exam score translates to a .4 unit increase on a 4.0 academic grading scale during freshman year classes. These effects persist through all four years of schooling but at a diminished rate. Finally, they find evidence of nonlinear effects, and that there are greater social gains to increasing the mix of academic ability within cohorts.

Empirical estimates of education production functions face considerable measurement and data availability challenges. Hanushek notes that the students innate ability is the variable most often omitted from regression analysis. Data aggregation issues are present and present unique problems. For example, data on individual test performance and school level test performance may be available but data on student level family background may be aggregated to a higher level, such as at the census tract or Metropolitan Statistical Area (MSA). Additionally, modeling school level effects when the school level variable is a composite of student data may require special econometric techniques to isolate group level from student level effects.

A major issue with econometric modeling of school production functions is endogeneity (Vignoles, Levacic,Walker, Machin and Reynolds, 2000). Two sources of endogeneity bias are prevalent. First, if parents can select schools based on perceived school quality then measured school outcomes will reflect the contribution that the school makes to the student and the ability of the family to purchase some amount of school quality. Any gains in achievement may be no more than a return on a family's resources.

Second, and acting as an offsetting bias, is that schools may already be compensating for the effects that family resources have on school quality by "compensatory spending" on higher need students from disadvantaged families. This would be reflected in lower class sizes, subsidized before and after school care and meals at schools with lower income students. As a consequence, empirical estimates on inputs such as student teacher ratios may produce spurious results. They conclude that parental income and resource allocation across and within schools need to be tightly controlled to minimize endogeneity effects.

Vignoles et. al further suggest that research is impacted by " the lack of an established theoretical model of how school resources might impact on educational outcomes "(p.8). No one set of variables has clearly been identified. Hanushek (1986) notes that models are more likely to be based on the availability of data than on a theory as to their role in the production function. Omitted variable bias is a common source of bias.

Despite the technical challenges, Hanushek and others have argued that econometric models of production functions show schools to be inefficient in the allocation of inputs, often spending more on an input than is necessary. Hoxby (2002) has argued that schools have become increasingly inefficient when productivity (achievement per dollar spent) is the dependent variable in a regression analysis.

Vignoles et. al note that there is a long history to this argument, dating back to the Coleman report (Coleman, Hobson, McPartland, Mood, Weinfield and York,1966). Coleman et. al reported vast differences in spending on education across school districts in America. They also argued that student inputs and family backgrounds were much more important in determining academic success than anything schools were doing, raising a significant question as to whether or not schools provide students any value-add.

Checchi (2006) takes this issue and frames it in terms of the functional form of the production function. Typically production functions assume decreasing returns to inputs. He argues that research may show that a school is not efficient in production since intensive use of an input reduces its impact on productivity to a level that can't be statistically identified from zero in an econometric model.

The literature suggests that an education production function should consider student, family, school and community inputs. Gender and ethnicity may be important variables as well as family income. Inputs can have cumulative effects, so including variables over multiple time periods is important, as opposed to cross sectional snapshots of student performance. School contributions, such as programming, size, student teacher ratios and funding per student are all variables of interest. Peer effects are offered as a unique input. Peer effects may be a composite of gender, income and ethnicity. Their impact has been reported at the classroom level in schools, but also in larger groupings. Peer effects can be nonlinear and persist across several time periods.

Matching the theory of education production functions with empirical estimation is challenging. A key student level variable, innate ability, is unobserved. A child's readiness to learn in the first years of schooling is a function of family inputs that can change over time. Self selection raises endogeneity problems and spending patterns by schools may represent endogenous solutions to resource utilization problems. With no formal theory as a guide researchers use a wide selection of variables to model student achievement. Peer effects may be an important input in a model of student achievement. Correct estimation of peer group effects, however, may require large time series datasets so that idiosyncratic differences between peers are all that remain after students self select and schools further select students into classes.

The data available to me presents an opportunity to address several of these research concerns. First, as self selection is an important concern, identifying which families made a specific choice can be used as a control. Additionally, since students in my models can change schools, I can see test if self selection from one environment to another impacts student performance.

I have organized the data so that I can track students over time. This allows me to model a production function where I introduce variables at different points in the child's educational development. These cumulative effects would also be reflected in a measure a student's peers in early years of schooling as well as in later years. I also include controls for student level effects, such as income and gender.

Methodology

I use student level data as described more fully in chapter two. The data sets exclude test scores for charter school students but includes those of magnet school students. I build three different panels where the school and student identifier define the panel and use one data set that simply comprises a student cross section in one year. I use the same variables in most models except where new variables became available in later years.

My first model establishes a baseline for comparing school performance as a function of school choice. Data for this model is from the 1999-2000 school year. Students in this model were in 4th grade in 1999 at all district schools. My second model builds on the first. I merge 1999 and 2001 records and then look at 6th grade student performance. I compare results from the 1999 model to see if school choice effects differ after two years.

In my third model I create a student cohort that starts with those students in kindergarten in 1999. I track these students through the following six years, gathering test score data at two time periods. Period one is in third grade and period two is 6th grade. All students in the panel are those who stayed in district schools for seven years.

My fourth model measures student growth. I build a new cohort, starting with students in third grade in 1999 who go on to complete 6th grade in 2002. My objective is to estimate a growth rate and test if the rate varies by student and school attributes.

Estimation Procedure

Hierarchical, or multilevel statistical modeling is a research technique widely used by educational researchers for exploring school and student effects. [8] The general principal is that students are clustered, or grouped with other students into grades and schools. A multilevel model allows for identification of group effects and individual effects as well as interactions across levels. A three level hierarchy in a school, for example, would have students nested into classrooms which are nested in schools. Cross classifications are possible as well. Students may be in one classroom for part of the day with one teacher, then with another, so they can be cross classified at the classroom level. Time series, as well as repeated measurers data can also be modeled this way. In this case, a student may take repeated tests over time. Each test is an event

[8] See O'Connell and McCoach (2008) for a discussion of the history and varied use of multilevel modeling of educational data.

modeled at one level with the student being the second level, with perhaps a classroom or school level aggregation at level three.

In the United States, Stephen Raudenbush and Anthony Bryk (2002) are major contributors to the development of multilevel modeling and have created a software package, HLM, to estimate models. In the United Kingdom, Harvey Goldstein (1987) has made major contributions and was involved in the development of an additional software product, MLWin. These authors recommend using multilevel modeling to build from a very basic model (random intercepts only) to develop more complex models as needed.

The most basic model, a random intercept model, is one where for a variable Y, an individual member is identified by group membership. The mean of the distribution is the mean of all the groups, and the group mean is a function of the grand mean and the random variation from the grand mean for each group. It is modeled as follows:

(3.1) $y_{ij} = \beta_{0j} + \varepsilon_{ij}$ where ε_{ij} is distributed $N(0,\sigma^2)$

(3.2) $\beta_{0j} = \gamma_{00} + u_{0j}$ where u_{0j} is distributed $N(0,\tau_{00})$

The parameter γ_{00} is an estimate of the grand mean, or $\bar{Y}$.

There are two variance terms to make note of. First, τ_{00} is the variance of u_{0j} and second, σ^2 is the variance of ε_{ij}. The variance of $\bar{Y}$ is going to be $\tau_{00} + (\sigma^2/n)$, where τ_{00} is called the parameter variance and σ^2/n is the error variance. By setting $\sigma^2/n = V_j$,$Var(\bar{Y}) = \tau_{00} + V_j$.

An important statistic in this random intercept model is the Intra Class Coefficient, defined as:

(3.3) $ICC = \tau_{00} / (\tau_{00} + V_j)$

As a rule of thumb the if ICC < .05 then the unique variance at a level is small and probably doesn't need to be modeled separately. In school research where performance was the dependent variable, the ICC from a baseline model would indicate variation between schools, or a rough estimate of any unique school effect.

As in any regression model the residual, y_{ij} - $\widehat{y_{ij}}$, is the difference between the estimated value of y and the actual value. There can be only one difference between an actual score and a predicted score. But, as we see in equations 3.3 the residual is a compound residual with contributions coming from u_{0j} and ε_{ij}. An estimate of u_{0j} is required and then ε_{ij} can be derived. .

Let r_{ij} = y_{ij} - $\widehat{y_{ij}}$ and call that the raw residual. For each group *j* we can find the mean of the $r_{.j}$ by group j. An estimator of u_{0j} then becomes:

$$(3.4)\quad (\tau_{00} / (\tau_{00} + V_j)) * r_{+j}$$

This is as a shrinkage estimator for $u_{0j.}$ The raw group residual is "shrunk" depending on the strength of the ICC. If σ^2 is large relative to $\tau_{00,}$ and/or the sample size is large, not much shrinkage of any predicted residual occurs. It shrinks substantially, though, if τ_{00} is large relative to σ^2, and/or sample size is small. If there isn't enough information to estimate $\hat{u}_j$ then essentially $E(\widehat{u_{0j}}) = \beta_{0j}$.

From this basic random intercept model, we add predictor variables for the intercepts, variables for level one elements, interactions across levels, and random slopes.

Raudenbush and Byrk note that early work in multilevel modeling languished as computation of covariance structures with unbalanced data was extremely difficult. With the development of expectation-maximization (EM) algorithms in the late 1970's came a more feasible approach to covariance component estimation. Today iterative GLS and restricted GLS algorithms are used in software packages.

Educational researchers use multilevel models in research that follows a parallel track with economist. Multilevel modeling provides a way to segregate school level and student level effects. Education researchers describe composite variables as variables where student level data is aggregated to a group variable. Effects found at both the aggregate and student level are called compositional effects. These are differentiated from contextual effects, such as curriculum type, which can be uniquely identified at the school level. Compositional effects are important to identify since students are rarely randomly assigned to schools. Non-random assignment arises through school choice or residential sorting, in areas where there are no school choice policies.

Ordinary least squares regression can be used to find similar effects. In an OLS model a school mean is subtracted from the grand mean to produce the school level variable, and a student value is mean centered. The coefficients on the two variables can be considered a composite. Raudenbush and Bryk (2002) argue that OLS estimates are unbiased but variances are inefficient relative to variances computed in a multilevel model.

Harker and Tymms (2004) suggest that compositional effects can be seen in four areas: peer effects, teaching effect, facilities effects, and what are called phantom effects. These effects mirror what economists describe as inputs in production functions. Phantom effects arise from measurement errors and misspecifications, where unexplained variation gets "mopped up" into level two variance.

I build a multilevel model following the process identified above. This model is viewed as reduced form production function, as I use student, family and school level variables to predict student outcomes.

Variables. The dependent variables in the models are scores earned on reading and combined reading and writing CSAP scores. CSAP tests are described in chapter 2. CSAP's were designed to measure achievement in content areas defined by Colorado content standards. These tests are indexed so that student progress can be measured over time. Prior to implementation, the Colorado Department of Education reviewed tests for internal validity and reliability and the tests were deemed appropriate. A test for external validity was conducted using a panel of teachers that hand score tests and rated student achievement. Results from this process were satisfactory and the tests were released for use (CDE, 1998).

Measuring student achievement through standardized tests has generated controversy. Luyten et al. (2005) note that criticisms are not only raised about testing but also regarding evaluating students on any criteria. They argue that there is no alternative to viewing education as a goal oriented activity. If it is not goal oriented then it becomes impossible to justify public expenditure on education. Standardized tests may measure only one goal of schooling, but provide a useful tool particularly if testing procedures are consistent over time so that comparisons can be made between and across students.

Independent variables include school level variables and student level variables. Several school variables are composites of student level values. School level variables are school size, the school FRED rate, the percent of Hispanic students in a school, the school mobility rate, the student teacher ratio and a measure of school type.

School size is a variable as school funding was adjusted based on school size (PSD, 2008). Very small schools received an adjustment close to 20% while large schools received no adjustment. Most schools ranged between 350 and 550 students in size, and adjustments made were typically from 6% to 4% of a school's budget.

The free and reduced lunch rate at the school is a variable to test composite impacts on individual student learning as a function of the relative income level all students within the school. As the FRED rate increases at a school, it also becomes eligible for additional funding through the Title 1 program. I control for these differences with this variable. The percent of

Hispanic students in a school is used to test for composite effects similar to how I use the school FRED rate.

The school mobility rate is a variable only available to me for the 2005 school year. It is reported by the Colorado Department of Education. A student is considered mobile if they enter or exit a school other then at the beginning of the school year. I use this variable to see if increased student mobility at the school level has an effect on individual student achievement.

I use the student teacher ratio at each school as a measure of school resources. This ratio is used as in input in production function models to test if decreasing the ratio improves performance. My use of it is more as a control across schools as schools receive additional staffing for special education, low income students and English language learners.

The final school level variable is to identify schools by type. Magnet schools are schools without attendance zones. Core and IB schools are schools that have adopted curriculums different from the standard district program. I test if student performance differs by school type after controlling for other factors.

Student level variables are gender, ethnicity, FRED designation, the school choice decision, an indicator if a student changed schools, the peer group scores and the students own score on a third or fourth grade CSAP tests.

I track gender as there is evidence that female students may outperform males on literacy tests in elementary schools (Denver Post, 2000). I offer no theory as to why there is a gender effect but use this variable as a control. I track Hispanic students as they make up the largest ethnic group in the district and again use this variable as a control. FRED status is used as a control as well. Student level FRED status is also needed to identify a compositional effect with school level FRED percent.

The student choice decision is a key variable in the model. I test to see if achievement is influenced by this choice, or if after controlling for other factors, students are no different whether or not they attend their neighborhood school.

I use a categorical variable to test if a student has changed schools between testing periods. This is a way to incorporate cumulative effects into the model in that the student will have been influenced by different peers and different school effects. I also test if continuity at a school impacts student performance.

I use the average CSAP score at a grade level as a peer effect. I compile this by including scores for all test takers at the school, even those that have been excluded from my panels. I interact this with student demographic variables to test if peer contributions are heterogeneous.

Finally, I use a student's prior score on a test as an indicator of cumulative achievement. Third grade tests, which are the first tests taken, provide a benchmark to measure future improvement. This variable is useful to see if two students who score similarly on the first test, but attend different schools, will score differently on the follow up test.

Research Propositions

Based on the historical analysis of the district I presented in chapter two, the literature review from this chapter and the variables available to me for testing, I examine the following research propositions in the models that follow:

First, school choice should lead to more efficient production and improved academic achievement. As families are better able to match student needs with school resources, private allocative efficiencies will be found at the student level.

Second, alternative school types, such as IB or Core, should see increased student achievement. Schools have invested in alternative programs that school leaders, and parents believe provide for more effective instruction.

Third, peer group effects exist and will have a positive impact on achievement. As parents have greater capacity to match student needs to school resources, they also have more control over their child's peer group. This should translate into higher achievement.

Fourth, both aggregate measures of student mobility and student level mobility should be negatively related to achievement. If a student changes schools he changes his peer group. He may also face a change in school curriculum and environment that he would need to adjust to. These effects should have a negative impact on learning.

Model 1. The dependent variable in model 1 is the combined 1999 4th grade reading and writing score. Many of the students in the data set would have been kindergarten students in 1995, the first year that magnet schools opened in the district. Families that self selected into schools outside of their neighborhood are identified with a categorical variable.

In figure 3.1 I display a caterpillar plot of the unconditioned school means produced when estimating the dependent variable with only the random intercept term and no covariates. The Y axis of the graph shows the variation from the grand mean of each school. It is clear from the figure that there is variation in test scores by school. Confidence intervals at high and low performing schools don't overlap, reflecting real differences between schools.

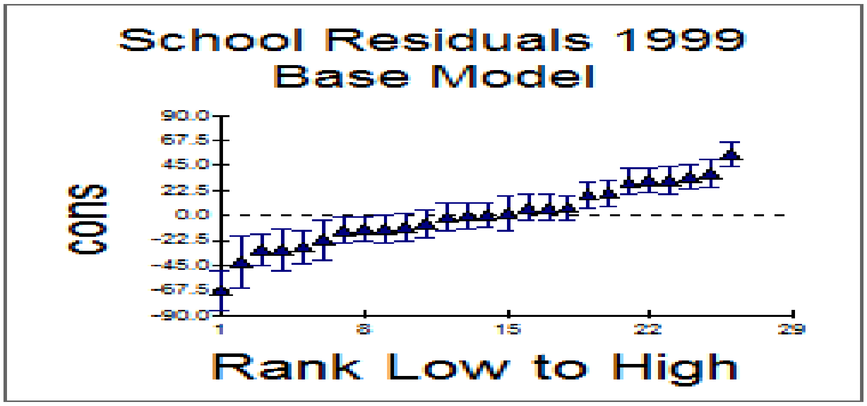

Figure 3.1 Model 1 school level residuals- no covariates

I estimate model 1 using equation 3.5.

(3.5) $Y_{ij} = \beta_{0j} + \beta_{1j} + \beta_{2j} + \beta_{3j} + \beta_{4j} + \beta_{5j} + r_{ij}$

$\beta_{0j} = \gamma_{00} + \gamma_{01}W_1 + \gamma_{02}W_2 + \gamma_{03}W_3 + \gamma_{04}W_4 + \gamma_{05}W_5 + \gamma_{06}W_6 + \gamma_{07}W_7 + u_{0j}$

$\beta_{kj} = \gamma_{k0}$

$Y_{ij} = \gamma_{00} + \gamma_{01}W_1 + \gamma_{02}W_2 + \gamma_{03}W_3 + \gamma_{04}W_4\, u_{0j} + \gamma_{05}W_5 + \gamma_{06}W_6 + \gamma_{07}W_7 + \beta_{kj} + u_{0j} + r_{ij}$

where:

W_1 = School is IB
W_2 = School is Core Knowledge
W_3 = School is a Magnet School
W_4 = Student Teacher Ratio
W_5 = School Size
W_6 = School FRED Rate
W_7 = School % Hispanic Students
β_{1j} = Student is Hispanic (1,0)
β_{2j} = Student is Female (1,0)
β_{3j} = Student is Free Lunch Eligible (1,0)
β_{4j} = Student is Reduced Lunch Eligible (1,0)
β_{5j} = Student Attended Another Neighborhood School (1,0)

Figure 3.2 is a caterpillar plot of the school means conditioned on the covariates in equation 3.5. It is clear that the variation between schools has been greatly reduced but that very high achieving schools still have confidence intervals that don't overlap with other schools. This suggests that there may be missing variables that would further explain these differences.

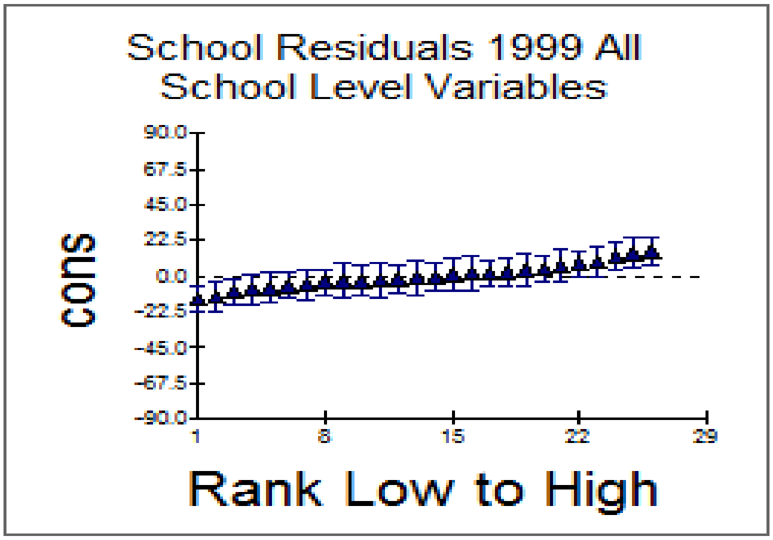

Figure 3.2 Model 1 school level residuals - full model

Regression results for the model are displayed in table 3.1. I begin by first addressing overall model adequacy. A pre-test calculation of the unconditioned random intercepts of school means yielded an intra class coefficient (ICC) of .11, suggesting that 11% of the total variation in student scores was variation between schools. An ICC of 5% or greater justifies building a multilevel model with level two covariates.

The values of the random coefficients in the model are reported at near the end of table 3.1. These can be used to approximate the effectiveness of the school level part of the model. The school means are μ_{0j} and represent the difference from the grand mean, γ_{00}. As the μ_{0j} are random variables, they have a variance. This is reported under the Variance Component header. The variance from the full model is compared to that from the base random intercept model. The proportion of school level variance in relation to the base model is approximately .80.

Table 3.1 Model 1 Regression Results
Dependent Variable
Combined 4th Grade Reading and Writing

Fixed Effect	**Coefficient**	**Std Error**	**T-Stats**
Average School Mean γ_{00}	1059.896	2.773	
School is IB γ_{01}	9.431	10.286	0.92
School is Core Knowledge γ_{02}	10.474	12.321	0.85
School is a Magnet School γ_{03}	-47.773	17.622	-2.71
Student Teacher Ratio γ_{04}	4.422	2.773	1.59
School Size γ_{05}	0.029	0.06	0.48
School FRED Rate γ_{06}	-1.011	0.45	-2.25
School % Hispanic Students γ_{07}	1.475	0.659	2.24
Student is Hispanic β_{1j}	-3.992	7.624	-0.52
Student is Female β_{2j}	8.128	4.462	1.82
Student is Free Lunch Eligible β_{3j}	-63.345	6.453	-9.82
Student is Reduced Lunch Eligible β_{4j}	-57.634	9.002	-6.40
Student at other neighborhood school β_{5j}	-12.3	7.065	-1.74

Random Effect	**Variance Component**	
School Mean, u_{0j}	112.988	67.922
Level 1 effect, r_{ij}	7478.87	272.783

-2 * LogLikelihood = 17969
(1527 of 1527) cases used

This supports the visual interpretation of figure 3.2 in that most, but not all school variation is explained. The coefficient values from model 1 allow me to address my first two research propositions regarding school choice and school type. I don't address the peer group and student mobility propositions in this model.

My first proposition was that school choice would lead to more efficient production and improved academic achievement. The coefficient on the school level variable, Magnet school, is negative and significant. The average score at these schools is significantly below that of other schools, on average 48 points lower. The coefficient on the student level variable, Student at Other Neighborhood School, is also negative and significant. Students not attending their neighborhood school are scoring lower on the 4th grade reading and writing tests.

This is initially a surprising finding given the expectation that parents use school choice to make better matches between student needs and school resources. But it is important to realize that successful matching may be time dependent. In 1999, district magnet schools were still young schools. The 4th grade cohort in my study would have been the entry level kindergarten class at these schools. It may be unreasonable to assume that these schools would quickly achieve higher levels of performance compared to other schools. In addition, parents had little information about these schools prior to enrolling. They may not have made very good initial matches between student needs and school resources.

I also find it important to consider who the early attendees of these schools were. In the early 1990's, school board members responded to input from parents for more choice in school curriculum. Some parents valued bilingual education and this school gave parents a unique opportunity that had not existed before. The other two magnet schools reflected parent interests in alternatives in both curriculum and school climate. The experiential school appealed to those with a demand for a more child centric approach to learning. The Core school stressed a back to basics curriculum that was held up as a contrast to the general school district curriculum.

I suggest that it is unlikely that parents whose students were being successful in neighborhood schools would be interested in leaving for these new schools. It is more likely that parents who preferred these options had children who were not being well served in district schools, or had expectations that they would not be well served. But as these new schools were untested, there is uncertainty that these students would experience success. There clearly can be no a priori expectation of success for these students. My finding that the 1999 reading and writing scores for magnet school students were lower is therefore not surprising.

The same interpretation cannot be offered for the effect of a student choosing another neighborhood school. Parents would be more familiar with these established schools and should be making better matches. Overall, there do not appear to be efficiency gains in 4th grade reading and writing achievement from parents using school choice.

My second proposition was that alternative school types, IB and Core, should see increased achievement in students. This would be demonstrated by positive coefficients on the IB and Core school level variables. This proposition isn't supported with results from model 1. The coefficients for both school types are positive but are not significant. Average scores in these schools are no different from scores in other schools. As in proposition one, it may be that these schools will experience increased performance over time, but this first model shows no significant school level effect.

There are other significant effects to report. Student demographic variables impact student achievement. There is a positive effect as females out score males. Lower income students score significantly below other students, both free and reduced lunch students. Hispanic students score similarly to other students after controlling for other variables.

The school FRED rates is a significant variable. The greater the percent of FRED students at as school, the lower the student performance. Combining student level FRED Status with school level effect produces a compositional effect. Both variables have the same negative sign and are significant. In a multilevel model this can be interpreted as meaning that FRED students will score increasingly lower the higher the rate of other FRED students in a school.

Model 2. I follow the 4th graders from model 1 as they move into 6th grade and again use their combined reading and writing scores as the dependent variable in this model. The equation for model 2 follows the form expressed in 3.5 but with added fixed effect variables. I add the students 4th grade exam score, the average exam score for a student's 4th grade peer group and a control variable to indicate if a student had changed schools between the 4th and 6th grade.

Results from the regression are displayed in table 3.2. I begin the analysis of model 2 by again first addressing model adequacy. The ICC from the base random intercept model was .096, slightly lower than the .11 value from model 1. This indicates that around 10% of model variance is at the school level. Caterpillar charts of the school residuals mirrored those from model 1 and are not displayed. The proportion of school level variance explained in the model was 85%, slightly higher than in model 1.

There are significant differences in fixed effect coefficients from model 1 which impact my analysis of propositions one and two. The new variables in the model allow me to address propositions three and four.

The first research proposition was that school choice should lead to more efficient production and improved academic achievement. The coefficients on Magnet school and on the Student at

Other Neighborhood School variables are now positive, but are insignificant. The represents a change from model 1 where they were negative and significant. Now, 6th graders at these schools score no different from other students. Students who underperformed compared with other students are now similar to them in achievement. As these are the same students studied in model 1, it suggests that there is a school level effect on achievement.

The second proposition is that alternative school types, IB and Core, should yield increased achievement. The coefficient on the IB categorical variable is positive and significant. The coefficient on Core is positive and has a probability value of .11. The t statistics for both coefficients have changed from model 1. These schools now show performance improvements, which may indicate, as with magnet schools, that improvements in achievement took time to develop.

Table 3.2 Model 2 Regression Results
Dependent Variable
Combined 6th Grade Reading and Writing

Fixed Effect	**Coefficient**	**Std Error**	**T-Stats**
Average School Mean γ_{00}	598.363	71.485	
School is IB γ_{01}	27.967	12.32	2.27
School is Core Knowledge γ_{02}	24.94	15.586	1.60
School is a Magnet School γ_{03}	3.435	20.135	0.17
Student Teacher Ratio γ_{04}	10.367	3.577	2.90
School Size γ_{05}	-0.072	0.052	-1.38
School FRED Rate γ_{06}	0.132	0.626	0.21
School % Hispanic Students γ_{07}	1.06	0.651	1.63
Student is Hispanic β_{1j}	84.087	87.095	0.97
Student is Female β_{2j}	2.001	4.61	0.43
Student is Free Lunch Eligible β_{3j}	-69.39	7.51	-9.24
Student is Reduced Lunch Eligible β_{4j}	-67.961	9.9	-6.86
Student at other neighborhood school β_{5j}	4.08	6.541	0.62
4th grade combined score β_{6j}	0.482	0.027	17.85
4th grade peer group score β_{7j}	-0.473	0.31	-1.53
Student Changed Schools 4th to 6th grade β_{8j}	-40.544	6.442	-6.29

Random Effect	**Variance Component**	
School Mean, u_{0j}	172.984	87.376
Level 1 effect, r_{ij}	6971.803	269.49

-2 * LogLikelihood = 15938
(1362 of 1371cases used)

The third proposition is that peer group effects will exist and have a positive effect on achievement. I find no peer group effect in this model. The coefficient on the 4th Grade Peer Group Score is negative but is insignificant. I reviewed the detailed student record file to better understand this result and found a positive correlation between a student's 1999 reading and writing score and his class average of .15. The correlation between his 20016th grade score and his 4th grade average peer group is .16. The negative coefficient in the model suggests that an interaction with one or more variables is reversing this effect. I test for interaction effects with FRED status and School FRED rate and find that the peer score is negatively related to FRED status but the interaction isn't significant.

Compositional peer effects for low income students are present. The income peer effect works similarly as in model 1. Both coefficients were negative and significant when pre-tested. School level FRED percent is insignificant in model 2 but Harker and Tymms (2004) note that when multiple compositional effects are found, the interaction of the school level variables can affect the coefficients in the full model. This indicates that there may be an indirect channel that peer effects operate through.

There appears to be a positive Hispanic peer effect in the model as both the student and school level variables are positive. In the pre-test, however, both were negative. These variables interact with the FRED indicators at both the school and student level. After controlling for income effects, Hispanic students do better when the population of Hispanic students in a school increases but there is no compositional effect on any individual Hispanic student.

The final proposition is that aggregate school mobility and student level mobility will be negatively related to achievement. I don't measure school level mobility here but the coefficient on Student Change Schools is negative and significant at the .01 level. Students who changed schools between 4th and 6th grade lost, on average, 40 points on the 6th grade test. The result is not sensitive to income level or use of school choice. On average, changing schools negatively impacts student performance.

As in model 1, FRED students score lower than other students. The gender gap is gone, but as it remerges in later models I hesitate to find any significance in this one result.

This model also added the student's prior test score as an independent variable. The coefficient on 4th Grade Combined Score was positive and significant at the .01 level.

Model 3. For this third model I created a panel spanning the 1999-2005 time period. I identify students who were continuously enrolled in district schools from kindergarten through 6th grade and took CSAP exams in 3rd and 6th grade in reading and writing. The third grade writing test is now available for me to use and gives me an earlier indicator of basic literacy compared to the 4th grade score used in model 2. Variables are the same as in model 2 with two exceptions. First, I combine the free and reduced lunch measures into a single FRED category. Second, I add the school mobility variable.

Results from the full model are displayed in table 3.3. The measures of overall model adequacy show an ICC from the pre-tested base random intercept model of .138, indicating that around 14% of total variance is at the school level. This is an increase from the first two models. The proportion of school level variance explained drops to 77%.

Table 3.3 Model 3 Regression Results

Dependent Variable

Combined 6th Grade Reading and Writing

Fixed Effect	**Coefficient**	**Std Error**	**T-Stats**
Average School Mean γ_{00}	1292.469	64.469	
School is IB γ_{01}	32.698	15.777	2.07251062
School is Core Knowledge γ_{02}	15.475	15.672	0.98742981
School is a Magnet School γ_{03}	11.405	24.493	0.46564325
Student Teacher Ratio γ_{04}	0.647	3.943	0.16408826
School Size γ_{05}	-0.079	0.051	-1.5490196
School FRED Rate γ_{06}	-1.07	0.652	-1.6411043
School % Hispanic Students γ_{07}	18.079	70.192	0.25756496
School Mobility Rate γ_{08}	-0.688	1.184	-0.5810811
Student is Hispanic $\beta1_j$	-27.541	70.192	-0.3923667
Student is Female $\beta2_j$	14.13	4.619	3.0591037
Student is Fred Eligible $\beta3_j$	-36.32	7.657	-4.7433721
Student is at another neighborhood school $\beta4_j$	-7.427	5.991	-1.2396929
3rd grade reading and writing score$\beta5_j$	0.503	0.02	25.15
3rd grade peer group score $\beta6_j$	0.184	0.108	1.7037037
Student Changed Schools Once $\beta7_j$	-32.711	11.214	-2.9169788
Student Changed Schools Twice $\beta8_j$	-36.326	7.657	-4.7441557

Random Effect	Variance Component	
School Mean, u_{0j}	409.406	152.299
Level 1 effect, r_{ij}	5014.565	230.753

-2 * LogLikelihood = 11087.611

(973 of 973 cases used)

In figure 3.3 I display a caterpillar plot of the school means after estimating the full model. The graph indicates that very high and low performing schools have mean values different from each other and that these differences aren't fully explained in the model.

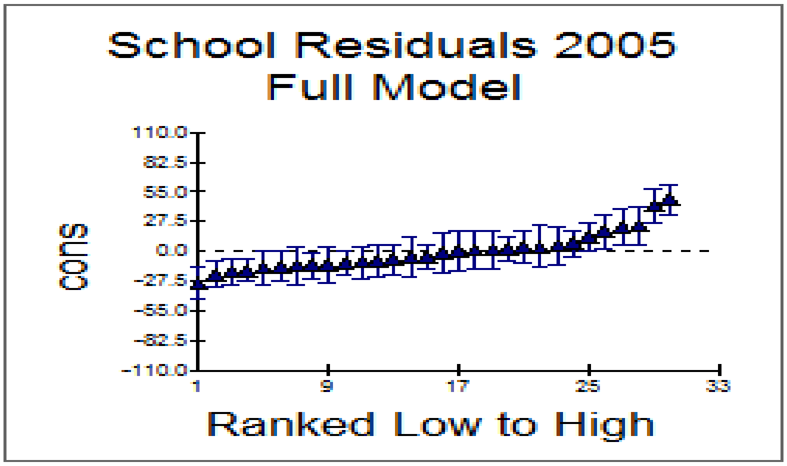

Figure 3.3 Model 3 school residuals - full model

I have suggested that change within the school district would evolve and performance differences, as a function of school choice and school type, might appear in later years. I use model 3 to test the validity of this. The coefficient on Magnet Schools is again positive but is insignificant. The coefficient on Student Attends other Neighborhood School is negative but insignificant. The coefficient on IB school is positive and significant. The coefficient on Core school is positive but not significant. These are the same relationships identified in model 2, which modeled 2001 6th grade combined scores. School choice students are performing the same as other students and IB schools boost achievement. School choice and school type effects appear stable.

Another different finding in model 3 is that the coefficient for the 3rd grade peer group score is now positive and significant. This indicates an academic peer effect. I interact this with school choice and school type but find no interactive effect. The peer effect operates across all schools. This result differs from model 2 where the peer coefficient was negative but not significant. An explanation for this change is found after I revisited the detail file for these students. I find a positive correlation between a student's 3rd grade reading score and that of his peers of .32, which is twice what it was in the 2002 data, suggesting a school level effect. Students who are in the same grade at the same school are scoring more alike than they were in the earlier years of my study. The more students score alike in an earlier grade the higher the peer influence in a later grade.

As in models one and two, an income peer effect is also present. The higher the school FRED rate, the lower the performance of any FRED student in the school.

One final effect to report is that females outscore males in this model and the effect is significant.

Model 4. For the final empirical analysis in this chapter I build a growth model by tracking a student cohort from 1999 to 2002, which covers students from grades three to six. A multilevel framework could be used for growth modeling as it provides a convenient device for measuring school, student and repeated measures effects. I chose not to follow this approach, however, as I don't enter school level variables to form a third level of a hierarchy. I use random effects estimation as an alternative where between effects model student differences and yearly differences are the within effect.

I allow for students to be changing schools over the course of the study. As there are no true school level variables, school effects are reflected at the student level. For example, a student will attend an IB, Core, other neighborhood or magnet school and I measure it as such. I also included the school size, student FRED rate and student teacher ratios as student level variables. These values are recorded for the year the student was in a particular grade. A predicted growth path for a student reflects the influence of each school he may have attended. The time variable in the model showed a diminishing effect, so the model includes a squared term.

Of particular interest is if the growth rate interacts with the type of school a student attends. To test this I add interaction terms for IB, Core and magnet student with the time variables.

Regression results are presented in table 3.4. The overall effectiveness of the model is reported at the end of the table. There is high between school variation and low within group variation. The yearly growth rate was originally calculated to be 41 points but adding in the square term changes the value now to 84.20.

Yearly reading scores are related to school choice. Magnet students score lower. This is consistent with the result form model 1 where I measured 4th grade reading and writing performance from 1999. It is inconsistent with the results from models 2 and 3 which showed that there was no difference is magnet school student performance. I had interpreted these results to indicate that while magnet school students started off at lower levels of achievement, they caught up with other students.

Table 3.4 Model 4 Regression Results	(1)	(2)	(3)	(4)
Dependent Variable = CSAP Read				
VARIABLES	coef	se	tstat	pval
Year (Growth Rate)	84.20***	(1.618)	52.05	0
Year Squared	-14.02***	(0.503)	-27.86	0
Female	7.612***	(2.509)	3.034	0.00241
Hispanic	-18.46***	(4.250)	-4.344	1.40e-05
FRED student	-32.59***	(3.243)	-10.05	0.0001
Changed school	-7.136*	(3.641)	-1.960	0.0500
IB student	-0.894	(3.057)	-0.292	0.770
Core student	5.851	(3.736)	1.566	0.117
Attended Magnet school	-20.06***	(4.393)	-4.566	4.96e-06
Attended other neighborhood school	-1.511	(1.896)	-0.797	0.425
School size	-0.0808***	(0.0105)	-7.719	0
Student teacher ratio	4.390***	(0.394)	11.15	0
IB by year	15.52***	(3.650)	4.252	2.12e-05
IB by year squared	-3.847***	(1.205)	-3.192	0.00141
Magnet by year	18.73***	(5.111)	3.664	0.000248
Magnet by year squared	-4.392***	(1.601)	-2.743	0.00608
Core by year	3.029	(4.534)	0.668	0.504
Core by year squared	-1.463	(1.442)	-1.015	0.310
Constant	499.9***	(5.746)	87.00	0
Observations	4,988			
Number of sno	1,247			

R-squared Between .84
R-squared Within .10
R-squared overall .53
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

There is evidence from model 4 that this may still be the real story. When I interact school type with the growth rate variables, the coefficient on Magnet By Year is positive and significant, and there is a diminishing effect. Growth rates for these students are higher than for other students. These students may be on their way to catching up.

I further explore magnet student performance by estimating separate OLS models for each year of the panel data. In years 1999 and in 2000, the coefficient on magnet school student achievement is negative, but it is positive in 2001 and 2002. Lower performance in grades 3 and 4 may be what weights the coefficient on Attended Magnet School to be negative overall.

There may also be an effect with magnet student scores that reflects that I only use reading scores as a measure of achievement, not the composite reading and writing score. I look back to the original data for this panel, starting with 4th grade, and find scores for both reading and writing. I break these out by magnet school students and those attending neighborhoods schools. The average writing score for magnet school students is higher than the average for neighborhood students, by 15 points. The reading score is lower for magnet students, by 4 points. My result in model 4 regarding magnet students may reflect this difference in the tests. Combining reading and writing scores may more accurately reflect literacy education at the magnet schools.

There is no difference in scores for students who attend other neighborhood schools, which is consistent with the other three models. IB students do not score higher in this model, but the interaction with the growth terms is positive and significant, as with magnet students. The growth rate for IB students is higher than for the control group. Core students' score higher, but the probability value associated with the test statistic is only .11. Their growth rate is no different from other students.

Females score higher in the model. FRED students score lower as do Hispanic students. This is the first model where Hispanic student performance has been statistically different from other students. My previous models all included a school level variable for the percent of Hispanic students at the school. here was some evidence that as this value increased, scores for Hispanic students increased as well. Including a school level measure for Hispanic populations may be needed to more accurately identify achievement.

Conclusion

My regression models represent reduced form school production functions. Student achievement is a function of school, family and student inputs, including the peer effects. I bring the school choice decision into the model as a control for a family's preference.

I use four models to explore effects that are unfolding over time. Model one establishes a baseline of 4th grade reading and writing performance for those students who were first presented, as kindergarteners, with an opportunity to attend a magnet school. My second model follows their progress through 6th grade. In model three I track a student cohort for seven years. These students entered kindergarten in 1999. Parents had more familiarity with school of choice by this time and had more years of CSAP data to use in comparing schools. My final model tests to see if growth rates, rather than level changes, tell a different story then what I find in the first three models.

Results indicate that models of student achievement can identify school effects, but differences between schools represent no more than 13% of the total variation in student test scores. Luyten, Visscher and Witziers(2005), in a comprehensive survey of the literature, report that the between school variance found in student achievement studies ranges from 10-15%. The intra class coefficients in my models fall within this range. I interpret this to mean that most of the variation in student achievement as reflected in performance on standardized tests is at the student level. Schools do impact achievement but a school's value add can be overwhelmed by student characteristics of gender, ethnicity and income.

Table 3.5a Summary Data 1999

Variable	Obs	Mean	Std. Dev	Min	Max
Combined Read/Write Score	1527	1022.55	93.89	580.00	1372.00
Hispanic Students	1527	0.11	0.31	0.00	1.00
Free Lunch Students	1527	0.16	0.37	0.00	1.00
Reduced Lunch Students	1527	0.07	0.25	0.00	1.00
Students in IB schools	1527	0.10	0.30	0.00	1.00
Students in Core Schools	1527	0.09	0.29	0.00	1.00
Attend other neigh.	1527	0.12	0.33	0.00	1.00
Attend magnet	1527	0.07	0.25	0.00	1.00
School Size 1999	1527	513.91	99.57	90.00	650.00
School FRED 1999	1527	23.41	17.01	0.00	67.63
School Hispanic % 1999	1527	11.89	11.78	1.79	70.28
Student Teacher Ratio 1999	1527	15.83	2.32	14.20	18.43

Table 3.5b Summary Data 2001

Variable	Obs	Mean	Std. Dev	Min	Max
Combined Read/Write Score 01	1369	1196.59	106.28	759.00	1601.00
Combined Read/Write Score 99	1369	1027.13	93.07	580.00	1372.00
Hispanic Students	1369	0.11	0.31	0.00	1.00
Free Lunch Students	1369	0.15	0.36	0.00	1.00
Reduced Lunch Students	1369	0.06	0.25	0.00	1.00
Students in IB schools	1369	0.10	0.30	0.00	1.00
Students in Core Schools	1369	0.09	0.29	0.00	1.00
Attend other neigh.	1369	0.16	0.37	0.00	1.00
Attend magnet	1369	0.06	0.24	0.00	1.00
School Size 1999	1369	499.79	96.12	91.00	656.00
School FRED 1999	1369	23.51	17.54	4.55	75.25
School Hispanic % 1999	1369	13.77	12.55	2.39	69.51
Student Teacher Ratio 1999	1369	16.57	2.18	10.90	19.89

Table 3.5c Summary Data 2005

Variable	**Obs**	**Mean**	**Std. Dev**	**Min**	**Max**
Combined Read/Write Score 05	973	1216.24	107.27	762.00	1657.00
Combined Read/Write Score 02	973	1088.81	125.53	379.00	1475.00
Hispanic Students	973	0.14	0.34	0.00	1.00
FRED Students	973	0.22	0.41	0.00	1.00
Students in IB schools	973	0.10	0.30	0.00	1.00
Students in Core Schools	973	0.11	0.31	0.00	1.00
Attend other neigh.	973	0.22	0.42	0.00	1.00
Attend magnet	973	0.09	0.29	0.00	1.00
School Size 05	973	502.71	132.98	42.00	808.00
School FRED 05	973	28.80	18.58	2.56	86.25
School Hispanic % 05	973	0.17	0.15	0.00	0.77
Student Teacher Ratio 05	973	16.57	2.19	9.47	20.08
Changed Schools from 99-02	973	0.18	0.39	0.00	1.00
Changed Schools from 03-05	973	0.16	0.37	0.00	1.00

To aid in interpreting the regression results from my models, tables 3.5 a-c are presented above. The mean values and standard deviations of student test scores prove useful in considering the magnitude and the marginal effects of the variables tested.

For the models using 4th and 6th grade reading scores covering the 1999-2001 time period, tables 3.5a and 3.5b reveal that one standard deviation in 4th grade scores is about 93 combined test points. The average difference in mean scores from 1999-2001 is around 85 points per year. Expressing monthly test score changes through a straight linear decomposition would indicate that on average, students gained 7 points a month.

When I suggest that school effects are overwhelmed by student level income effects, I mean that for 6th grade students taking tests in 2001, both free and reduced lunch status students score at almost one year's growth below average. The coefficients on these variables from table 3.2 are 69 and 68, close to the average yearly growth of students. This income effect is approaching one full standard unit from the mean of all students. The magnitude of the income effect on test scores is large.

The magnitude of the effect from changing schools, as reported in table 3.2, is also large. The coefficient is -40.544, representing around 6 months of student growth, or close to one half a standard unit from the mean of all students.

Several school level effects can be expressed in terms of yearly or monthly student achievement as well. In 1999, as table 3.1 reveals, magnet schools averaged 48 points lower than other schools on 4th grade combined reading and writing scores. This would represent around 6 months of student achievement. In table 3.2, using 2001 data, IB schools perform on average, at a level that would represent around three months of student achievement above other schools.

The results in model 3, 6th grade scores from 2005, follow a similar pattern but the average yearly change is lower. I use the 3rd grade test results as the first performance test and the difference between the mean 6th grade score and the mean 3rd grade score is 128 points, averaging 43 points per year. The average 2005 and the 2001 6th grade scores differ by 20 points, but the 3rd grade score for model 3 is almost 60 points higher than the 4th grade score in model 2. As the 3rd grade test was not available to use in model 2, it may be that the 3rd and 4th grade scores were rescaled, but I cannot find documentation to verify this. I also exclude hundreds of test takers in model 3 who did not attend local schools for all seven years, and this may skew the average as well.

For the 2005 data, FRED students' scores are almost one year lower than the average, as in models one and two. The magnitude of the effect of changing schools, either between kindergarten and third grade or after third grade is also highly significant, representing around one year of average academic achievement. IB schools continue to average higher achievement than non IB schools, with average scores higher by nearly 9 months of achievement.

My results show that in this district school choice yields no unique contribution to student achievement. In some cases there may even be losses. School type differences exist for IB programs but no significant effect is found for Core schools.

These results are surprising given how active parents are in school markets. Parents can be heavily invested in their school choice decision. Schools where parents and students actively engage should be able to capitalize on this. Woessman (2003) suggests that increased parental agency and the degree of autonomy that a local school has in administering its own affairs is positively related to school performance. He based his findings on standardized international test results collected from schools in thirty nine countries. He claims that greater autonomy for schools leads to "more effective monitoring of teachers by parents concerned about student learning "(p.123), which translate into productivity improvements. The magnet schools in this district fit this school type description but I don't replicate his result with my data.

School resource variables, which were student teacher ratios, school size and school level student mobility also aren't shown to be significant inputs into student achievement. This is consistent with Checchi's argument that if schools use scarce resources as efficiently as they can, then coefficients on these variables when used in regression models would be zero since schools experience diminishing returns to inputs. District budgets for schools may already reflect differences in school size, demographics and student need.

I consistently find that students who changed schools score lower on subsequent tests. This finding is supported in the education literature. Dunn, Kadane and Garrow (2003), for example, report that students in Pittsburg who change schools score lower on standardized achievement tests. Other research has sought to identify specific factors that contribute to increased mobility and the impact on test scores. Dong, Anda, Felitti, Williamson, Dube and Giles (2005), writing in a pediatrics journal, argue that adverse childhood experiences (ACE's), such as family alcoholism, childhood neglect and family dysfunction are highly correlated with mobility. Astone and Mclanahan (1994) suggest that divorce and family separation leads to higher rates of student mobility. Hanushek, Kain and Rivken (2004), using data from the NLSY find higher rates of job change, divorce and other changes in family structure in movers than in non-movers. Using Current Population Survey data they further report that 65% of those moving for non-family related issues move to find a better, larger or newer home, or to purchase a home. Lower income families had significantly higher divorce rates and job losses that triggered residential relocation.

Schools life is highly structured and follows close routines (Audette and Algozzine, 2000). In addition to out of school factors that create difficulties for children, disrupting their routines may negatively impact achievement. One way to isolate the impact mobility has on performance would be to look at how well students were doing before they changed schools and how well they do after a move. The data I use in models two and three allow me to examine this in some detail. I have a measure of performance from before a student changed schools and one following. In model two, I capture a student's 4th grade reading score then note if the student changed schools before taking tests in 6th grade. In model 3, I use the 3rd grade score as the prior measure of achievement.

There is a high positive correlation between both the 3rd and 4th grade score and the 6th grade score. For model 2 the correlation is .49 and for model 3 it is .69. When I calculate a partial correlation controlling for mobility (student changed schools after the first test), these correlations stay virtually the same. This suggests that these students are no different from those that didn't change schools with respect to the relationship between the two scores. The partial correlation between changing schools and the 6th grade score is negative (-.22 in model 2 and -.12 in model 3) which supports the negative coefficients found in the models.

Another appropriate test would be to compare the mean reading and writing scores on the early tests between those who later changed schools and those that did not. For model 2, using the 1999 data, there was no significant difference between the mean scores of the two groups. Using the 2002 data from model 3, I find a significant difference in means scores (1099 for non movers and 1031 for movers) but this is confounded by the fact that some of those who moved between 4th and 6th grade also moved between kindergarten and 3rd grade.

There is one anomalous result regarding student teacher ratios that is worth discussing. In model 2, which used 2001 sixth grade data, and in model 4, the growth model for 1997-2002, the student teacher variable was positive and significant. This suggests that the fewer teachers in a building, the higher the level of student achievement, and is counterintuitive.

When I reexamined summary data from this time period I found that between 1999 and 2002 enrollments increased at schools while staffing levels did not. This made the student teacher ratio rise. Average school achievement also increased over these years. Now, a rising student teacher ratio is correlated with rising test scores. This only happened for a short time, however, and reflects a one-time productivity gain for the school district. Schools were asked to do more with less and did so. The average student teacher ratio in 2001 was 16.57. It was 15.98 in 1999, almost half a staffing unit different. Student teacher ratios increased at all schools in 2001, reflecting a rise in student populations.

My ability to further analyze the research propositions could be enhanced in several ways. I would prefer to measure student achievement as a composite of reading, writing and math scores but as CSAP tests were introduced in different years in different grades, it is difficult to put panels together that capture this broader measure of achievement in the early years of school choice. I am left with a reliance on reading and writing scores which reflect only one form of student achievement. Data available after 2003 would have results for all subjects in all grades, so a study of student progress from that time forward could make use of a more robust measure of achievement. Additionally, since 2007 the state has been reporting on what it terms adequate yearly progress, which shows growth by subject area. Adequate yearly progress would be a robust variable for a researcher to make use of.

I would benefit from additional school level data as it relates to teacher training and experience, as well as administrative turnover. I have made the assumptions that schools are similar in these effects and any variation would be random. If, however, there is systematic bias in hiring, or that better teachers self select into schools with higher ability students then I would have a bias that could be identified and controlled.

I would also benefit from having student level test scores from the 1997 and 1998 for this district. While I have student records for these time periods, with information on school choice, ethnicity and student FRED status, my data was missing 4th grade CSAP results. These years represented the first two years of CSAP testing and would allow me to more accurately identify baseline effect from when the testing began.

My analysis has considered school choice to be an additional input to a production function. It should capture preferences for different school types and reflect the ability of parents to match student needs with school resources. I find no significant effects for this in the models I tested. Students may be best served at any school, on the condition that they there throughout their elementary years. It would be difficult, however, to convince parents who made school choice decisions, that this was true. School choice is popular with parents despite the lack of evidence that choice yields gains from private allocative efficiencies. It may be, though, that choice benefits us all, as aggregate social efficiencies may exist. This is the subject of my next chapter.

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Chapter Four

School Markets and Competition

For generations, children in our local community attended either a private religious school or a public school close to their home. The public system was residency based. Innovations in school choice now position parents to act like consumers in other markets, selecting from a host of options other than their local school. School choice has "injected a degree of consumer driven, market style competition into the system as schools seek to attract families" (Feinberg and Lubienski, 2008, p. 2). A school model based on local monopolies has been replaced by one of local competition.

Caroline Hoxby (2003a) writes that economists should be well suited to study school choice as understanding markets is central to economic thinking. Hoxby maintains that economists are good at identifying how market structures affect the way market actors behave, and how their behavior alters outcomes, such as achievement and school productivity. She labels this line of analysis as "structure, conduct, performance" (Hoxby, 2003 p. 4).

In chapter two I outline the structure of our local school market and pay particular attention to the institutions, or the rules of the game, that govern the market. I also report on conduct changes by parents, particularly patterns I observed in their choice behavior within the local school market. My purpose now is to look at school conduct, particularly how successful schools have been in attracting families to them. Studying our changing school system reveals that structural change preceded conduct change which leads to altered outcomes. One outcome is the recruiting patterns at schools, which is the focus of this chapter.

I begin with an overview of the role of demand and supply for education and the role of markets in equilibrating the two. School markets have unique characteristics that need to be understood. Next, I review literature on how competition can alter school performance, paying particular attention to work by Caroline Hoxby. I summarize the literature and suggest a series of research propositions and a methodology for addressing them. I build two empirical models, report their results and discuss their interpretation. The chapter concludes with a discussion of school choice as a policy option for managing school district populations.

Checchi (2006) offers a stylized model of demand for education in terms of human capital acquisition. In his specification the optimal amount of time spent acquiring an education (demand) is a function of innate ability, the human capital one currently possesses, future wage earnings, the price of schooling and the resources the school has to put to use. Future earnings are discounted and additional time spent in school may have a diminishing return. If expectations of future wages are low, interest in schooling is low.

Neal (1997) studied the demand for schooling while differentiating schools by type. His research centered on Catholic versus public schooling. He offers a stylized model of utility for individuals in a two sector education market, public and Catholic. Individuals obtain utility from educational outcomes and from unobserved consumption goods that are a product of a child's schooling, such as moral values or character education. Preferences for different school types may be idiosyncratic and enter his model as a unique error term.

Constitutional and other legal institutions form the basis for supply of public schools in quasi school markets. Resources for schooling are related to community resources and ability to raise revenue through taxes. Increasingly, state and federal interventions in school markets have shifted funding away from local sources to a mix of funding from multiple revenue streams. In Colorado, state funding now provides 58% of operating revenues for school districts with 42% being provided by local property taxes (CDE, 2012).

For some economists the supply curve for education is simply the production function for schooling (Checchi, 2006)(Dewey, Husted and Kenny, 2000). A school's revenue is simply a function of the number and characteristics of students (Levacic and Vignoles, 2002).

Brasington (2003) takes issue with the conceptualization of the production function as supply curve. These must differ in that supply curves should include the price of schooling. As most economists find no "readily available market" that yields a market price, he recommends using hedonic modeling to yield a unit price from which the supply of school quality can be estimated. He suggests that what some consider to be inputs into production are better viewed as supply shifters, such as the number of schools in an area, the school environment and student characteristics.

In Brasington's model community residents have an incentive to increase supply as prices of school quality rise. Increasing school quality benefits residents in that their children receive a better education and, ceteris paribus, the value of housing owned within the district increases. Homeowners have incentives to "move up the supply curve" (Brasington, 2003, p.375). Lobbying efforts and control over local school boards are the channel by which community members impact supply.

Suppliers and demanders meet up in school markets. School markets are referred to as quasi-markets since government makes market decisions. Kelly (2007) notes that public schools are expected to cooperate and compete with each other to meet public objectives, which differentiates them from private firms.

Oplatka (2004), an Israeli educator, outlines the general nature of market forces in school markets. First, parents must be active agents. They select schools, both in and out of their neighborhoods, on the basis of appropriate and properly informed criteria. Second, markets lead to differentiation in types of schooling and in school quality. Parents must be able to accurately interpret these type and quality differences. Finally, schools improve performance when striving to increase market share. This makes them sensitive to market demands and produces change within schools.

When school choice is introduced into public school monopoly markets, parents can choose schools that best meet their needs and the needs of the broader economy (Kelly, 2007). Competition may increase student performance, increase productive efficiencies and play a role in "reducing principle agent friction" (Kelly, 2007 p.102) between teachers, administrators and parents. Teachers have incentives to further align their interests with that of school administrators, parents and taxpayers. Kelly claims that first mover advantages may be available to suppliers in new markets. Successful innovators capture market share and find ways to profit from their innovations, such as in selling them to other schools.

Caroline Hoxby (1999, 2000, 2002, 2003b) has written extensively on the unique role that competition from school choice plays in school markets. She argues that researchers have been sidetracked by investigating the distributional impacts of school choice when the real significance is in what happens when schools compete for students. For Hoxby, if schools compete, more efficient providers draw students away from less successful schools. These schools are then forced to raise their levels of productivity. Those schools that cannot raise productivity continue to lose students until the school ends up closing. While closing schools may have costs, Hoxby believes that productivity gains from school choice are so large that school choice becomes "the rising tide that lifts all boats". The gains and losses from any reallocations "might be nothing more than crests and valleys on the surface of the much higher water level" (Hoxby (2003b, p. 290).

Hoxby writes that there is great opportunity to improve productivity in schools, as schools are significantly less productive than they were thirty years ago. Using test scores from the National Assessment of Educational Progress, or NAEP, which was first given to students in the U.S. in 1970, she demonstrates that NAEP points per thousand of real dollars spent on public education declined over the next twenty years, by 54.9 % for nine year olds and by 73.4% for seventeen year olds. Had productivity in 1999 been equal to 1970, the average nine year old American student in 1999 would have a score that fewer than 10% of students in 1970 achieved. The average seventeen year old would score at a level that fewer than 5% of students achieved. These productivity decreases hold even as she controls for demographic changes, differing career opportunities for women teachers and education level of parents. School choice and competition become policy options to reverse this fall in productivity.

If schools are made to compete, what leads to changes in school conduct? Hoxby (2002) writes that this is determined by what school producers are maximizing and what a school production function looks like. Schools maximize different objectives and school types differ, ranging from private for profit to traditional public schools. She makes the assumption that while school types vary in their objective functions, parents are similar in theirs. She argues that most parents tend to prefer schools that "have better academic achievement, emphasize academic standards and promote a relatively structured (disciplined) school atmosphere" (Hoxby, 2002, p. 296). Parents then seek out more productive schools that meet these objectives.

Hoxby models education production functions for differing school types. She suggests that for profit and nonprofit school types operate with similar objectives and differ only in the distribution of any surplus that gets generated. Surplus is distributed to owners in the for-profit sector. In the nonprofit sector surplus is distributed through such things as changes in working conditions and in the pursuit of valued social goals. Public schools fit this model if, when faced with competition, a school loses revenue on a per student basis. Hoxby suggests that when a traditional public school shares market space with a charter school, the public school is fee-based at the margin.

Hoxby suggests that in a public school choice system, schools of superior quality capture all the public school students in its area. It shares enrollment if quality is equal. She assumes all school revenue is derived from fees. These fees need not be paid by parents but can be paid by taxpayers on their behalf. Parent choices then determine where money flows and if a school is viable or not.

Hoxby looks for evidence of productivity increases in public school systems following the introduction of school choice. Her 2003 paper looks at three cases. The first is a voucher program in Milwaukee, Wisconsin. The second is the introduction of charter schools in Michigan and the last is the introduction of charter schools in Arizona. In each case Hoxby offers evidence that public schools increased their achievement after holding spending constant, evidence of a productivity effect. Her main explanatory variable is the amount of exposure to competition that a public school faced. The greater the competition a school faces, on average, the greater the increase in productivity.

Researchers have challenged Hoxby on a number of points. One line of argument is that alternative schools don't yield performance improvements, questioning their usefulness in school markets. An example is Cullen, Jacob, and Levitt (2006) who look at the results of randomized lotteries in an open enrollment program in Chicago. They find no systematic benefits to lottery winners on traditional measures of outcomes, even when the lottery winners are attending schools with peers that perform better than peers at assigned schools.

Another line of argument is that Hoxby miscalculates productivity effects. Ni (2009) offers an example, challenging Hoxby's results from the Michigan charter program. She argues that charter school competition in Michigan has had a negative effect on traditional public schools, with test scores at traditional public schools actually falling over time.

Checchi (2006) suggests that most schooling is local and that legal and constitutional requirements assure a degree of convenient access based on distance. Checchi notes that in quasi-markets, less efficient providers are maintained simply in order to provide a minimum level of education to some students. This limits the ability of successful competitors to capture increasing market share and likelihood for competition to raise productivity at all schools.

For competition to be a productivity driver there must be credible threats from school authorities to close underperforming schools (Adnett and Davies, 2003). Alternative schools that fail to perform face such threats. In a recent report, the Center for Education Reform claims that of the 6,072 charter schools that were started after 1993, 15% have been closed with cause (CER, 2011). The primary cause of closure is lack of revenue. These schools failed to attract enough students to be economically viable.

The literature reveals that demand for schooling is based on future benefits from educational outcomes and preferences for outcomes such as moral values and character building. Most parents demand higher achievement for their students. Supply of schooling in quasi markets is a function of government spending but parents can influence local school boards to expand school offerings. Market forces play out when parents have access to information, the ability to act on information (agency) and diversity in choice. Market decisions force suppliers to adapt to changing market demands. Hoxby argues that the presence of competition leads public schools to increase performance per dollar spent. Successful schools capture all of a market and markets are shared when school quality is equal. Administers at nonprofit schools have incentives to maximize revenue and redistribute profits indirectly even if the revenue flows are from taxes. In local school markets, though, threats to close schools, rather than marginal revenue losses from student defections must be credible to motivate performance changes in schools.

Research Motivation

In chapter two I document how the board of education responded to parent demand by opening three magnet schools within the district. As these schools had no defined attendance zones, this act marked the introduction of school choice into the school district. This represented a supply shock consistent with Brasington's model of school supply. Importantly, local school assignment areas were not modified in any way to accommodate this.

In 1997, a fourth school without an attendance area opened after the school board approved a charter application. Combined, the district had authorized a potential increase in elementary school supply of close to 1,400 seats, 12% increase in local school supply. These new schools would need to recruit students or risk failure. Existing neighborhood schools now faced shrinking enrollments, but as the district was growing at 2% a year, over time new students could replace those who left.

New students did come, but growth within the district was uneven and many schools experienced declines in their attendance areas. As all schools were losing students to charter and magnet schools, some now faced further threats as it was unlikely that the school could remain viable without capturing all students in its attendance zone. These population changes provide a unique opportunity to study how local schools responded to this challenge. Figure 4.1 is a scatter plot of changes in school populations and area size from 1997 to 2001 for 22 neighborhood schools. The graph reveals that generally, as area size decreases school enrollment falls. The change in school size, however, is not perfectly correlated with the change in area size. Three schools show small decreases in area size but increase in enrollment. Four schools in the upper right quadrant show increases in area size and increases in enrollment.

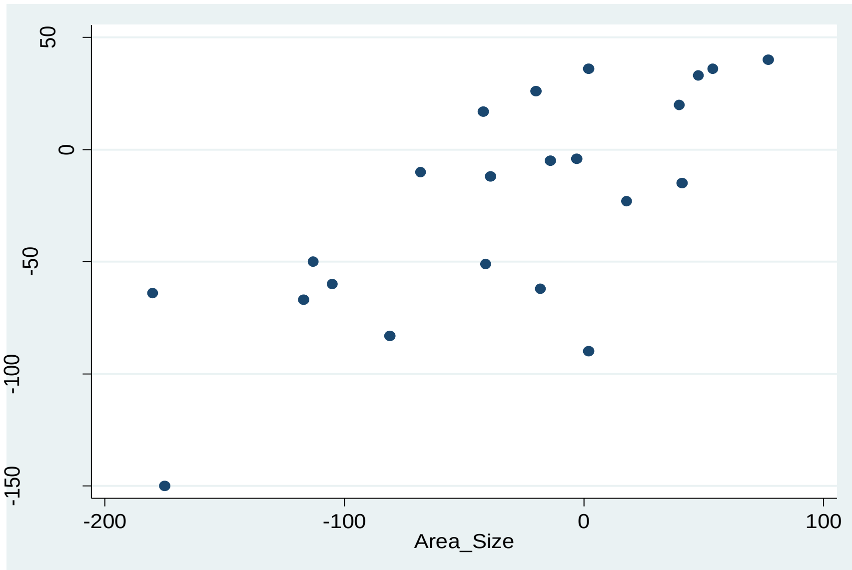

Figure 4.1 Scatter plot of changes in school size and school attendance area, 1997 to 2001.

I've constructed aggregate variables from the student records I have to model how schools responded to changes in their attendance areas. If schools face decreasing enrollments, they will be motivated to increase enrollments by capturing more students from their attendance zones and by recruiting students away from other neighborhoods. Schools could experiment with innovation and curriculum change that appealed to parents. Competition would be at work and it would be a competition for students. Parents responded by making more choices. From 1997 to 2001, the percent of families using school choice increased. I want to model a school's success in capturing students. I will use results from the model to test the following research propositions:

First, a local schools ability to draw students will be a positive function of school performance. If parent's value increased achievement, they will respond to improving test scores by selecting higher performing schools over lower performing ones.

Second, a school's ability to draw students will be invariant to income and ethnic differences as most families are achievement motivated. Hoxby suggests that most families value high achievement and want this for their children. This should be true for families regardless of income levels or ethnic background. School choice allows all families to align the needs of their child with the resources and capacities at a school.

Third, a school's ability to recruit will be negatively impacted as more students from its own attendance area don't enroll at the school. Proposition three suggests that there is an externality to a family's school choice decision. As more families choice out of a local school, it signals other neighborhood families that they too should look elsewhere.

My research questions diverge from the productivity ones that Hoxby asked. Changes in school quality are important here the extent that it encourages parents to choose a school. Expectations of higher performance could very well presage actual performance changes in motivating school selection. For my analysis, over this time period, the ability of a school to recruit becomes the dependent variable that measures competitiveness. I am focusing on what Hoxby called conduct, or the behaviors of actors in a market. Market structure and conduct are interwoven with performance. Schools that improve performance, schools that can overcome income and ethnicity effects on learning and schools that retain students from their attendance zones should be seen as schools that are successfully competing.

Methodology

I organize data from twenty nine district elementary schools for the 1997-2001 time period. Four of the schools were either magnet or charter. Three schools were located in remote locations in the foothills just west of the urban core and had small student populations . I exclude the magnet, charter and remote schools and have data for 22 schools, each with a unique attendance area. Student living in the attendance area enroll in that school unless they exercise a school choice option.

Variables. The dependent variable in the model is the percent of students attending a school who do not live in the assigned school area. I label this the school's choice-in rate. This variable reflects the ability of a school to draw students. As all schools are losing some students to magnet, charter and other neighborhood schools, this measures the success the school has in competing for students. I test if the choice-in rate is a function of school performance, school type, ethnic an income composition, or attendance area size.

Independent variables are all one period lagged values. My first independent variable is 4th grade CSAP aggregate reading score for each school, which I take as a measure of school quality. A description of CSAP test scores is presented in chapter 2. Aggregate test scores first became available in 1997 and are available for all the time periods in my study. The score represents the percent of students who scored proficient or advanced on the test.

The next independent variable is the number of students in the school's attendance area. Attendance zones are established by the district. Each contains a pool of students that would, absent of school choice, constitute the school population and excludes students who attend private school or home school. These school attendance areas were originally drawn to yield a student population that matched a school building's capacity. Over time, though, the number of school aged children in an area changes. As families age but retain their homes after their children leave school, the yield from an attendance area will decline. Demographers plan for these changing yields but growth throughout a school district as well as changes in neighborhoods impact projected yields. At some point, boundaries are realigned so that the yield from the attendance zone keeps the school at capacity.

This is an important variable for me to use in a regression model as it became clear from the data that a 100% yield of assigned students would not keep all schools at capacity. I test to see if this variable is related to the choice-in rate at a school, as seats for them were now available.

I track school by school type. Two dummy variables are used, IB school status or Core Knowledge status. Schools following the standard district curriculum make up the default category.   Schools will have adopted unique curriculum if the administration, staff and parent groups at the school believe that a curriculum type aids a school in meeting its objectives.

I add aggregate values of student demographic variables to the model. These are the percent of students at a school who are FRED eligible and the percent of students who are Hispanic. Evidence from chapter three suggests that these students tend to perform below other students on CSAP tests. I use these variables to test it the presence or lack of FRED or Hispanic students impacts the number of families that would choice into a school.

The percent of FRED or Hispanic students in a school may or may not reflect the corresponding ratios of these students in a school attendance area. A school may have a small number of Hispanic students but for some reason draw in a larger number of Hispanic students from outside its area. Or, a school may have a large number of FRED students in its attendance area but these students may use school choice to attend another school. I define a new variable to measure this, the school to area ratio, where the number of students by demographic type is the numerator and the number in the attendance area is the denominator. A school with a ratio of one would have a matched number of Hispanic or FRED students with the number of Hispanic or FRED students in the area, even if all area students don't attend the school. If ethnic and income composition of a school matters to parents then this ratio allows me to test if parents perceive the mix of students at a school as supportive of their child.

My last variables measure the impact that losing students to other schools has on the choice-in rate at a school. I track the percent of students from the attendance areas who attend other neighborhood schools and the percent that attend a magnet school and enter these as predictor variables. Schools that are losing students to other schools should be motivated to make changes to get these students to stay. It is possible, though, that mass defections from a school signal school failure, impacting the ability to recruit.

Models. I build a panel to include data from1997 through the 2001 school year. My full panel contains observations on 22 schools over five time periods. I take lagged values of the independent variables to create my model for estimation. This reduces the panel by one year so I now have 22 schools across 4 time periods. This is the panel I estimate first.

I create a second set of observations from the full set, taking the difference between the 2001 and 1997 values for each variable.   This data set includes 22 observations, one for each school. I label both the data generating process and the regression the delta model.

Pooled Model. Before estimating the model I display summary statistics in table 4.1. These show that the maximum choice-in rate at a school was 48%. Almost half of this schools population came from outside the neighborhood. Area sizes vary dramatically, from a low of 285 to a maximum of 752.   Hispanic populations range from 3% to 48%. FRED populations range from 4% to 73% and test score performance ranges from 39% proficient or advanced to

89%. As documented in chapter 2, there are performance and income hierarchies in neighborhood schools and they certainly were in place from 1997-2001.

The school to area Hispanic population ratio averages .89, so the average school has slightly less Hispanic students than it has in its attendance zone. The FRED ratio is .98 so the average school is equally representative of its neighborhood in terms of FRED students.

Table 4.1 Summary Statistics for Pooled Model

Variable	Obs	Mean	Std. Dev.	Min	Max
Choice-in rate	88	17.12	9.95	1.76	45.78
Percent Hispanic	88	12.75	10.87	3.38	48.5
School to area Hispanic rate	88	.89	.21	0.61	1.95
Percent FRED	88	27.05	18.05	4.018	72.75
School to area FRED rate	88	.98	.19	0.717	1.62
4th Grade Reading Score	88	67.28	11.36	38.88	89.70
Area Size	88	551.26	101.43	285	752

I use pooled OLS regression to estimate this model. The dependent variable is the school's choice-in rate. I estimate the choice-in rate as a function of a constant and the lagged values of school area size, the square of school area size, the % of Hispanic students in the school, the Hispanic school to area Hispanic ratio, school FRED rate, the FRED student to area ratio, the % of area students who choose to attend another neighborhood school, the % who choose to attend a magnet school and the school type indictor for Core or IB.

I first test for the overall significance of the model and the properties of the error terms. The unadjusted R-squared for the regression is .79 and the adjusted R-squared is .76. A Ramsey RESET test indicated that there was no significant relationship between the regression residuals and the covariates. White's test for heteroskedasticity indicated that the residuals were homoskedactic. A test the residuals could not reject the null hypothesis of normality. Figure 4.2 is a density plot of the residuals which provides visual support for normality.

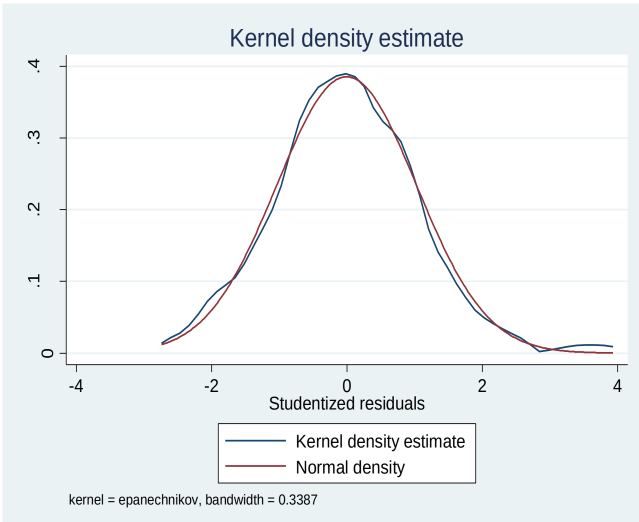

Figure 4.2 Density plot of pooled OLS residuals

Regression results are presented in table 4.2.

My first proposition is that a local school's ability to draw students will be a positive function of school performance. The coefficient on 4th grade reading scores is positive and significant at the .10 level. The reading score is a lagged value, so prior year's achievement impacts current student recruitment. This is a significant finding and is consistent with Hoxby's claim that parents have a demand for academic achievement. As scores increase more families choose to attend a school outside their own attendance area. This is an effect that school choice advocates would expect to find.

Table 4.2 Pooled Model Regression Results

VARIABLES	(1) Choice In Rate	(2) Choice In Rate
4th Grade Reading Score	0.133*	0.107
	(0.0769)	(0.0809)
	1.729	1.328
School Area Size	-0.236***	-0.282***
	(0.0398)	(0.0370)
	-5.940	-7.606
Square of Area Size	0.000178***	0.000214***
	(3.42e-05)	(3.18e-05)
	5.214	6.735
School is IB	4.427**	3.820**
	(2.205)	(1.693)
	2.008	2.256
School is Core	0.341	1.434
	(3.417)	(2.974)
	0.0997	0.482
% Hispanic Students	-0.0705	0.0776
	(0.121)	(0.120)
	-0.581	0.649
School to Area Ratio: Hispanic	3.279	2.895
	(3.453)	(3.099)
	0.950	0.934
% FRED	0.112	0.157*
	(0.0905)	(0.0892)
	1.236	1.762
School to Area Ratio: FRED	7.735	8.283*
	(4.788)	(4.376)
	1.616	1.893
% Choice Out other neigh.	0.745***	0.706***
	(0.136)	(0.134)
	5.485	5.277
% Choice Out magnet schools	-0.102	-0.117
	(0.171)	(0.161)
	-0.598	-0.724
School is Title 1		-7.366***
		(2.464)
		-2.990
Constant	60.06***	74.71***
	(14.77)	(13.95)
	4.066	5.356
Observations	88	88
R-squared	0.786	0.808

Robust standard errors in parentheses, t-stat below standard error
*** p<0.01, ** p<0.05, * p<0.1

My second proposition is that the ability to draw students will be invariant to income and ethnic differences as most families are achievement motivated. The results from the pooled model initially support this proposition. I cannot differentiate choice-in rates based either on the school composition or on the school composition to area ratio variables. There is weak evidence that students are drawn to schools where the school FRED rates matches the area FRED rate, but the coefficient on this variable has a probability value of .11. This result is consistent with data reported in chapter two as to the percent of lower income families that use school choice.

Choice participation rates weren't significantly different for FRED families compared to all other families, although lower income families were less likely to choose a magnet or charter school. They are, however, active participants in school choice between other neighborhood schools. The demographic composition at a school initially appears to not affect the percent of students that choice into it. There is a degree of egalitarianism in school choice among neighborhood schools in this model. On the recommendation of my dissertation committee, I test for nonlinearity here by using a categorical variable to indict if a school is Title 1 eligible. As noted in noted in chapter 2, Title 1 funding for additional staffing is provided to schools that have free or reduced lunch rates of 35% or more.

Results for this test are displayed in column three of table 4.2. The coefficient on Title 1 is negative and significant. Fewer students choice into Title 1 schools. Adding this variable also changes the relationship between test scores and school performance. The coefficient on past years reading scores remains positive but is now insignificant. Additionally, the coefficients on % FRED and the school to FRED ratio are now significant at the .10 level. I interpret this result to suggest that families are considering the income composition at a school to be a factor in making a school choice, and that the more the school closely resembles the income levels of the attendance area, the more likely they are to choice into the school. This effect breaks down though, for those few schools with high populations of FRED students. There appears to be a threshold that once crossed, discourages school choice.

My final proposition was that a school's ability to recruit would be negatively impacted as more students from its own attendance area don't enroll at the school. In the pooled model, the coefficient on % Choice Out Other Neigh is positive and significant. The coefficient on the percent that choice into a magnet school is not significant.

This result suggests that as more students choice out, more students choice in. I can conclude that there appears to be no negative externality from the choice-out behavior of parents in a school zone, at least as it impacts the schools ability to recruit. Since families choose schools based on performance and to some small degree on income then this variable is simply reporting that there is a significant choice activity in our local schools.

There are important variables to discuss that are not addressed in the propositions. The results show that the area size variable and school type affect choice-in rates. Lagged values of area size are negatively related to choice-in rates. As the number of students in an attendance zone is decreasing, then more students' choice into a school the following year. As the number of students in an attendance zone increase, a lower percent choice in. I add the square of area size to the pooled model to test for nonlinearity and find that the coefficient is positive and significant. Local schools recruit students from other areas as their own attendance zones decrease in size. These schools are successfully competing for students.

While test score performance influences choice in rates, shrinking area attendance zones may be the force that drove schools to compete. Not only are some attendance areas shrinking, all schools are losing students to other schools. Changes in a school's local monopoly power appear to motivate schools to recruit students. Hoxby argued that the mere threat of competition motivates behavior changes in schools and my result is consistent with her claim.

Motivation to change is not universal. Schools with larger attendance zones, regardless of how many students choice out of the area, recruit a smaller number of students. Schools with small attendance zones recruit more students, even while losing students to other neighborhood schools. For these schools the need to recruit is vital. Several schools with small attendance zones would have difficulty filling their schools, even if they captured all students in an attendance zone.

I treat the lagged value of area size as an exogenous predetermined variable. An argument could be made that one factor contributing to school area size is the quality of the local school. Families may simply leave an area where the local school no longer meets their needs. It makes little sense, though, that a school would still be able to recruit other students into it while at the same time discouraging people from living near it.

Schools are competing for students as they lose their monopoly over their local area and as the size of their attendance area shrinks. Improving test scores and decreasing attendance zones help explain choice-in rates at schools. Changing attendance zones motivated changes at schools.

IB school type is positively related to choice-in rates and is significant. The Core school type is unrelated to choice-in rates. Some schools appear to recruit by differentiating instruction. I document in chapter two how several neighborhood schools asked for and received permission from the district to deliver alternative elementary curriculums. Schools that adopt the IB school type are successful in competing for students. Schools may have changed curriculums to meet the unique needs of their students but I think it more likely that changing the school's curriculum was a competitive response to decreasing attendance areas.

Delta Model. Summary statistics for variables used in this model are presented in table 4.3. They reveal that while the mean change in choice-in rates among the 22 schools was 3.7 points, the range was from -7 to 20. The mean change in area size was a loss of 34 students, which would represent a loss of over one classroom for a typical school. The greatest loss was 180 students in one school area, which would represent over seven classrooms of students. Average change for FRED rates wasn't very large. Hispanic populations changed, though. One school saw its Hispanic population drop by 35 points. All schools show decreases in Hispanic populations as a percent of total school size. There was an increase in the percent of families' choicing out of areas to attend other neighborhood schools and a slight decrease in the percent choosing magnet schools. Reading scores improved on average, but one school saw a drop of 14 points in the percent proficient or advanced in 4th grade reading.

Table 4.3 Delta Model Summary Statistics

Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Delta Choice In	22	3.70	6.94	-7.16	20.31
Delta 4th Grade Read	22	4.24	9.37	-13.70	18.70
Delta Area Size	22	-33.36	71.67	-180.00	77.00
Delta % Hispanic	22	-11.47	9.33	-34.86	-3.35
Delta School to Area Hispanic	22	0.00	0.22	-0.36	0.60
Delta % FRED	22	0.49	5.35	-12.27	9.49
Delta School to Area FRED	22	-0.01	0.17	-0.29	0.30
Delta Attend Other Neigh.	22	4.00	4.86	-2.36	13.94
Delta Attend Magnet	22	-1.79	3.73	-6.76	11.40

The delta model tests if changes in variables from 2001 to 1997 confirm or contradict the results from the panel model. The dependent variable is the difference in 2001and 1997 choice-in rates. Independent variables are the 2001-1997 difference for the same variables used in the panel with the exception of the IB and Core variables. These were not significant when tested alone with the dependent variable. As this regression uses only 22 observations I limit the number of independent variables and exclude these from the regression. Results for model 2 are displayed in table 4.4.

Table 4.4 Delta Model Results

	(1)	(2)	(3)	(4)
	Delta Choice_In			
VARIABLES	**Coef**	**se**	**tstat**	**Pval**
Delta 4th Grade Read	0.214**	(0.0971)	2.200	0.0465
Delta Area Size	-0.0512***	(0.0127)	-4.023	0.00145
Delta % Hispanic	-0.379**	(0.172)	-2.197	0.0467
Delta School to Area Hispanic	-14.08**	(4.804)	-2.931	0.0117
Delta % FRED	0.141	(0.191)	0.735	0.475
Delta School to Area FRED	13.57***	(4.354)	3.116	0.00819
Delta Attend Other Neigh.	0.126	(0.285)	0.443	0.665
Delta Attend Magnet	0.163	(0.291)	0.562	0.583
Constant	-3.460*	(1.762)	-1.963	0.0714
Observations	22			
R-squared	0.793			

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

I first evaluate the overall goodness of fit and error specification of the model. The overall R-squared from the regression was .79 and the adjusted R-squared was .67. The Breusch-Pagan and Ramsey RESET tests indicated that there were no heteroskedasticity or specification issues.

Results are consistent with the panel model with respect to the impact of 4th grade reading scores and area size. Changes in performance increase the change in the rate that families choice into a school. As area size shrinks, the choice-in rate at a school increases. This gives further weight to the conclusion from mode1 that schools compete and competition is based on performance. Changes in the size of area attendance zones further motivate competition.

Results differ from the pooled model for the Delta Hispanic and Delta FRED variables. The coefficients on Delta Hispanic, Delta School to Area Hispanic and Delta School Area to FRED ratios all are now significant and alter how I view my second research proposition, that choice-in rates are invariant to income and ethnic differences.

In the delta model, as the change in percent Hispanic at a school increases, the change in choice-in rates at a school decreases. It may be that families recognize that the Hispanic population is increasing at a school and decide they don't want to choice in. This increase in percent Hispanic at the school may indicate that the percent Hispanic in the attendance area has increased and more of these students are attending the local school. I have data on the percent Hispanic in each attendance area and the change in area Hispanic populations. From 1997 to 2001, the percent Hispanic increased on average by 3 points. The standard deviation was just over three points. The area with the maximum change in percent Hispanic stood at 13 points, over 4 standard deviations from the mean. It is possible then that in at least one school area, Hispanic populations increased significantly and these students attended the local school.

The coefficient on Delta School to Hispanic Ratio was negative and significant. As the change in the ratio increases, the change in choice-in rates decreases. The change in this variable supports the interpretation I offer above regarding changes in the local school's Hispanic population. In looking at the actual values of the observations for this variable, I find that most schools reflected only a small change here. Two schools saw large increases, one of .4 and one of .6. It appears that two neighborhood schools were increasingly becoming home to a larger number of Hispanic students.

In the delta model the coefficient on Delta School to FRED Ratio is positive and significant. As the school composition of FRED students more closely matches the area, there is an increase in the percent of students choicing in. This may reflect sorting at schools based on income, which was undetected in the pooled model. It is consistent with the data reported in chapter two that, over time, the range of FRED rates at district schools increased, with some schools becoming more concentrated with FRED students and some schools having virtually none.

Results from the delta model suggest that changes in choice-in rates do vary by income and ethnicity. There is some preference to assimilate by these attributes and this impacts a parent's school choice decision, even if it makes it more likely that a student will attend the local school. In a school choice system, staying in the neighborhood is still a choice.

Conclusion

Two important institutional events led to behavior changes within the school district. The first was the authorization of new magnet schools and the acceptance of a charter school application. The district now had schools without defined attendance areas. The second change was the decision not to realign existing school boundaries so that all schools would be able to recruit a sufficient base population from within their own borders. As student populations changed within existing attendance zones, schools faced disproportionate challenges to support a base population.

Schools facing declining student populations compete more and recruit more students into their schools. Improving test scores increases recruitment and adopting the IB curriculum has helped some schools to recruit students. These are all ways in which competition for students impacts schools.

I suggested that a credible threat of school closure would be needed to motivate school change. If all schools know that district funding would continue regardless of changes in populations then the motivation for school improvement may diminish. In actuality, in 2008 one neighborhood school was closed and students were reassigned to other neighborhood schools. The threat was real.

School districts provide a quantity of schooling based on budget constraints. New schools are added as populations increase and existing schools can be closed as populations decrease or shift. School attendance zones are ways for districts to optimize building capacities based on population densities, student yields and distance to travel. As I report in chapter two, school choice is a policy option for districts when managing school populations. The school district in Wyoming decided to make all schools open enrollment and let parents decide how far they were willing to travel to attend a school. Schools competed for students from all areas of the community. If school populations shrink, the district could decide to close schools based simply on attendance.

The option to close schools based simply on attendance is a naive one, however. The data from Wyoming revealed that school performance hierarchies exist even after full implementation of school choice, and that schools were segregated by income as well as ability. A decision to close a school would be a decision based not only on attendance, but on performance and demographic composition of a school. School choice doesn't appear to make these decisions any easier for school officials.

Optimally, an efficient school district should have an exact number of seats for each student. Our district experienced a supply shock as new schools were added that outstripped population growth. The district eventually closed a school, establishing credibility to the threat. But over time, a new charter school was approved, and a third charter, authorized by the state board of education, opened for elementary students. These two schools added almost 1,000 more elementary seats within the district borders. Faced with fiscal challenges, the school administration recommended to the board that an additional school be closed in 2011. The board rejected the recommendation on a split vote. Threat of school closure may no longer be credible in the district. Without it, motivations for school change weakened.

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Chapter Five

School Choice and Property Values

Are parents with young children willing to pay more for a house that is located in a high performing school area? A significant body of literature over the past forty years suggests a positive relationship between house prices and local school quality. This effect impacts all households in a school area and not just those with school-aged children.

Parents with young children who are just entering the school system represent a subset of all demanders for housing in an area. I suggest that they should, as a group, be more motivated to observe school quality differences and include school quality as a factor in purchasing a specific home. But would the availability and access to school choice impact both the location and the price decision that young families make? I take up this issue in this chapter and test if school choice alters the relationship between local school quality and housing prices.

I investigate this question using the data set described in chapter two. I am able to identify students by their street address and match these to local county sales and property tax records, identifying families that bought homes and soon after placed students in district schools. This forms the basis of the regression analysis in this chapter.

In preparation for the empirical work I briefly review the literature on school quality and housing prices. I look at theory and research suggesting that school choice alters the relationship between school quality and housing prices. I then describe the data and research question in more detail. Following that I present the results from regression analysis and discuss an adjustment process in house prices that appears to be unfolding over time. The chapter concludes with some final comments and suggestions for future research.

From a regional and urban economic perspective, school quality and housing have been linked since Oates (1969) empirically estimated willingness to pay for public services in a Tiebout framework. Several generations of hedonic pricing models followed that attempted to resolve specification and identification issues that had been raised by Rosen (1974) and others. Nonlinear modeling was used more extensively. Questions about the usefulness of such modeling continue to this day, however, as hedonic models that identify the marginal price of school quality are found to be highly sensitive to specification and identification issues. Of special concern are endogeneity and heterogeneity issues (Chesire and Sheppard, 2004 and Chiodom, Hernandez-Murillo and Owyan, 2009).

From a public policy point of view, school choice and housing prices are factors in land use in urban areas where residents become segregated by income and by policy options, such as zoning and infrastructure development (for both housing and schools). If public policy is designed to ensure fairness then an understanding of how income impacts consumption of public goods is important. Chesire and Sheppard (2004) note:

> Many public goods, overtly funded from taxation and which we think of as naturally being provided on an equal basis to all households are really much better thought of as being allocated through the housing market. Consumption of them is thus conditioned on household income in just the same way as consumption of foreign holidays, private education, personal security services or broadband internet access is conditioned on income. (p. F392)

The use of the term public good here requires qualification. Access to education can be excluded, on some grounds, and public education can be viewed as a publically provided private good. Equity and distributional concerns, however, have motivated public provision. Given a jurisdiction's commitment to equal access to a quality education, and a structure for financing that is not solely income based, any advantages or disadvantages arising out of income inequality would raise distributional questions. Adoption of school choice programs may offer policy makers an opportunity to address this issue.

Research into housing and schooling generally suggests that parents are attempting to maximize utility from education while at the same time choosing a location that maximizes other location preferences, such as distance to work, access to major highways and access to commercial centers (Hoxby, 2000). I review several key studies that measure these factors. These studies suggest that capitalization of school quality into housing prices exists, that unique research designs help isolate the effect, that preferences for school quality may not be homogenous, that school quality may enter a hedonic regression nonlinearly and that researchers need to cast a wide net in choosing variables for modeling.

In an important paper, Black (1999) looked at housing prices and school quality using data from thirty-seven school districts in Massachusetts. Her focus was on housing on the border of attendance areas within school districts. Several studies since then have followed her methodology. She samples houses close to each other but within different catchments, where school achievement levels across boundaries may be discontinuous. Home characteristics are also changing on and at small distances from the boundary, but continuously. This natural experiment approach allows her to control for unobserved neighborhood attributes as well as for variables across districts such as tax rates and funding policies.

Black's method has been labeled boundary discontinuity design (BDD) and similar studies following BDD have been done. One alternative is to vary the distances between homes on the boundary from, for example, .15 to .35 miles (Bayer, Ferreira and McMillan, 2007). Black's finding was that higher test scores at a school (at the elementary school level) increased property values, as measured by sales data. A 5% improvement on test scores yielded a 4.5% increase in housing prices, at the mean.

Weimer and Wolcoff (2001) follow a similar approach by looking at housing prices and school quality in a county in New York. There are multiple political units, including school districts, within the county and Weimer and Wolcoff find homes on the boundaries where the political jurisdictions are the same but access to schools is different, allowing them to further isolate school effects. They report a range of estimates for the marginal change in house prices for a 1% increase in test scores, and attempt to isolate the contribution of both the assigned elementary school and the assigned high school. Valuing the assigned high school contribution is problematic, however, since there are fewer of them in an area. They conclude that if scores could be raised to the area average, then home prices within the urban corridor of Rochester, New York would increase and the city would benefit from increased property tax revenue.

Bayer, Ferreira, and McMillan (2007) follow Black in using a BDD model of neighborhoods and schools in the San Francisco area. Using restricted tract level census data they identify income, education, and ethnicity levels for approximately one-hundred households per tract. These households are located both one and two tenths of a mile from a school district boundary. They look for discontinuities at these boundaries in school performance (using 4th grade math and reading scores) and present a series of results from hedonic regressions that include or exclude boundary fixed effects and a second panel that includes neighborhood effects with and without fixed effects. As Black noted, when fixed effects are included, the coefficient on school quality in a hedonic regression model decreases significantly, and when neighborhood socioeconomic variables are added with the fixed effects, it diminishes further.

Bayer, Ferreira, and McMillan extend their analysis to present a discrete choice model for housing preference. The research question here is if preferences for housing are homogenous, in which case, hedonic models provide accurate price representations for mean willingness to pay. If preferences are heterogeneous, however, hedonic price regression results differ from mean choice preferences that vary less continuously and/or are limited in supply. In their study, this heterogeneity of preferences appears as a preference to segregate along ethnic and educational attainment lines, even though all households prefer to live in higher income neighborhoods.

Uyar and Brown (2008) use a hierarchal or multi-level model to estimate housing prices as a function of neighborhood affluence and school achievement scores. They note that houses are clustered in multiple administrative groups: from blocks, to block groups, to school zones, school districts, census tracts, and towns and cities. These groupings form hierarchies but these hierarchies are not always perfectly nested. They argue that even at the census block unit, houses can be located within different school attendance zones. This creates a cross classification that needs to be accounted for. Another problem is that a school zone will encompass multiple census blocks. Uyar and Brown find a higher willingness to pay for school quality that diminishes as you move away from the school, but are still within the school zone. This interacts with school quality. The further away you are from a high performing school, the larger the decrease in home prices, all else equal. Their data set was obtained from a mid-western U.S. community with a sample of 750 house prices, representing 45 neighborhood blocks across 10 school zones.

Chiodo, Hernandez-Murillo, and Owyang (2009) in a paper for the St. Louis Federal Reserve present a non-linear hedonic estimation of the impact of school quality on housing pricing. They closely follow Black as well as Bayer, Ferreira, and McMillian, but model school quality using a linear, quadratic, and cubic representation. Their data set includes 121 attendance zones across 15 school districts in the St. Louis area. They present multiple specifications that include a full sample based on all house sales over a three-year period, a restricted sample based on BDD, and a fixed neighborhood effects model. They conclude, as did Black, that fixed effects reduce the premium associated with school quality, but unlike Black, whose specification was linear, they suggest that a higher premium is paid to purchase a house near the best schools

Cheshire and Sheppard (1998, 2004, and 2005) have written extensively on the demand for housing, school quality, and the relationship to income in school districts in the United Kingdom. Their recent work uses a complex model of land features, since they suggest that the price of land is partially a function of the features of the land (without a structure) and the features of land nearby, distance to work and distance to highways and other places. In an earlier work, they focused on the income elasticity of housing, where school quality is a right hand side variable. Another significant contribution from Cheshire and Sheppard is their introduction of other omitted variables into their model. For example, they consider the amount of new land available for construction of new homes (and schools) in an area. A measure of school quality risk is introduced with the argument that school quality can vary over time. There is a probability associated with that variance that may impact the decision to purchase a particular home at a particular price. Lastly, they consider the likelihood that boundary changes would be made (particularly in a community with room to grow on the periphery).

Hilber and Mayer (2004) take up a similar issue and consider the financial interest that households without children have in maintaining local school quality and how the availability of land at the periphery of a district alters this relationship.

The research reviewed in this section shares a commonality in that no study attempted to identify the impact of inter or intra district school choice on housing prices. Several authors acknowledge that school choice is taking place, but Black (1999), in particular, notes that she excluded any district that had open enrollment within the district from her study. Cheshire and Sheppard (2004) note that school choice influences the extent of capitalization of school quality, when a household is granted permission to attend an out-of-district school. They write that "at the limit, if parents could freely choose any school then (except for distance costs), the supply of school quality for every home would be perfectly elastic (p. F402)".

As Chesire and Sheppard note, school choice alters the supply of school quality. Theoretical models of a school voucher program, as one form of school choice, suggest that vouchers would significantly lower housing value and income differences across school districts. Many of these estimates are from CGE models, as in Nechbyba (2003) and Epple and Romano (1998). The Epple and Romano model suggests that public school choice should lead to equalization of school quality and house prices with a single school district.

Limited empirical work has been provided in this area. In an important paper, Reback (2005) looked at open enrollment across school districts in Minnesota. He found house valuations from the time just preceding the adoption of open enrollment and from time periods following its adoption. He had records of the number of students transferring between districts. His conclusion was that that property values fell in districts on the "receiving" end of open enrollment and rose in "sending" districts. This equilibrium adjustment took place over time, estimated at around seven years.

Walden (1990) addresses the adjustment process in a study of housing in a large school district in North Carolina. He suggested that the number of magnet school options parents had at different grade levels was related to the premium or discount, as a function of school quality, that fell on a home. In his study area, magnet schools were more prevalent at the elementary level but only a small number of middle school magnets and no high school magnets existed. He suggests that a test for school quality across all three levels would find that as the amount of choice increased, the premium a buyer would pay for higher quality schools would diminish. This result would be most apparent at the elementary level.

The literature suggests that the relationship between school quality and house prices can be uncovered, but unobserved heterogeneity should be controlled for through fixed effects estimation. Unique research designs may be useful in creating comparisons that further reduce unobservable effects. There may be a nonlinear relationship between school quality and house prices as well. Preferences for school quality may be heterogeneous across income groups as well. Theory and empirical research suggests that the relationship between prices and school quality is altered by school choice. Much of the research reviewed here modeled prices in districts without school choice, or the researchers eliminated school districts that allowed school choice from their data sets.

My observations from the literature lead me to a specific research question. Are parents of K-1 students willing to pay more for housing in catchment areas with higher school test scores, after controlling for student and neighborhood characteristics? My hypothesis is that if open enrollment is available within a school district, school quality, as measured by the average score on the 4th grade CSAP reading exam, would not be related to house prices.

This hypothesis assumes that in the early days of school choice there was a positive relationship between school quality and test scores exist. Reback, in his Minnesota study, tested for this, but Walden, in the North Carolina study, simply assumed it. I propose a specific test for this, even though I lack data on house sales from the time period when there was no school choice within the district. I test this by assuming that the adjustment process takes time and by including a dynamic term in the model that distinguishes house sales in an early period, compares these sales to later periods, when use of school choice was expanding.

Methodology

The school records available to me have been thoroughly described in chapter two. I use student level records to produce several aggregate measures that are independent variables in the models that follow. The following paragraphs describe these variables.

The dependent variable in my first regression model is the natural log of the house sales price. House sales data was taken from county real estate records and include sales from 1994 through 2001.

The data selection process I use is to first identify kindergarten and first grade students entering the district's schools beginning in the fall of 1997. There are around 1,500 students in each grade cohort each year. I consider this group as 'early entrants' into the school system.

I match the address for a member of the fall 1997 K-1 cohort with county property sales records from 1994 through 1997. I chose this time period to capture parents who were making a home purchase decision knowing that their young children would be attending a school in 1997. I assume that the matched property tax record represents a sale to this student's family but it is possible that the property was sold to an investor who is renting the property. The most definitive statement I can make is that a property was sold between 1994 and 1997, and not resold in that period. A student living at that address attended a district school beginning in fall 1997. The property tax record identified the purchaser and the seller and I excluded records where the purchaser was a company or partnership. If the family living in the home is a renter, I will still be capturing a relationship between the rental rate and house and neighborhood attributes. I repeat this matching of K-1 addresses to sales records for the students enrolling in the 1999 and 2001 school years.

My analysis focuses on single-family residences. The majority of housing in the school district is single-family residences and finding these matches was easiest. There are townhome and condominiums in the community and I have some families in my sample from this housing stock. Matching these addresses was problematic in that the unit number, for example, may not have been recorded correctly in the school record, making it difficult to match with a county record. I exclude renters in large, multifamily housing complexes.

I adjust housing prices using the quarterly Colorado House Price index published by the Federal Housing Finance Agency.[9] House prices in the area experienced significant price inflation over the study period, reflecting generally low national interest rates from 1994-2006.

My independent measure of school quality is the aggregate fourth grade reading score reported by the school district for a school with an assigned catchment. As described in chapter two, the CSAP scores are on an indexed scale so that year to year student growth can be determined. Students earn a grade on the test, either being unsatisfactory, partially proficient, proficient or advanced. My school quality measure is the percent of students scoring proficient or advanced.

My house characteristics are from the county assessor's database. I include square footage, basement square footage, porch and garage square footage, land size in square feet, rooms, type of room, stories, age and a categorical quality measure indicating homes that are classified as being better than average quality according to the county's assessment methodology. I exclude

[9] Data available from the St. Louis Federal Reserve at http://www.research.stlouisfed.org/fred2/graph/?chart_type=line&width=800&height=480&preserve_ratio=true&s%5B1%5D%5Bid%5D=COSTHPI

some house features such as roof composition, heating system and exterior type as I found little variation in these and pre-testing revealed no significant relationship to house price.

My measure of land features is only the lot size in square feet. I lack the detail that Chesire and Sheppard report, such as land slope. This doesn't raise a concern for me as most of my observations are from single family homes nested into subdivisions within the urban core. Lots will vary in size and in foliage, for example, but I capture size and other features might be reflected in the age variable.

I geocode student addresses and calculate distance to the assigned school, which is an additional independent variable. Several studies I reviewed found both linear and nonlinear relationships between distance from home to school. I also calculate the distance from the house to the major employer (a university, which is very close to the historic downtown district) and to the major employer in the high-tech sector, which is located very near a major interstate highway.

I use aggregate measures of school level measures as additional independent variables. As described in chapter four, I use the schools choice in and choice out rates to measure the potential number of families that would not need to move to a school area in order to attend the school and those that decide to leave the neighborhood school for another destination. These are captured as rates. I find these values by sorting the school choice decision by assigned school and then subtotaling the counts of students coming in and out of an area. I know the number of students in a catchment, which becomes the denominator of these rates.

I also calculate the percent of students in a catchment who are free and reduced lunch status and use this as a measure of income within a school zone. I do the same for the number of students at the local school who are FRED status and use this variable in my second regression.

I use the median income from the 2000 census block group as a proxy for neighborhood income as well.

Additional independent variables at the family level reflect family income and the school choice decision the family made when their child enrolled in school. The income measure is the FRED status of the student and I track if the family attends the neighborhoods schools, another neighborhood school or a magnet school. This allows me to test if the preference for local schooling impacts is related to the price a family would pay for a home.

I stack the 1997, 1999 and 2001 observations and create a repeated cross sections data set and identify three cohorts of families: those who enrolled in kindergarten or first grade in any of the three time periods and had purchased a home within four years of enrolling. I add year dummy variables to the model to control for time differences across cohorts.

Empirical Model. My dependent variable is the natural log of the inflation adjusted sales price and my estimated model for sales to the three cohorts is:

$$(5.1)\quad \ln(RealPrice_{\mathbf{ai,t}}) = BS_{\mathbf{a,i,t}} + BX_{\mathbf{a\,i\,,t}} + BW_{\mathbf{at}} + Z_{a} + U_{\mathbf{ait}}$$

where a = assigned school identifier
i = individual property identifier
t = time period where parents entered the school system
S = a vector of student characteristics in a,i,t
X = a vector of property characteristics in a,i,t
W = a vector of school level variables in a,t
Z = school area fixed effect in $_{a}$.

I estimate the model using the random effects linear regression function in Stata with clustered standard errors. The regression result is displayed in Table 5.1.

School quality is positively related to house prices for those houses purchased between 1994 and 1997. The effect is significant at the five percent level after controlling for other variables and school fixed effects. This variable is percent of students scoring proficient or advanced on

Table 5.1 Hedonic Sales Price Model: 1994 to 2001 House Sales

VARIABLES	(1) lnprice coef	(2) Standard Error	(3) t-stat	(4) p value
School Quality (read) 1997 cohort	0.0164***	(0.00570)	2.882	0.00842
School Quality (read) 1999 cohort	0.00251*	(0.00130)	1.930	0.0660
School Quality (read) 2001 cohort	3.74e-05	(0.00132)	0.0284	0.978
Area FRED rate at purchase	-0.0805	(0.0750)	-1.073	0.294
Choice In rate at purchase	-0.524**	(0.249)	-2.107	0.0462
Choice Out rate at purchase	0.278*	(0.138)	2.020	0.0552
School Size at purchase	-9.56e-05	(0.000166)	-0.577	0.570
Distance to School 1997 cohort	-4.66e-05***	(1.50e-05)	-3.112	0.00491
Distance to School 1999 cohort	-0.0139	(0.0330)	-0.423	0.676
Distance to School 2001 cohort	0.0491	(0.0299)	1.640	0.115
Year 1999 dummy	0.999**	(0.397)	2.516	0.0193
Year 2001 dummy	1.150**	(0.419)	2.746	0.0115
Distance to High Tech Center	-0.118***	(0.0191)	-6.205	2.49e-06
Squared Distance to High Tech Center	0.00690***	(0.00189)	3.653	0.00133
Distance to Major Employer	0.00845	(0.0183)	0.461	0.649
Family FRED qualified	-0.141***	(0.0456)	-3.100	0.00505
Family Chose Neighborhood School	-0.00673	(0.0243)	-0.277	0.785
Family Chose a Magnet School	0.0308	(0.0190)	1.620	0.119
Table 5.1 Continued	coef	Std error	t-stat	p value
Land Gross Square Feet	-5.33e-08	(3.39e-07)	-0.157	0.876
Square Feet	0.000215***	(2.50e-05)	8.605	1.20e-08
Basement Square Feet	8.58e-05***	(2.10e-05)	4.076	0.000466
Garage Square Feet	8.95e-05*	(4.66e-05)	1.918	0.0676
Above Average Home Quality	0.0438	(0.0328)	1.335	0.195
Stories	0.0276*	(0.0148)	1.864	0.0751
Rooms	0.0185**	(0.00814)	2.277	0.0324
Age at Purchase	0.00517**	(0.00198)	2.616	0.0154
Square of age	-2.52e-05	(2.25e-05)	-1.121	0.274
Median Income 2000 Census	4.10e-06***	(1.12e-06)	3.657	0.00131
Constant	10.03***	(0.412)	24.36	0
Observations	2,069			
R-squared	0.318			
Number of School Areas	24			

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

R Squared Within = .31,R Squared Between = .78 R Squared Overall = .43

CSAP reading tests and then multiplied by 100. As this results in a semi-log model, the 1997 reading coefficient would suggest that a 1 unit increase in test scores yields a 1.64% increase in house price. My hypothesis assumed that prior to, and in the early years of school choice, a positive relationship existed between these variables. This result is confirmation of that assumption.

School quality for houses purchased between 1996 and 1999 is positively related to house prices but the effect is not significant. School quality is negatively related to house prices for houses purchased between 1998 and 2001, but the effect is not significant.

I am attempting to find the relationship between school quality and school choice by looking at house sales during the time when school choice was just expanding in the district, from 1994 to 1997. I argue that finding a positive value on the coefficient for this cohort would indicate a relationship existed prior to 1994. My challenge here is not having a measure of school quality prior to 1997. I assert that families who purchased in this time frame had expectations of local school quality, based on informal observation and sales prices of neighboring properties. CSAP test results published in May of 1997 validated or contradicted the family's expectation. They would have had the choice to move or change schools prior to enrolling their student in fall of 1997. I take the 1997 test score to be a proxy for school quality between the years 1994 and 1997.

As the coefficient on school quality for the 1999 cohort is positive and significant at the .10 level, there is additional support that there was a positive relationship between house prices and school quality from 1996-1999.

The coefficient for the 2001 cohort is not significant. These families purchased homes between 1998 and 2001 and would have had access to school test score results in each year. These better informed parents purchased homes and did not pay a premium for school quality.

The coefficient on distance to the assigned school is negative and significant for the 1997 cohorts. These buyers pay more to be closer to a school. The coefficient for 1999 is negative and is positive for 2001. Neither effect is significant. On average, homes are close to schools, around 1.1 miles in any given year. As school choice rates increases over time however, parents are paying less of a premium to live very close to a school. A test of nonlinearity was performed on the school distances using the square of distance. This nonlinear term was not related to house prices.

The school size in the year the family purchased the home is negatively related to house price, but the effect is not significant. The school area free and reduced lunch rate is negatively related to house prices, but the effect is not significant.

House characteristics in the model reflect the preferences of young families for these house features. All the variables show positive and significant relationships with house price with the exception of the land variable. I test if there is a diminishing return to the house age but the effect is not significant.

Distance to the high tech corridor enters with a negative sign, expressing a preference to be close to it. I add the square of distance to control for a diminishing effect, which is positive and significant. Distance to the major employer is not significant.

The school choice variables show that the coefficient on 'attends neighborhood school' is negative but is not significant. The coefficient on 'attends magnet school' is positive but not significant at the .10 level. These categorical variables capture the preference of the family to attend the local school. Alone, families can't change market prices for houses. As more families place less value on the local school, they can change market prices.

The flows of school choice participants in and out of the school area are captured by the Choice Rate In and Choice Rate Out variables. Both effects are significant. The choice-in rate has a negative sign, so as more families who don't live in the school area attend the school, the price falls. The sign on choice-out is positive, so as more families leave an area, prices rise on houses in that area.

The effect of choice-in and choice-out rates on prices was surprising to me as I expected that an adjustment process related to school choice would be dynamic. Reback found that adjustments played out over seven years. To the extent that I model house prices from 1994 to 2001, I am analyzing a similar time period. But expanded school choice began in 1995 and the first charter school opened in 1998. My result indicates that for this sample, adjustments are happening at a faster pace. This may be do the proportions of families that use school choice in my study and in Reback's. Less than 10% of Minnesota families participate in inter-district choice. In this study close to 30% of families used school choice by 2001.

I had student characteristic data for gender, ethnicity and the family free or reduced lunch status. In testing the model gender and ethnicity were unrelated to house prices, so I deleted these variables. Free or reduced lunch students appear in the model with a negative sign with respect to house price, and the effect is significant. This is a measure of family income.

A final variable is 2000 census median income for the block group where the house is located. These census block groups are not perfectly nested into school attendance zones, so the coefficient needs to be interpreted with caution. These values also proxy income for residents who purchased prior to 2000. The coefficient is positive and significant indicating that there is an income effect that increases house prices.

The regression results from the hedonic model indicate that in the early years of expanded school choice, families paid a premium to live close to their assigned school and to a school that had higher performance on 4th grade CSAP exams. This effect diminishes over time. I control for preference for school choice and find that it is not related to house prices. School choice does impact housing prices, however. Flows of students into and out of a local school are what matter. As more students cross over a school area boundary to attend that school, area prices decrease. As more parents leave an area, prices in that area increase. This expresses an adjustment process in house prices. Community income impacts house prices positively but family income, as measured by FRED status, is negatively related.

Price Adjustments in Later Years

The equilibrium effect that Reback reports comes from an examination of changes in property valuations in school districts over time. His conceptualization is in a sense a convergence story in valuations from an early period to a later one. I look at convergence in this section by using the change in housing values over time as a function of the change in a school's test scores, changes in area FRED rates, and the flows into and out of the school area that indicate use of school choice.

Methodology. My data selection process for house sales involved finding a larger sample of sales that matched with school addresses over a shorter time span. My motivation here is to limit the impact of the price deflator on house sales. In the hedonic regression results reported in table 5.1, sales ranged from 1994 to 2001. The price index I used stood at 166.83 in the first quarter of 1994 and rose to 302.15 by 4th quarter 2001. While all prices are deflated using the same index, the growth in the index over this time is nonlinear. I look to create a larger data set where the price index would have less impact on my dependent variable.

To accomplish this, I searched for address matches for all students enrolled in kindergarten through sixth grade in district schools in 2001 with the county real estate sales database. I follow the same selection process as in the first experiment, where I look from four years back up to find sales. I find over two thousand matching records. After eliminating records where I could not identify the buyer as a person, I have 1,845 records for the analysis.

My dependent variable is constructed from the 2005 county assessed valuation for a property. The assessor's office uses a marketing, or sales based method, to determine valuation. I take the 2005 valuation as a proxy for market value. I take as my dependent variable the difference between the inflation adjusted sales price (in 1998 dollars) to the 2005 valuation. I label this difference the valuation delta.

The independent variables in the model are the differences between the 2005 and 1999 levels of reading proficiency, FRED rates, school and area size, and the flow variables. In addition, I am able to add test scores at the junior high school that is assigned to the residence. This follows the procedure suggested by Walden. The year 1999 marked the first year that these tests were given to junior high school students. I use the difference in the 1999 and 2005 scores as a measure of change in reading at the junior high school level.

One final variable is school quality for the senior high schools attached to the residence. A problem arose here as measures of high school quality were not put in place at the senior high schools between 1998 and 2000. Additionally, there were only three high schools in the district at the time of the study. Their boundaries divide the urban community along a north/south and east/west axis. I settled on using dummy variables for high school areas.

I include static variables as in the model reported in table 5.1 on page 13, such as distances to the school, the high tech corridor, and the university, as well as the same list of house characteristics. I also include the median census income from the 2000 census block group, since it is representative of income at the time most homes were purchased. I don't have a corresponding income measure for 2005, but do have the changes in FRED rates in the school area, allowing me to measure if the low income population near the school has increased or decreased.

Empirical Model. I use a random effects model to test the relationship between changes in house valuations from their adjusted sales prices as a function of changes in school area variables. Results are presented in table 5.2.

Changing test scores at local schools are not related to changes in valuations from adjusted sales prices. This is consistent with the early result in that I find no relation between school quality and house prices for the 2001 buyer cohort in that model.

Changing flows into and out of school areas do impact changing values. The coefficient on Delta Choice Out is positive and significant. The more that family's use school choice out of an attendance area, the greater the increase in their home valuation. This reflects the second part of the adjustment process. The coefficient on Delta Choice In is negative and significant. As the percent of students that choice into a school increases, the price reduction for houses in that area increases.

As the size of the catchment area shrinks, the valuation delta shrinks as there are less demanders in this submarket of buyers for homes in this specific geography. However, as the local school increases in size, the valuation delta increases. This seems counter to the impact of the choice-in rate on prices, which is negative. It may be that some schools face capacity constraints. As school populations rise, fewer students can choice in, since local residents have priority. This variable may be capturing that effect.

Table 5.2 Changes in House Values 2005-1999

VARIABLES	(1) ln DeltaVal Coef	(2) se	(3) tstat	(4) pval
Delta Read 05_99	0.000770	(0.00260)	0.297	0.767
Delta Choice Out 05_99	0.00824**	(0.00332)	2.482	0.0131
Delta Choice In 05_99	-0.00769**	(0.00352)	-2.185	0.0289
Delta Area Size 05_99	-0.000829**	(0.000354)	-2.343	0.0191
Delta School Size 05_99	0.00128***	(0.000455)	2.820	0.00480
Delta Area FRED 05_99	-0.00298	(0.00205)	-1.450	0.147
Delta School FRED 05_99	-0.00128	(0.00196)	-0.654	0.513
High School 1 (dummy)	-0.0389	(0.0434)	-0.896	0.370
High School 2 (dummy)	0.0935	(0.0597)	1.567	0.117
Delta Jr. High Read 05_99	-0.00153	(0.00138)	-1.109	0.267
Distance to Tech Corridor	-0.00432	(0.0111)	-0.391	0.696
Distance to Major Employer	-0.0318**	(0.0131)	-2.423	0.0154
Distance to local school	0.0116	(0.0174)	0.665	0.506
Square Feet	0.000204***	(2.88e-05)	7.071	0
Basement Square Feet	0.000267***	(3.28e-05)	8.122	0
Garage Square Feet	0.000415***	(6.82e-05)	6.086	1.16e-09
Porch Square Feet	-2.59e-05	(3.01e-05)	-0.860	0.390
Stories	-0.0455***	(0.0167)	-2.716	0.00661
Rooms	0.0221***	(0.00694)	3.183	0.00146
Bedrooms	-0.000252	(0.00939)	-0.0268	0.979
Baths	0.122***	(0.0187)	6.515	7.27e-11
Age	0.00112	(0.00129)	0.871	0.384
Land Gross Square Feet	1.08e-06*	(6.45e-07)	1.679	0.0932
Median Income 2000	-1.29e-06	(8.93e-07)	-1.444	0.149
Constant	10.25***	(0.112)	91.79	0
Observations	1,786			
Number of Clusters	22			

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

R^2 Within: .50 R^2 Between: .83 R^2 Overall: .56

Changes in the area FRED rate lower the valuation delta. This variable is significant when I test a model without clustered standard errors, but with clusters at the school level the effect is insignificant. Changes in the FRED rate at the school do not impact the valuation delta. The median income in the school area in 2000 is negatively related to the valuation delta, but is not significant at the .10 level.

The changes in junior high school scores and the coefficients on the high school dummy variables are not significant in this model. Walden argued that impacts from these variables would depend on the number of school choice alternatives at these levels. There were no magnet schools at either level for parents to choose, but many families do use school choice for junior and senior high, choosing another school that has an attendance area assigned to it. Interpreting a relationship between house prices and elementary, junior and senior high quality is challenging, as no perfect nesting relationship, or feeder system, existed in the district. Two homes in the same elementary area could be assigned to different junior high schools.

A final variable of interest is the change in valuation with respect to the distance to the major employer, which is located near the downtown. There is now a premium in valuation to be closer to this center.

Conclusion

In the district under study, non-boundary magnet schools were introduced along with state mandated standardized testing in the 1990's. Open enrollment had always been an option for district parents, but these new choice options and standardized testing brought this district full speed into the era of school choice. My random effects model suggests that in 1997 when standard tests were introduced, parents paid a premium to attend a school that had higher test scores. This premium reduces over time and appears to have been eliminated in the 2001cohort.

This is consistent with Reback's model of equilibrium price adjustment across school districts when open enrollment policies are adopted.

The house price adjustment process over time can be modeled by looking at changes in valuations from earlier sales prices. In this model, test score differences do not impact changes in house values. That is consistent with the idea that school quality and house prices are no longer linked. Changes in the school size, the catchment population, and flows into and out of the neighborhood school impact house valuations. The results suggest that the adjustment process may not be complete as of 2005.

My analysis would benefit from more data regarding neighborhood variables that may impact house prices, such as distance to parks and other amenities. A look at current house school relationships would also benefit from use of census track data which would reduce the size of the neighborhood being studied from the census block group I use.

A future study could also expand the number of house sales used as the dependent variable. I lacked maps that showed the exact school boundaries from 1997 to 2004. I identified house location and school assignment by linking the school data record to the county sales record. It should be possible to map out an approximation of a school boundary area and then find house sales on streets where the specific school assignment was known using GIS software. Expanding the sales data base would provide more reliable estimates of the value of house and neighbor specific attributes.

While my study lacks certain house feature and neighborhood variables, it is clear that hedonic regression models can benefit from the inclusion of school level variables such as school size, school FRED rates and school choice flows. This requires gathering much more information about schools then aggregate test scores.

My initial aim was to explain what I observed in simple correlations between house prices and school quality. These correlations started at .31 for the 1997 cohort and dropped to .15 by 2001. I had sampled a small number of house sales to make up a 2005 cohort and the correlation declined even further, to .06. My choice of variables models these changing relationships.

The overall R-squared values for my regressions vary from .43 to .56. The between school R-squared is much higher, from .78 to .83. These results support my choice of the random effects estimator to model this data. The random effects model is controlling for unobserved random variation in sales prices both between and within school attendance zones. The variables I have chosen to differentiate houses by attendance area are effective. The use of robust standard errors with clustering at the school level yields efficient estimates.

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Conclusion

The school district that is the focus of this dissertation has unique properties that make it an interesting one for study but may limit the usefulness of generalizing results to other locations. While the student population places the district in the top ten out of the 176 districts in Colorado, its physical location in the north center of the state isolates it from other urban and suburban areas, limiting student migration into and out of the district. Schools districts of similar size in the Denver metro area, for example, see large student flows across district boundaries.

The relative isolation of the district enhances the value of that part of this dissertation that looks at flows of students and homeowners within the district. In chapter 4, I model school choice behavior and look at competition between district schools as it is relatively uncontaminated by migration from other local districts. This competition may mirror competitive effects that occur across district boundaries, but I can effectively control such variables as tax policy, district spending and district administrative policies. The same is true of chapter 5, where I look at home buying decisions across local school area boundaries, and not across district boundaries. As much research in these areas involves inter district comparisons, I make a unique contribution to the literature by studying school choice impacts intra district.

The student level data available to me offered a unique view into the choice behavior of parents. And, as I was able to obtain data over a nine year period, I could look at how activity changed over time. This is reflected in the regression analysis I conduct in chapter 4 using changes in student choice behavior from 1997 to 2001 and in the property valuation regression in chapter 5 that looked at changing home valuations from 1997 to 2005.

The district is also home to a major state university, and many local residents are highly educated. Median family income exceeds the state average. These characteristics may also explain why the district moved quickly in the mid 1990's to expand student choice options. The three new magnet schools that opened had strong support from parents, which most likely reflects the higher level of education of area residents, their focus on their children's education and their abilities to both negotiate and partner with school administrators and board members. By 2001, there were two charter schools in addition to the magnet schools. In the two districts closest to this one, no charter or magnet schools were opened until 2005, a full ten years after the three magnet schools opened here. Early CSAP scores in the district were also higher than state averages, once again reflecting the income and education levels of the local community. Extending my findings to districts with fewer college educated parents and lower overall income levels could be problematic.

My finding that school level effects on student achievement are rather small, and account for less than 12% of the variation in student test scores, is consistent with the literature. I am also consistent in reporting that income and, to some extent, ethnic differences in students impact student achievement and school composition, as these results are found in numerous other studies. What I would be hesitant to make a claim to is that I have identified any particular order of magnitude or marginal effect in my regressions, as these appear to me to be very time dependent and are sensitive to the measure of achievement used. For example, combining reading and writing scores yielded slightly different results than when reading scores were looked at separately. My focus has been more on identifying relationships than in specifying a claim as to the importance of their magnitude.

Given that I have explored school choice impacts over time, it may be that as time further unfolds, variables that I found to be significant in some models would become insignificant. For example, if house prices reached a new equilibrium based on historical school choice patterns then the flows of buyers into and out of school areas may no longer be related to current property values. In particular, the models I present that study change over time would see less change between time periods, reducing variances and covariances, perhaps yielding insignificant regression coefficients. But, since markets aren't static, changes in tax policy, population, employment and the entrance of new charter schools could once again lead to changing patterns of student choice.

What I can be certain of is that the right to choose a school other than the one nearest your home will not be easily taken away from parents. School choice is popular and widely used. Whereas residential location was once the norm for public schooling, school choice is now taken as a given. I find little evidence that it alone has contributed much to increased performance of district schools, but that isn't a strong argument for doing away with it.