ABSTRACT

KHALAF, CHRYSTELLE WALID. The Effect of Charter Schools on Housing Prices. (Under the direction of Melinda Sandler Morrill.)

In the United States, students are typically assigned to public schools based on their residence. Parents that want access to good quality zoned schools pay a higher house price to guarantee admittance. Households that cannot afford a school quality house price premium or private school tuition attend lower-performing schools. Introducing charter schools, a form of school choice, can impact housing prices. In this dissertation, I present results that suggest charter schools have an effect on housing prices and I examine the different possible channels by which charters can impact residential choice. Chapter 1 lays out the motivation and framework behind the research questions in this document. Chapter 2 presents a detailed examination of two prevalent school choice policies currently in place at the state level: charter schools and open-enrollment (inter-district and intra-district). I survey the literature on the effect of these policies on academic performance and student sorting. Charter school policies and open enrollment policies share a common goal: increasing access to good quality education but empirically they serve different types of households. I use the Parent and Family Involvement in Education Survey to present descriptive evidence on the type of students taking advantage of each of these policies. Chapter 3 examines the effect of charter school legislation on housing prices using data from the metropolitan American Housing survey (AHS). States introduced charter school laws in different years starting in 1991. Examining how charter school laws impact housing prices provides information on households' valuations of charters. It is possible that charters are capitalized in housing prices as an amenity or a disamenity. However, it is also possible that the effect of charters on housing prices reflects a change in the link between zoned school quality and residential choice. Using self-reported transaction prices from 43 metropolitan areas for 1985-2005 and a fixed effects estimation strategy, I find that the introduction of charter schools is associated with a decrease in housing prices. Using quantile regressions, I present results consistent with the litterature's predictions of a weaker link between zoned school quality and housing prices once school choice is in place. In fact, I observe an increase in housing prices in the bottom part of the housing price distribution and a decrease in housing prices in the top part of the housing distribution. This observed pattern probably reflects residential sorting following the introduction of charters. Households can

live in a lower quality school zone but still have access to schools other than the zoned school thus avoiding the need to pay a school quality house price premium. In chapter 4, I use data on housing transactions from New York City (NYC) which provides detailed geographic identifiers that allow houses to be linked to their respective zoned school quality. I merge NYC housing transaction data from the NYC Department of Finance with information on school quality (grade 3 score on NY state math test) from the NYC Department of Education. Using boundary fixed effects, I can assess the effect of charter schools on housing prices while controlling for neighborhood unobservables. I find that charter schools operating within 1 mile of a house are associated with a decrease in housing prices. However, I am unable to confirm the heterogeneous impact of charter schools across different zoned school quality. The results from chapter 3 and chapter 4 suggest that charter schools act as substitutes to zoned public schools. The goal of charter school policy is to provide households with choice and access to good quality education. This dissertation provides results that suggest households value the choice available through charter school policy.

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The Effect of Charter Schools on Housing Prices

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INTRODUCTION

Economic literature has documented that changes in zoned school quality are reflected in housing prices [Black and Machin, 2011]. School choice policies allow parents access to schools other than the one to which they are geographically linked. The introduction of these policies can impact the link between zoned public schools' quality and housing prices. The impact will vary depending on the viability of choice associated with a given policy.

Chapter 2 presents two common state level policies that were implemented to allow households choice: charter schools and open-enrollment. Under these policies, households can directly access good quality schools and would indirectly benefit from an increase in the average school quality available in the education market. Increased competition between schools would force low-performing schools to exit the market.

A consequence of school choice is a weaker link between zoned school quality and residential choice [Epple and Romano, 2003; Ferreyra, 2007; Nechyba, 2000]. Households would no longer need to pay a school quality house price premium to access good quality

zoned schools. While papers on open enrollment have confirmed this prediction [Brunner et al., 2001; Brunner et al., 2012; Machin and Salvanes, 2016; Reback, 2005], less is known about the effect of charters on housing prices.

In chapter 3 and chapter 4, we add to the literature on the effect of school choice by examining the impact of charter schools on housing prices. Charters can impact housing prices through multiple channels. We will refer to the first channel as the de-linking hypothesis. Once charters are introduced, they act as substitutes to traditional neighborhood schools. Households' demand for zoned public school quality decreases and becomes more elastic. Thus, the school quality house price premium would decrease. Charters can impact housing prices indirectly through their impact on the link between zoned school quality and residential choice but they can also have a direct impact on prices. We refer to the second channel by which charters can impact housing prices as the amenity/disamenity hypothesis. The school quality of charters themselves can be capitalized in housing prices, especially in areas where charter schools provide priority to students residing in close proximity to the charter school. We refer to the last channel as the information channel. It is possible that the decision of a charter to locate in a given neighborhood is interpreted as a signal that the neighborhood in question has low performing schools and should be avoided. Charter schools tend to locate in urban areas with high concentrations of minority and low-income students [Bifulco and Buerger, 2015; Epple et al., 2015].

In chapter 3, I provided a more detailed explanation of the three channels mentioned above. I take advantage of the variation in when charter laws were implemented across states to estimate the effect of charter school policy on housing prices. The effect of charter school policy on the distribution of housing prices mirrors the predictions from the literature. Charters decrease prices in the upper part of the distribution which is consistent with the literature's prediction that school choice would weaken the link between public schools and residential choice. Higher-income households' revealed preferences reflect that they consider charters a substitutes to good quality zoned schools. In chapter 4, I use detailed geographic data on housing transactions from NYC to link a house to its corresponding zoned school quality and to its closest charter school. Using boundary fixed effects to control for neighborhood unobservables, I am unable to confirm the heterogeneous impact of charter penetration on housing prices.

If charter schools are acting as viable substitutes to public schools, there should be a

weaker link between zoned school quality and housing prices [Epple and Romano, 2003; Ferreyra, 2007; Nechyba, 2000]. However, if charter schools are impacting prices through channels other than the school quality house price premium, then documenting these unintended effects is important. Studying the impact of charter schools on housing prices can inform the debate on the effectiveness of charter school policy. This dissertation presents results consistent with the literature's prediction that charter schools, a form of school choice, can weaken the link between zoned school quality and residential choice.

CHAPTER

2

STATE-LEVEL SCHOOL CHOICE POLICIES

2.1 Introduction

Public school systems in the United States are locally administrated by elected school boards. A school district is the geographical unit where a school board is responsible for providing education services for children in pre-kindergarten through 12^{th} grade. The geographic structure of the school district varies by state and region. Public school funding is provided through federal, state, and local sources but it is spent at the district level. School districts reported more than 623 billion dollars in revenues for the 2013-2014 school year [CCD, 2016]. School districts received about 55 billion dollars from the federal government

or about 8.7 percent of their total revenues.[1] State government provided over 288 billion dollars and local governments provided over 280 billion dollars, 46 percent and 45 percent respectively of total revenues. The source of most local funding is property taxes. Funding from property taxes was 36.4 percent of total school revenues in 2013-2014. Figure 2.1 is a map of the United States illustrating the share of total school funding from property taxes.[2] Most states rely on property taxes for at least a quarter of school funding: 26 states receive 25 to 49 percent of their school funding from property taxes while 8 states receive more than 50 percent of their school funding from property taxes. Only 16 states receive less than 25 percent of their funding from property taxes.

School districts are divided into smaller zones that determine the area served by local schools. A zone within a school district in which a house is located determines which school the household can access. Under a zoned school system, all else being equal, households are willing to pay more for a house linked to a higher quality school than for a house linked to a lower quality school. Therefore, parents wanting to exercise choice over the school their child attends can pay a school quality premium capitalized in housing prices or they can pay tuition for their child to attend a private school.

Starting in the 1980s, states moved towards offering students more control over which public school they attend. These school choice policies were motivated by a multitude of arguments ranging from equity to efficiency. Choice can delink high quality schooling from the student's socioeconomic background [Holme, 2002]. Additionally, parents might value choice itself [Goldring and Phillips, 2008]. Moving away from a geographically assigned school and offering students a choice over which school to attend, can also increase competition [Cookson Jr, 1995]. Schools would have less market power. They would have to compete to attract students. Introducing competition leads to low quality schools exiting the market which has the potential to improve school quality for all students.

School choice policies have the common goal of providing parents and their children with more choice, but they differ in the feasibility of choice that they offer and the degree of delinking that occurs between zoned school quality and residential choice. Policies can

[1] Revenue from the federal government includes money allocated for special education programs and child nutrition programs.

[2] The map does not include Alaska and Hawaii for scale purposes. Alaska receives 11 percent of total school funding from property taxes while Hawaii does not rely on property taxes for school funding.

be implemented at the district level, the city level, or the state level. This policy review focuses on two prevalent statewide policies. We examine charter school laws and open-enrollment laws. Open enrollment laws can be inter-district (offering a choice of school across districts) and intra-district (offering a choice of school within a district). The most common school choice policy is charter schools: 42 states have charter legislation as of 2015. Open enrollment laws are also popular: 15 states have mandatory inter-district laws and 27 additional states have voluntary inter-district laws while 14 states have mandatory intra-district laws and 15 additional states have voluntary intra-district law. Table 2.1 lists the years when the different states adopted charter school legislation and open enrollment legislation.

The existence of a law does not always translate into choice for households and even when it does the impact of the law is not always immediate. Charter school laws and mandatory open enrollment laws require the participation of local school boards. Once a charter school law is in place, individuals or organizations that are interested in starting a charter school must file an application with an authorized charter-granting agency.[3] Authorizers either post formal requests for applications or simply reply to applications as they are submitted. The applicant must build a team, develop a mission, identify a target community, and create a work plan that includes the start-up budget needed to operate a charter prior to applying. Not all applications are approved. Applications are rejected for not meeting the criteria set by the authorizing agency or due to cap provisions in place.[4] Once the authorizing agency approves the application, a charter school can begin to operate. It takes authorizing agencies 6 to 12 months to authorize a charter school once they receive an application. Minnesota was the first to pass charter school law on June 4th, 1991. The first charter school did not start operating in St. Paul until September 7th, 1992.

Mandatory open enrollment legislation requires local school districts to allow student transfers across school zones or districts. A local school authority can refuse to accept an incoming student if the school has reached its capacity or in some cases if the transfer interferes with desegregation laws already in place. Voluntary open enrollment legislation lets the local school boards decide if they want to allow students to transfer schools across school zones or school districts.

[3] Authorizers vary by state but they are mainly local school boards. Refer to table 2.2.

[4] Some authorizers use outside experts to review applications while others rely only on internal staff.

Using data from the Parent and Family Involvement in Education Survey [PFI, 2012], we examine the use of zoned public schools and choice schools by student type. The PFI is a nationally representative survey that samples the student population. The PFI survey file contains data from 17,563 surveys completed with the parents or guardians of children in kindergarten through 12th grade. Households in the survey are randomly selected to be representative of the educational experiences of Americans. About 2.3 percent of students were homeschooled while about 8.5 percent attended private schools in 2012. The rest attended a public school: about 75.8 percent attended their zoned school, about 5.4 percent attended a charter school, and about 8 percent attended a public school other than their zoned school. Therefore, we infer that about 13.4 percent of students in the US take advantage of school choice policies. Figure 2.2 presents gender proportions by school type.

Gender proportions are similar across school types. The student population of zoned schools and private schools is made up of 52 percent males and 48 percent females. Choice schools are made up of 51 percent males and 49 percent females. [5] Only charter schools have a higher concentration of females, about 55 percent of their student population. The results from figure 2.3 illustrate the racial composition of students by school type. Private schools have a higher concentration of White students: 66.3 percent of private school students are White compared to 53.2 percent in zoned schools, 46.5 percent in choice schools, and 33.5 percent in charter schools. Charters have a higher concentration of Asian, Black, and Hispanic students. Charter schools' population is 9.7 percent Asian, 24.5 percent Black, and 11.3 percent Hispanic. Zoned schools and choice schools have very similar racial composition. Choice schools' population is 4.7 percent Asian, 16.6 percent Black, and 8.1 percent Hispanic. Zoned schools' population is 5 percent Asian, 14.1 percent Black, and 7.9 percent Hispanic. Private schools are not as racially diverse as other type of schools. Private schools' population is 5.1 percent Asian, 9.6 percent Black, and 3.9 percent Hispanic.

Figure 2.4 illustrates income sorting by school type. Charter schools have a higher concentration of low-income students but students attend charter schools across all income brackets. Students from households making less than 40,000 dollars (lower income households) make up 46.6 percent of charter students. The remaining students are from middle

[5] Choice schools are any schools other than charters that enroll non-zoned students.

and higher income households. Middle income households have income over 40,000 dollars and less than 100,000 dollars. Higher income households have income greater than 100,000 dollars. Households that transfer out of their assigned school to another school (not a charter) are more likely to be middle income households: 44.1 percent of students in choice schools are from middle income households. Households that send their children to private schools are concentrated in the higher income category: 49.5 percent of students in private schools are from higher income households. Zoned school's student population is made up of 35.3 percent lower income households, 39.6 percent middle income households, and 25.1 percent higher income households.

Examining the choice of households across school type by income, we note that the majority of students attend zoned schools: 81.3 percent of lower income households, 77.6 percent of middle income households, and 72.8 percent of higher income households. Charter schools have a smaller share of students across all income brackets: 7.7 percent of lower income households, 5.3 percent of middle income households, and 3.3 percent in of higher income households. Private schools are less likely to be a choice for lower income households: 3.6 percent of lower income households, 8 percent of middle income households, 16.1 percent of higher income households. The remaining students attend choice schools: 7.3 percent of lower income households, 9.1 percent of middle income households, and 7.8 percent of higher income households. Figure 2.5 illustrates the distribution of grades across school types. Private schools have a higher concentration of students that mostly score A's on their exams. Charters are slightly more likely than zoned schools to have students scoring mostly A's: 44.8 percent in charters compared to 40.4 percent in zoned schools. The figure gives some information on the academic performance distribution across school types but it does not account for any differences in scoring across the different schools. For a better examination of student performance across school types, we refer to the literature later on in the chapter.

Households reported if they had the option to choose: 42 percent of households were not afforded choice, 31.7 percent had the option to choose, and 26.3 percent did not know if they were allowed choice.[6] Introducing choice that lacks transparency or that is too complicated for households to use can introduce asymmetry of information in the education market and

[6]We only examine if choice was available for households that are not homeschooling or attending private schools.

create unintended effects [Alexander, 2012; Ferreyra and Liang, 2012]. Below, we examine in detail charter school laws and open enrollment laws (inter-district and intra-district). We review the literature on the effect of these policies on academic performance and student sorting.

2.2 Charter schools

Charter schools are the fastest growing type of school choice policy. Only 7 states (Kentucky, Montana, Nebraska, North Dakota, South Dakota, Vermont, and West Virginia) do not have charter school laws in place as of 2015. Minnesota was the first state to implement charter school legislation. The charter school bill was introduced in the 1989 Minnesota legislature but did not gain enough votes in the state House of Representatives until 1991. The Minnesota governor signed the bill into law that year after it received sufficient votes in both the House of Representatives and the Senate. In the 1990's, an additional 35 states passed their own charter school legislation. Out of 93,273 schools enrolling over 47 million students in 2000-2001, 1,993 (2.14%) were charters enrolling 448,343 (0.95%) students. By 2012-2013, over 2 million students or 4.58 percent of all enrolled students were attending one of the 3,000 operating charter schools.

Charter schools are publicly funded through a contract with a state or a district. The contract, or charter, details how the school will be organized and managed, what students will be taught and expected to achieve, and how success will be measured. Charter schools are often exempt from rules and regulations affecting other public schools, for example regulations on hires and fires. Charter schools can be new newly created schools or they may have previously been a public or private school. If charters fail to satisfy the charter terms, the charter is not renewed or even revoked.

Charter authorizers are mostly school districts. However, other types of authorizers exist: higher education institutions, state boards of education, nonprofit organizations, independent charter boards, and municipal governments. Table 2.2 lists the different years in which states implemented charter legislation. It also includes a list of charter provisions by state. The differences in legislation by states are mainly around the following provisions: the type and number of authorizers, the level of operational autonomy, the cap on number

of charter schools allowed, and the source of charter school funding.

A charter in a state with complete operational autonomy receives a blanket waiver from most rules and regulations governing traditional public schools at both the state and local level. Charter employees can work independently of district contract work rules and do not have to participate in the state retirement system (they can have the option). However, a state with no operational autonomy would not exempt its charter schools from any of the regulations imposed on traditional public schools at the state and local levels (or exempt from only a small number). It would also not exempt charter school employees from being covered by district bargaining agreements and the state's retirement system. Most states fall in between the two extremes of complete operational autonomy and no operational autonomy.

The sources of funding for traditional public schools are a combination of federal, state and local revenue. Districts receive state funding based on the number and characteristics of enrolled students which creates variation in district revenues. The source of local funding is mostly property taxes. Revenue from property taxes explains the remaining variation in total district revenue. Charter schools are publicly funded schools. Therefore, they receive money for the students they enroll. States differ in their basis for charter funding. Charters are funded at approximately 64 percent of their district counterparts, averaging 7,131 dollars per pupil compared to the average per pupil expenditure of 11,184 dollars in the traditional public schools in the 2009-2010 school year [Rebarber and Zgainer, 2014].[7]

Regardless of residential location, each household has the right to apply to any charter school that serves the student's grade. Charter schools cannot impose admission requirements. However, if the number of applicants exceeds the number of available seats at a given charter school grade, the school conducts a public lottery to determine assignments. There is a deadline to apply to for most charter schools. If a student misses the deadline, they are added at the bottom of the waitlist. Schools usually have their own applications and deadlines. Charter schools can give enrollment preferences to returning students, siblings of students already enrolled, and students living in the same school district where the charter is located. Charter schools may also give preferences to students who are eligible

[7] In 2012, CER distributed surveys to 5,294 operating charter schools. The survey posed a range of questions about educational programs and operations, standardized testing, and demographics. A total of 743 charter schools returned their surveys, for a 14 percent return rate.

for free or reduced price lunch.

Charters can have different admittance priorities by state. Some state laws do not include a provision on admittance priorities while other state laws outline very detailed preferences. Most state laws with charter priorities include preferences for students who reside in the district containing the charter. This provision creates a link between charters and residential choice although not as strong as the link between zoned public schools and houses.

The goal of charter school policy is to improve school quality either through providing a more innovative student centered approach to education or through market forces [Lubienski and Weitzel, 2010; Shanker, 1988]. There are multiple channels by which charter schools impact the demand for zoned school quality and the capitalization of school quality in housing prices. First, the de-linking hypothesis, if charters are a viable substitute to zoned public schools, as the demand for charter school quality increases, we would observe a decrease in the demand for zoned public school quality. The decrease in demand for zoned public school quality decreases the equilibrium price of that zoned school quality (school quality premium), ceteris paribus. Charters can weaken the link between public school quality and housing prices.

Second, the amenity/disamenity hypothesis, charter schools can have a direct impact on housing prices since charter school quality can be capitalized in housing prices similarly to public school quality, especially in areas where charter schools give priority to students based on residential location. However, it is not clear if charters are capitalized positively (as an amenity) or negatively (as a disamenity) into housing prices given that charter schools vary in quality. Some charter schools have been very successful at providing students with good quality schooling [Abdulkadiroğlu et al., 2011; Angrist et al., 2011; Dobbie and Fryer Jr, 2015; Dobbie et al., 2011], while others have not performed better than public schools [Hanushek et al., 2007], and in some cases had adverse effects on students' academic performance [Bifulco and Ladd, 2006; Imberman, 2011b; Zimmer and Buddin, 2006]. If charters have a negative effect on academic performance, we would expect the charter school quality to be negatively capitalized in housing prices. The worse the quality of the charter school, the bigger the negative effect on housing prices.

Finally, the information hypothesis, a charter locating in a school zone can be interpreted as a negative (more transparent) signal that this school zone has a lower school

quality and residing in this location should be avoided. Charters locate where public school achievement is relatively low [Bifulco and Buerger, 2015] and in urban areas with high concentrations of minority and low-income students [Epple et al., 2015].

In Chapter 3, we use the variation in the timing of charter school laws across states to estimate the causal effect of charter schools on housing prices. The effect of charter legislation will not be immediate in any of the states. There is a lag between when a charter school law is implemented and when the first charter starts operating. Therefore, we expect a gradual effect of charter schools on housing prices that would increase with time as the share of students enrolled in charters increases. Chapter 3 presents results showing the gradual effect of charter school legislation on housing prices. Multiple channels exist by which charter schools can impact housing prices. Once charters are introduced, households might value public schools less, especially households paying a higher school quality housing price premium. Households paying a bigger share of their budget on school quality will be most responsive to the introduction of substitutes. Chapter 3 presents results suggesting the decrease in housing prices is largest in magnitude for higher priced houses. In chapter 4, we examine the impact of charter schools on housing prices using housing data from NYC.

Economic shocks or policy changes that occur at the same time as charter legislation and impact both housing prices and charter penetration are a possible threat to the identification strategy used in Chapter 3. Reviewing when the other common state level school choice policy was implemented allows us to ascertain that no other policy related factors are confounding the results.

2.3 Open-enrollment

Only 3 states (Alabama, Maryland and North Carolina) do not have state level open-enrollment laws as of 2013. Under open-enrollment, families still get assigned a school based on their geographic location but have the option to attend any other public school conditional on the receiving school's capacity. These policies encourage competition among zoned public schools, since staffing and other school resources are a function of number of students enrolled. Losing students is analogous to losing resources. State and local funding normally

follows the student from residential district to district of attendance.

Open enrollment is supposed to provide parents with school options that they could not otherwise access. Parents can access good quality schooling without having to reside in a high-priced house. However, most states provide capacity opt-out provision for districts and schools. Additionally, districts are often allowed to set priorities to admit students (e.g., siblings, children of in-district teachers, etc.). Transportation in most states is an added cost to parents. Given these de facto barriers to choice, open-enrollment policies are most effective when choice is feasible and transportation costs are low. For example, in cities with well-developed public transportation, there is a low cost associated with exercising choice. Epple and Romano [2003] postulates that schooling qualities equalize in equilibrium across school zones when intra-district choice is introduced if there is low or no transportation costs. The paper theorizes that if transportation costs exceed the housing price differential that exist without choice, then these costs will prohibit the exercise of choice. Running simulations on a general equilibrium model, Epple and Romano [2003] finds that choice with significant transportation costs causes a welfare loss to below-median income household compared to choice with no transportation cost. Households that choose not to commute will face a diminished peer group. High transportation costs discourage students from the lowest-income households from attending a higher quality choice school.

Open-enrollment is an envelope term that includes intra-district transfers (a choice within school district boundaries) and inter-district transfers (a choice between school districts). State policy determines whether schools and districts may choose to participate (voluntary) or whether they are required to participate (mandatory). A voluntary open enrollment policy allows individual schools or districts to decide whether they will accept students who live outside their boundaries. A mandatory policy requires all districts to accept students transferring, although as we mentioned previously, these policies can be restricted by opt-out provisions as well as priorities set by districts and desegregation provisions. Transfers cannot supersede a court-ordered desegregation program.

Open enrollment policies were implemented to increase access to better school quality either directly by allowing students to transfer to schools outside their school zone or indirectly by allowing market forces to increase the average school quality available in the education market. However, these policies can have an adverse effect on disadvantaged students. When a student transfers out, the zoned school effectively loses the state funding

for that student and in addition, the best students are often the ones that transfer out. Advantaged students, specifically students whose parents have a college education, are more likely to opt out of their assigned schools and they are more likely to opt out of schools with concentrations of disadvantaged students to attend schools with high levels of achievement [Bifulco et al., 2009].

2.3.1 Inter-district

Inter-district open enrollment laws allow choice of public schools across district boundaries. These laws can be mandatory or voluntary. Voluntary open enrollment laws allow receiving districts to accept or refuse student transfers. Mandatory open enrollment laws require districts to accept students transferring to the school of their choice. The first mandatory inter-district open-enrollment policy was passed by the Minnesota Legislature in 1988. The number of states with mandatory inter-district policy is 15 as of 2013. An additional 27 states have voluntary inter-district open enrollment laws in place.

Parents are responsible for transportation in most instances. Iowa, Minnesota, Nebraska, and Wisconsin require parents to transport students to a point within the boundaries of the receiving district, and then they can use the district's public school buses. Transportation provisions determines the effectivity of the policy. If parents cannot take advantage of inter-district open enrollment because they do not have the financial means or the time required to drive their children to a different school district, then the set of options available to them is restricted and the policy cannot successfully achieve its goals. Other than provisions on transportation, state legislation can also include provisions on capacity, special education, and desegregation.

Students wishing to transfer under inter-district rank the schools they wish to attend on their transfer application and then the district administrators decide the highest ranked school that has sufficient capacity to serve the student. Once a student transfers into a district, the student is entitled to remain in that district until graduating high school. Students are not guaranteed admittance. A district can refuse a transfer if capacity provisions are in place without having to provide any evidence that they reached capacity. Inter-district transfers lead to districts competing for students. State funding follows the student from the residential district to the district of attendance. The exact amount transferred per student

across districts varies by state but it is usually exceeds the marginal cost of educating an additional student in the receiving district (Reback, 2008).

Out of 47,638,430 students enrolled in districts with more than one school, 688,530 (1.45%) were enrolled in a district other than their residential district in 2007-2008 (NCES).[8] State level participation varied from 0.5 percent to 18.8 percent.[9] The median was 4.7 percent. Arizona, Utah, and Washington do not keep track of students enrolled under inter-district open enrollment at the state level. Table 2.3 lists the number of student enrolled under inter-district in the states that enacted this type of legislation.

2.3.2 Intra-district

School quality in the USA does not only vary across the 14,000 school districts available but variation also exists across school zones within a school district. Burke [1999] examines within and between district disparities in teacher-pupil ratios for 1,204 large districts and finds that looking only at the district level distribution pattern of educational resources underestimates the level of variation that exist among students. Intra-district open enrollment laws allow choice of public schools within district boundaries. Similar to inter-district legislation, these laws can be mandatory or voluntary. Mandatory intra-district open enrollment laws require districts to accept student transfers. Voluntary open enrollment laws allow districts to choose whether to allow student transfers. Minnesota was also the first to pass mandatory intra-district open-enrollment policy in 1988. The number of states with mandatory intra-district policy is 13 as of 2013. An additional 15 states have voluntary intra-district open enrollment laws in place. We also note that in 2001, the No Child Left Behind Act (NCLB) required states to allow students the option of transferring to a higher-performing school willing to accept new students within the district if their home school failed to make Adequate Yearly Progress for two consecutive years. NCLB provides intra-district school choice to those attending a failing school.

Parents are responsible for transportation in most instances. Transportation provisions are important in all forms of school choice because they can restrict the set of options avail-

[8] In 2007-2008, the US had 16,330 public school districts. 5,210 districts only had one school within their boundaries.

[9] See "A Review of Open Enrollment States: Policies and Practices"(December 2009), prepared for the Missouri General Assembly by the Joint Committee on Education.

able to parents, thus, making school choice less effective. The availability of intra-district transfers leads to schools competing for students. Funding follows the student from the residential school to the school of attendance. District size and access to transportation can constrain students' choice. In county-wide school districts, intra-district open enrollment policies are going to be effectively less successful than in smaller school districts since the commute is longer (more costly in terms of time and money).

Intra-district transfer policies exist in many districts across the country regardless of district size, region, and population density [Phillips et al., 2009]. Other forms of choice (charters, magnets, and voucher programs) are typically located in large urban districts. Intra district choice is available through districts that explicitly participate in intra-district choice but also through desegregation plans, magnets, and sometimes transfer waivers. Magnets can be a form of intra-district choice or a form of inter-district choice depending on the magnet school's priority. A magnet's goal is to insure racial, ethnic, and economic diversity while offering a high quality curriculum.

Open enrollment policies will lead to a change in the composition of students in schools which will translate in a change of zoned school quality. This change in zoned school quality will be reflected in housing prices. Additionally, the link between school quality and residential choice will weaken since under mandatory open-enrollment a household is able to reside in a house zoned to a low-quality school but still access a higher quality school. The effect on housing prices will depend on the feasibility of transfers. If schools and districts do not resist transfers and if transportation costs are minimal or null, then the school quality premium should decrease for houses linked to higher quality schools and increase for houses linked to lower quality schools to reflect the change in households' preferences and the change in market demand for this house amenity.

2.4 Review of the Literature on School Choice Policies

Next, we survey the the literature on the effect of charter school and open enrollment policies on student sorting and academic academic performance. The student composition of charter schools will depend on both charter location and student selection into charters conditional on charter location. Glomm et al. [2005] studies charter school location in

Michigan. The paper finds that charters are located in diverse communities in terms of race and adult education. Bifulco and Buerger [2015] investigates charter school location in New York. The paper finds that charters locate in districts where per-pupil expenditures are high, teacher costs are low, and public school achievement is relatively low. Imberman [2011b] studies the effect of charters on student outcomes by instrumenting for charter location using measures of building availability. The first-stage regression results show the important role of building availability on charter school location. Using panel data for Washington, D.C. schools for the period from 2002 through 2003, Ferreyra and Kosenok [2015] estimates an equilibrium model of charter entry decisions and household choice among schools. The paper finds heterogeneity in household preferences, with African American and Hispanic households having higher preference for charters than whites, and with poor households favoring charters more than those with higher incomes. They also find high fixed costs to be a deterrent to entry in areas where charters would attract enrollment.

Epple et al. [2015] investigates the student composition of charter schools compared to traditional public schools. The paper finds that charters and public schools exhibit similar degrees of racial and ethnic segregation, but schools with a high degree of segregation (more than 80 percent of students are the same race) are more likely to be charters if predominantly nonwhite and are more likely to be traditional public schools if predominantly white.

Students utilizing open enrollment policies are different than charter school students. Students that enroll under inter-district policies choose a higher quality attendance district than their residential districts which is consistent with the goals of open enrollment policies. Reback [2008] finds that mean student test scores are strong predictors of transfer demand in Minnesota. Students transferred to districts with higher average test scores and socio-economic characteristics. The paper also finds that districts with higher average scores and socioeconomic characteristics are more likely to reject transfers. In a study by the Citizen's Commission on Civil Rights which received survey responses from 10 states and 53 districts in other states, the authors report that 5.6 percent of eligible students requested transfers out of failing schools during 2003-2004 but only 1.7 percent of eligible students actually transferred schools [Brown et al., 2004].

Lavery and Carlson [2015] investigates the characteristics of students enrolled under inter-district in Colorado from 2005-2006 to 2009-2010. The paper finds that low-income student do not take advantage of this policy. Socioeconomically disadvantaged students-

measured by free lunch eligibility-were significantly less likely to open enroll than their more affluent peers. Less advantaged students were also more likely to return to a school in their residential district after having transferred out.

Carlson et al. [2012] uses Colorado and Minnesota data on the number of inter-district transfers between pairs of districts within 100 miles from each other for the 2003-2004 school year. The paper finds that a larger numbers of students opt out of high-achieving districts than out of lower-achieving districts but they enroll into even higher achieving districts. Holme and Richards [2009] finds similar results using district level data from the Denver metropolitan area in 2006-2007. Higher income students were more likely to take advantage of inter-district open enrollment than their less affluent peers and those that transfer enroll in even higher income school districts. The evidence from the literature suggests that inter-district policy is mostly used by higher-income families. The lack of free transportation might explain these results as well as possible district filtering of students [Holme and Richards, 2009].

Phillips et al. [2012] examines which factors influence the propensity for parents to choose a school other than the one assigned to them when intra-district open enrollment is in place. The paper finds that advantaged and disadvantaged parents make similar choices in that they are both likely to choose more affluent schools with better academic records than the schools they are zoned to attend. However, these choices operate in different spheres, as advantaged parents choose the most affluent schools with the best academic records, and disadvantaged parents choose away from the least affluent schools with the worst academic records to schools that are slightly better.

School quality in the economic literature is measured either by inputs, for example per-pupil spending and number of student per teacher, or outputs, for example math scores, reading scores, and graduation rates. First, we examine the impact of charter policy on students' academic performance. Examining lottery-based studies, the evidence suggests that attending a charter has a positive effect on student achievement. When charters are oversubscribed, lotteries are used to randomly assign students to seats which allow researchers to compare two similar groups that only differ in which school they attend: zoned or charter. Hoxby and Rockoff [2004] finds that students enrolled in Chicago charter schools performed 5 to 6 percentile points better in reading and mathematics than their non-admitted cohorts. Hoxby et al. [2009] examines urban schools in New York City and finds

that upper elementary grade students (grades 4-8) in public charter schools outperformed similar grade students who did not attend a charter school. Abdulkadiroğlu et al. [2011] shows that charter schools lead to large and significant score gains in Boston middle and high schools. Abdulkadiroglu et al. [2015] estimates large achievement gains in Denver from charter school attendance using the quasi-experimental variation introduced by lotteries. One possible drawback with using lotteries to assess the effect of charters is that we cannot generalize the results to undersubscribed charter schools.

Much heterogeneity exists when dealing with charter schools. Hanushek et al. [2007] suggests that initially, charters had varying quality. However, charter exits and improvement of existing charter schools over time raised average charter school effectiveness. Imberman [2011a] distinguishes between the different types of charters and examines how charter schools affect student discipline, attendance, and test scores. The paper concludes that charters are effective at improving student discipline and attendance while students are enrolled but that the effects do not last after students return to non-charter schools.

Hoxby [2003] presents evidence using a difference-in-differences estimation strategy at the district level that charters in Michigan and Arizona improved student achievement in neighborhood schools. The paper classifies a district as "treated" and in the "after" period if it is losing at least 6 percent of students to charter schools. It shows that neighborhood schools experience an increase in achievement level and trend once charter competition commences.[10]

Some studies indicate that charter school participation is particularly effective for the achievement of students in lower grades [Hoxby and Rockoff, 2004]. However, charter schools' effect on academic performance remains a topic of discussion. Attending a charter school was associated with either an actual decline in achievement relative to public school students or at least a smaller gain than the students would have experienced in public schools [Bettinger, 2005; Bifulco and Ladd, 2006; Eberts and Hollenbeck, 2002; Sass, 2006]. Studies that differentiate their results by type and quality of charter schools suggest that high-quality or classroom-based charters significantly improved student performance, while low-quality or non-classroom-based schools were negatively related to student achievement [Buddin and Zimmer, 2005; Hanushek et al., 2002].

[10]The measure of achievement is a school's national percentile rank (NPR) score on a nationally normed standardized test (the Iowa Test of Basic Skills or the Stanford 9).

Just as the impact of charters on academic performance is not consistent across all charter schools, the effect of open-enrollment policies is not uniform across districts and school zones. Inter-district policies will have different effects depending on the geographical relationship between state and districts. Hawaii (10,432 km2) has one district with 179,000 students. Vermont (24,923 km2) on the other hand has 291 school districts, each serving an average of 327 students. Inter-district choice in Vermont would provide households with a lot of options. Welsch and Zimmer [2012] examines open enrollment between districts in Wisconsin, they find that districts that experience an outflow of students, produce higher standardized test scores in the subsequent year. The findings are evidence that schools improve quality once faced with competition.

Cullen et al. [2006] examines intra-district choice and does not find that attending a school other than the residential school improves any of the traditional academic measures. However, the paper reports that students do experience improvements on a set of nontraditional outcome measures such as self-reported disciplinary incidents and arrest rates. Phillips et al. [2012] finds that intra-district transfer in itself does not affect student achievement. However, when students use intra-district transfer options to choose away from low performing schools and choose higher performing schools, their achievement increases in both language arts and mathematics. Hastings and Weinstein [2008] finds that attending a higher-scoring school increases student test scores. Dee and Jacob [2011] reports that NCLB generated increases in the average math performance of fourth graders as well as improvements at the lower and top percentiles. The paper also finds evidence of improvements in eighth-grade math achievement, particularly among traditionally low-achieving groups and at the lower percentiles. However, NCLB does not seem to impact fourth-grade reading achievement.

2.5 Discussion

Charter school policies and open enrollment policies both share a common goal: increasing access to good quality schools for those that can not afford to pay to gain access. Open-enrollment policies positively impact academic performance. Students that transfer out of their zoned public schools transfer to higher performing schools. The effect of charters on

academic performance is less clear. Charter schools vary in quality. A good quality charter school will improve academic performance while a bad quality charter school can adversely impact academic performance.

Transportation costs in money and time effectively dictates which school a student attend. District size and access to transportation may prevent families from choosing the optimal school for their child. In large, county-wide school districts, attending a school other than the zoned school could require long commutes. Only students whose parents have the time and resources to accommodate long commutes can take advantage of the full spectrum of choice within such district, particularly if school choice is not accompanied by district-sponsored transportation [Bauch and Goldring, 1995; Hastings et al., 2005].

It is more feasible for higher income students to attend a school outside their residential zone. Transportation costs are a bigger hurdle for lower income students. Households from disadvantaged socio-economic backgrounds tend to attend charters because attending a charter does not have to be conditional on having access to transportation. Charters locate in lower income and lower school quality neighborhoods. While open enrollment has the potential of exacerbating student sorting problems by removing the best students from lower performing schools, a well performing charter has the potential of remedying student sorting problems by attracting top performers to areas with a big concentration of lower income students.

Many factors can affect parents' willingness to take advantage of school choice. Parents can use choice schools because they provide more convenience, for example closer to parents' workplaces, or because the choice allows their children to participate in better athletics program or extracurricular activities. Parents can also choose not to take advantage of school choice policies, either because their residential school is the most convenient or because the process to attend another school is too cumbersome. Lack of information may prevent parents from choosing the ideal school for their child. Lack of access to information may also occur as a result of parents' proficiency levels in English. Non-English speakers often do not have access to translated information about school quality or about the schools choice process. Lack of internet access in homes tends to disproportionately affect lower income households and minority families' ability to exercise choice [Mickelson and Southworth, 2005].

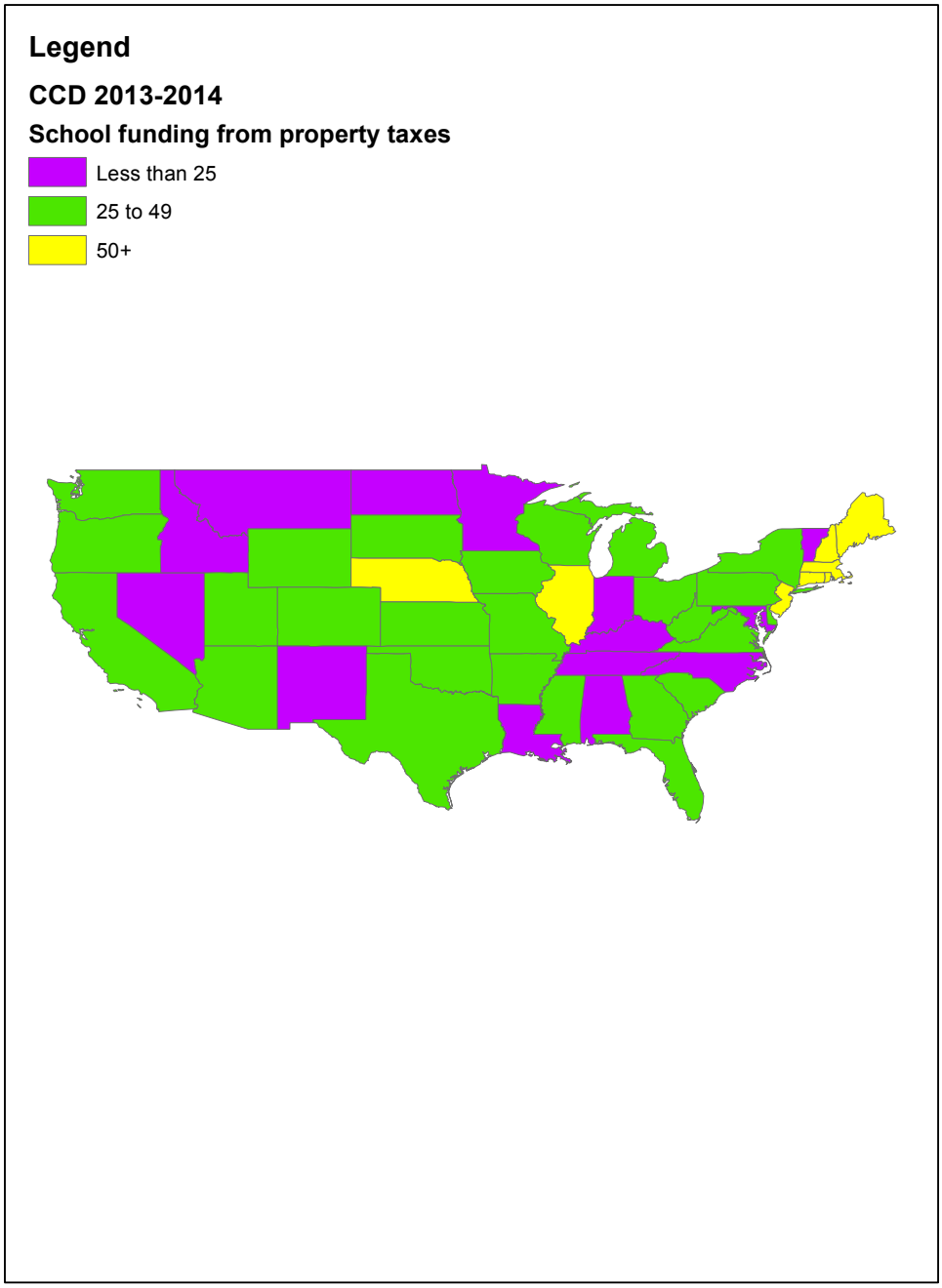


Figure 2.1 Share of school funding from property taxes by state

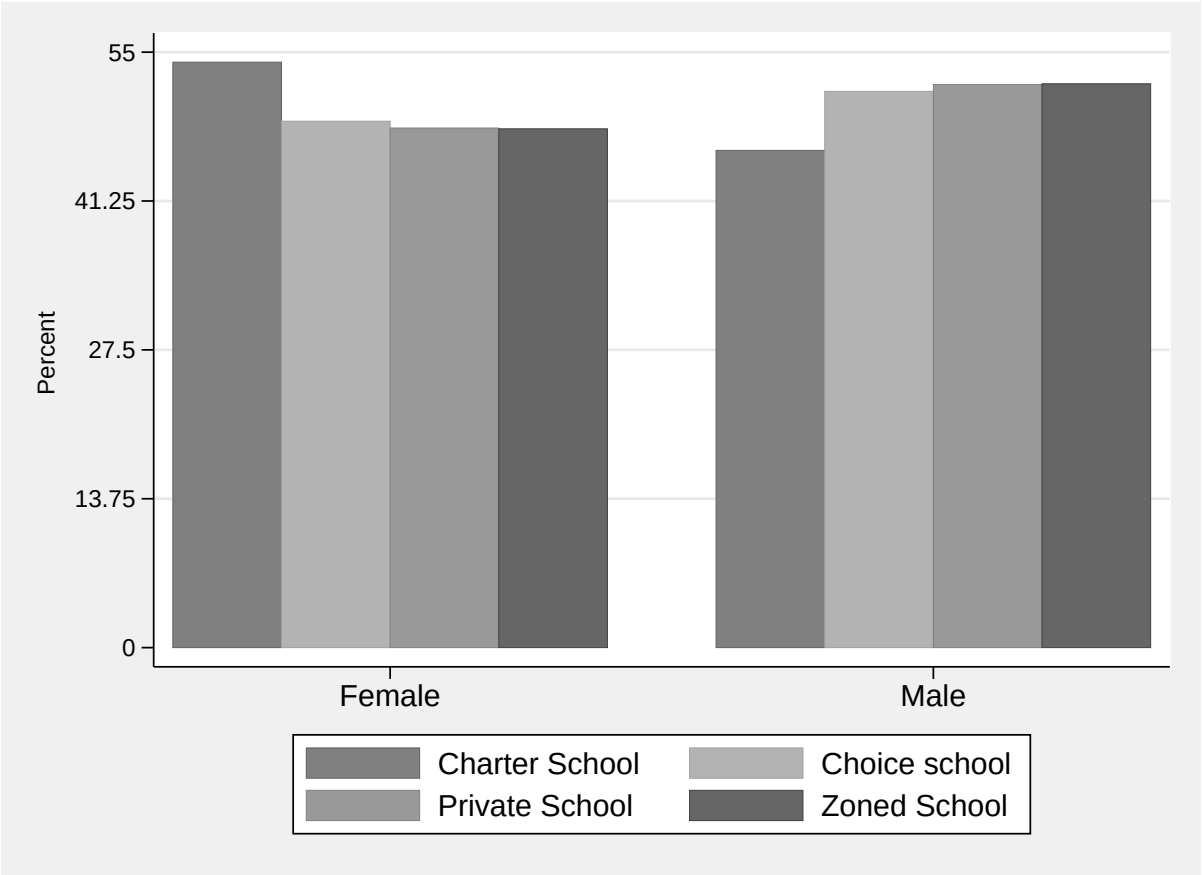


Figure 2.2 Student characteristics: gender

Notes: The figure shows the student population by gender and school type. The number of observations is 17,166 students that attend public and private schools. We remove students that are home schooled from the sample. The tabulations are weighted so the results are representative of the U.S. student population.

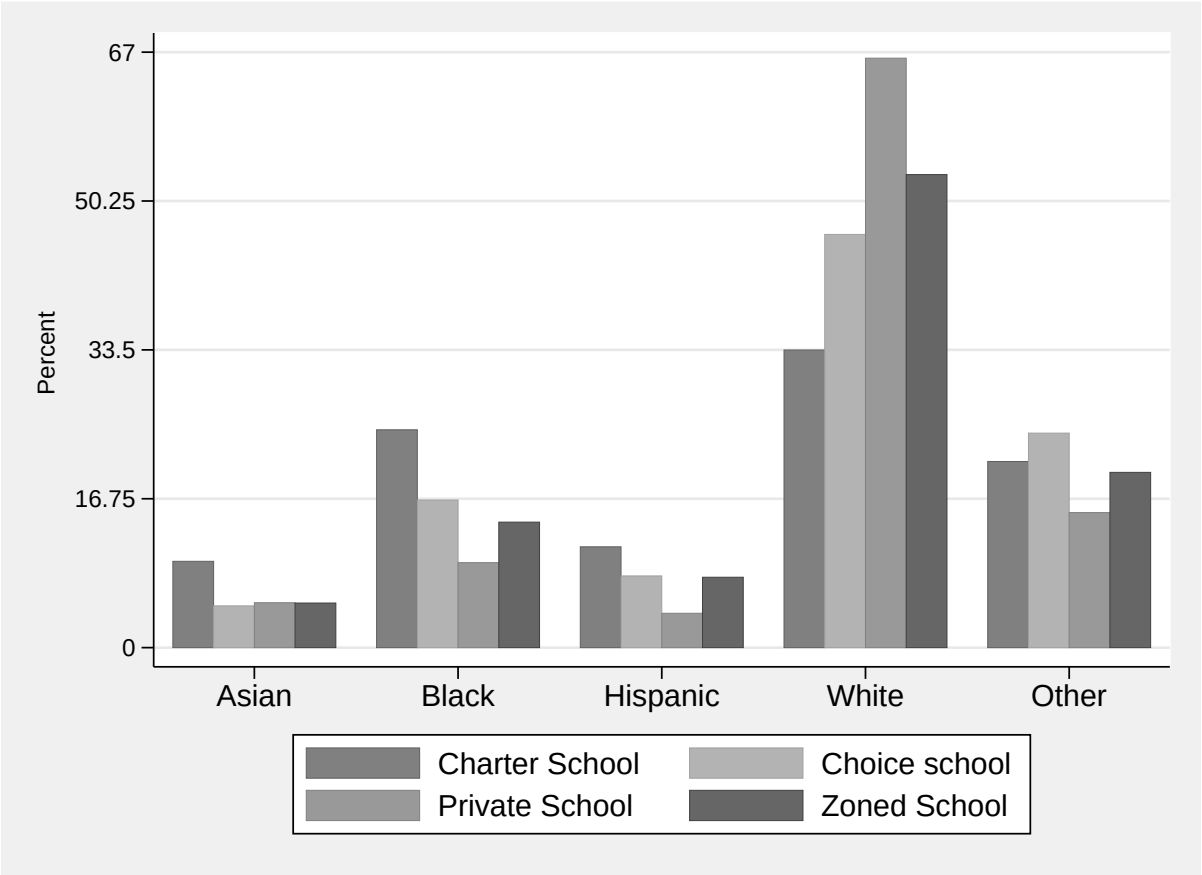


Figure 2.3 Student characteristics: race

Notes: The figure shows the student population by race and school type. The number of observations is 17,166 students that attend public and private schools. We remove students that are home schooled from the sample. The tabulations are weighted so the results are representative of the U.S. student population.

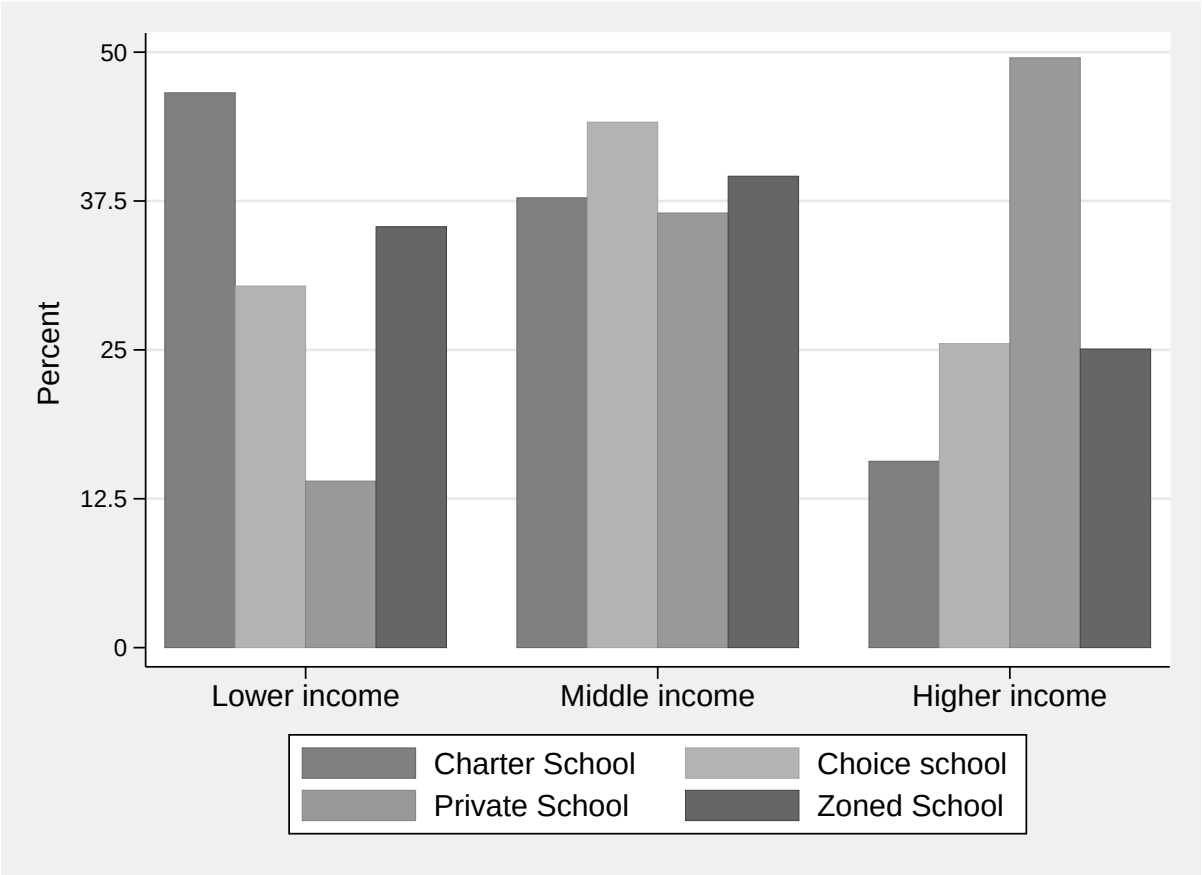
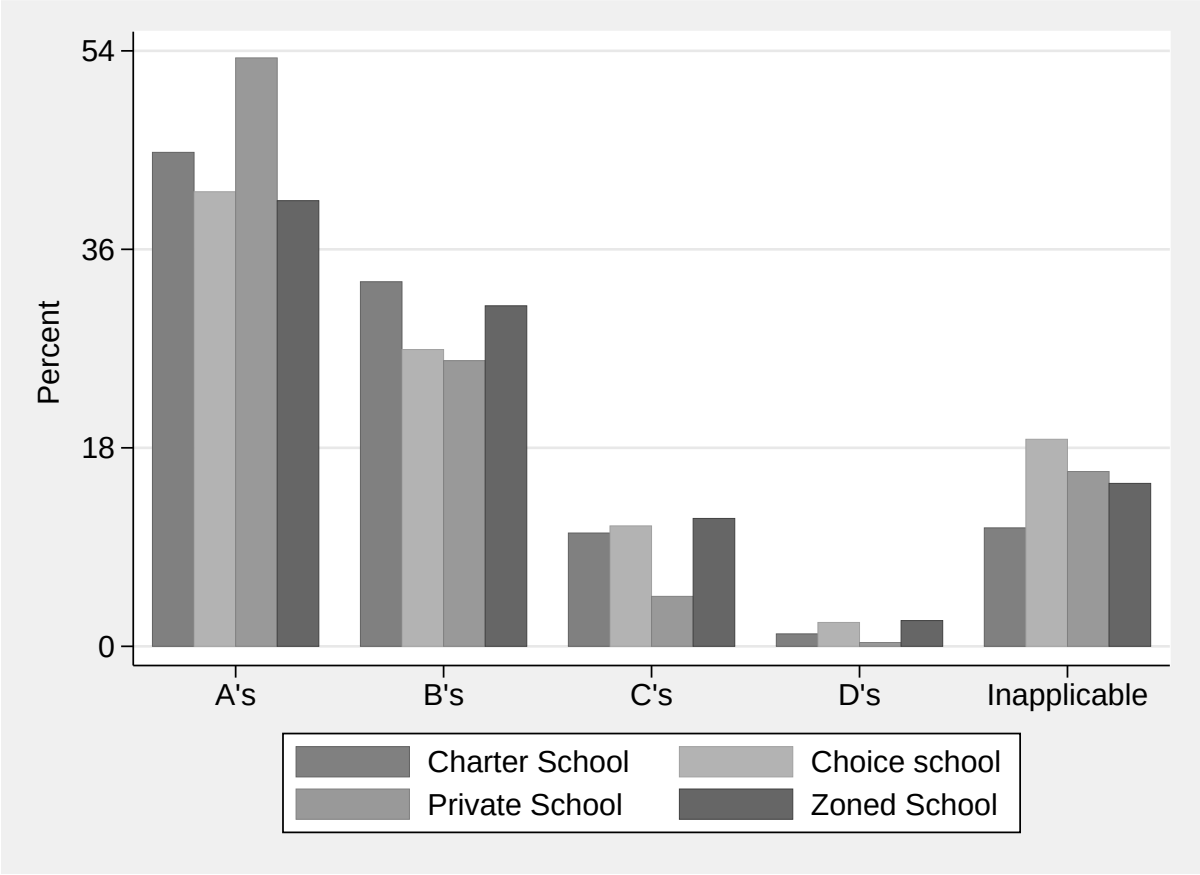


Figure 2.4 Student characteristics: income

Notes: The figure shows the student population by income level and school type. The number of observations is 17,166 students that attend public and private schools. We remove students that are home schooled from the sample. The tabulations are weighted so the results are representative of the U.S. student population.

Figure 2.5 Student characteristics: grades



Notes: The figure shows the student population by grades and school type. The number of observations is 17,166 students that attend public and private schools. We remove students that are home schooled from the sample. The tabulations are weighted so the results are representative of the U.S. student population.

Table 2.1 State level school choice policies

State	Mandatory Inter-district	Voluntary Inter-district	Mandatory Intra-district	Voluntary Intra-district	Charter Schools laws
Alabama	No	No	No	No	No
Alaska	No	No	2003	No	1995
Arizona	1994	No	1994	No	1994
Arkansas	1989	No	No	No	1995
California	No	1993	1993	No	1992
Colorado	1994	1990	1990	No	1993
Connecticut	1998	1997	No	1996	1996
Delaware	1996	No	1995	No	1995
Florida	No	2002	No	1997	1996
Georgia	2009	2000	2009	No	1993
Hawaii	No	No	No	No	1994
Idaho	No	1991	1993	No	1998
Illinois	No	No	No	1980	1996
Indiana	No	1976	No	1995	2001
Iowa	1989	No	No	No	2002
Kansas	No	1984	No	No	1994
Kentucky	No	No	No	No	No
Louisiana	No	2001	No	2006	1995
Maine	No	2000	No	2012	2011
Maryland	No	No	No	No	2003
Massachusetts	No	1992	No	No	1993
Michigan	No	1996	No	1992	1993
Minnesota	1988	1987	1988	No	1991
Mississippi	2001	No	No	No	2010
Missouri	No	1993	No	2003	1998
Montana	No	1993	No	No	No
Nebraska	1989	No	No	1976	No
Nevada	No	1967	No	No	1997
New Hampshire	No	1998	No	1998	1995
New Jersey	No	1999	No	No	1996
New Mexico	No	1978	1998	1979	1993
New York	No	1993	No	2003	1998
North Carolina	No	No	No	No	1996
North Dakota	No	1993	No	No	No
Ohio	No	1993	1993	No	1997
Oklahoma	1990	No	No	No	1999
Oregon	No	1991	2011	No	1999
Pennsylvania	No	1949	No	No	1997
Rhode Island	No	1956	No	No	1995
South Carolina	No	1976	No	No	1996
South Dakota	1997	No	1997	No	No
Tennessee	No	1992	No	1992	2002
Texas	No	1995	No	1995	1995
Utah	1993	No	1993	No	1998
Vermont	No	2000	No	No	No
Virginia	No	1993	No	1993	1998
Washington	1990	No	1990	No	2012
West Virginia	No	1985	No	No	No
Wisconsin	1997	1987	No	1975	1993
Wyoming	No	No	No	No	1995

Notes: Information on charter school policies comes NCES. Information on intra-district and inter-district programs is based on state legislation that describes each state's relevant policies (using LexisNexis).

Table 2.2 Charter schools legislation (A-L)

State	Year charter law passed	Operational autonomy	Authorizers	Number of schools allowed	Basis for charter school funding
Alabama	2015	Not limited	Local school boards Alabama Public Charter School Commission	10 charters/year for the first 5 years Unlimited conversion schools	Authorizer's per-pupil revenue
Alaska	1995	Very limited	Local school boards	No cap	Authorizer's per-pupil revenue
Arizona	1994	Yes	Local school boards State board of education Arizona state board for charter schools Public universities and community colleges	No cap	Single statewide formula
Arkansas	1995	Very limited	Local school boards a	Unlimited conversion schools Initial cap set at 24 Cap increases by 5 when number of charters is cap-2.	Single statewide formula b
California	1992	Slightly limited	Local school boards County boards of education State board of education	100 charters per year Unused quota rolls over to following year	Authorizer's per-pupil revenue
Colorado	1993	Slightly limited	Local school boards c Colorado charter school institute d	No cap	Authorizer's per-pupil revenue e
Connecticut	1996	Very limited	Local school boards State board of education	No cap f	State charters: Single statewide formula Local charters: Authorizer's per-pupil revenue
Delaware	1995	Limited	Local school boards State department of education	No cap g	Student's resident district per-pupil revenue
Florida	1996	Slightly limited	Local school boards	No cap	Authorizer's per-pupil revenue h
Georgia	1994	Limited	Local school boards State board of education Georgia charter school commission	No cap	Authorizer's per-pupil revenue
Hawaii	1994	Limited	State public charter school commission i	No cap	Single statewide formula
Idaho	1996	Slightly limited	Local school boards Public charter school commission Colleges j	No cap	Single statewide formula
Illinois	1996	Limited	Local school boards State charter school commission	120 charters allowed k	75%-125% of the authorizer's PCTC l
Indiana	2001	Not limited	Local school boards Indiana charter school board The mayor of Indianapolis Colleges and universities m	No cap	Authorizer's per-pupil revenue
Iowa	2002	Very limited	Local school boards	No cap	Up to district's discretion
Kansas	1994	No	Local school boards	No cap	Up to district's discretion
Kentucky	N/A	N/A	N/A	N/A	N/A
Louisiana	1995	Limited	Local school boards State board of education Local charter authorizers n	No cap	Authorizer's per-pupil revenue

Notes: This table includes information from the National Center for Education Statistics (NCES), the Center for Education Reform (CER), and the National Alliance for Public Charter Schools.

Table 2.2 Charter schools legislation (M-N)

State	Year charter law passed	Operational autonomy	Authorizers	Number of schools allowed	Basis for charter school funding
Maine	2011	Limited	Local school boards	No cap for local	Authorizer's per-pupil revenue
			Maine charters schools commission	10 schools in 10 years for the commission	
Maryland	2003	No	County school boards	No cap	Authorizer's per-pupil revenue
Massachusetts	1993	Limited	State board of education o	72 Commonwealth charters and 48 Horace Mann charters p	StudentâĂŹs resident district per-pupil revenue
Michigan	1993	Yes	Local school boards	No cap q	Single statewide formula
			Intermediate school boards		
			Community colleges and state public universities		
Minnesota	1991	Yes	Local school boards	No cap	Single statewide formula
			Intermediate school boards	7	
			Cooperatives		
			Public and private colleges and universities		
			Nonprofit organizations		
Mississippi	2010	Very limited	Mississippi charter school authorizer board r	15 charter schools per fiscal year	Authorizer's per-pupil revenue
Missouri	1998	Slightly limited	Local school boards	No cap t	Authorizer's per-pupil revenue
			Missouri charter public school commission		
			Statewide independent entity		
			Special administrative board		
			Colleges and universities s		
Montana	N/A	N/A	N/A	N/A	N/A
Nebraska	N/A	N/A	N/A	N/A	N/A
Nevada	1997	Limited	Local school boards	No cap	Authorizer's per-pupil revenue
			State public charter school authority		
			Any college or university within the Nevada system of higher education		
New Hampshire	1996	Very limited	Local school boards	10 charters per year	StudentâĂŹs resident district per-pupil revenue
			State board of education		
New Jersey	1995	Very limited	The state commissioner of education	No cap	StudentâĂŹs resident district per-pupil revenue
New Mexico	1993	Very limited	Local school boards	15 charters per year	AuthorizerâĂŹs per-pupil revenue
			State public education commission	Up to 75 in 5 years	
			Unused quota rolls over to following 5 years		
			Public school conversions are not allowed		
New York	1998	Slightly limited	Local school boards u	460 charters per year	Student's resident district per-pupil revenue
			SUNY board of trustees	No cap on conversion schools	
			The state board of education		
North Carolina	1996	Limited	North Carolina Charter Schools Advisory Board	No cap	StudentâĂŹs resident district per-pupil revenue v
North Dakota	N/A	N/A	N/A	N/A	N/A

Notes: This table includes information from the National Center for Education Statistics (NCES), the Center for Education Reform (CER), and the National Alliance for Public Charter Schools.

Table 2.2 Charter schools legislation (O-W)

State	Year charter law passed	Operational autonomy	Authorizers	Number of schools allowed	Basis for charter school funding
Ohio	1997	Limited	Local school boards	100 charters w	Single statewide formula
			The department of education u		
Oklahoma	1999	Limited	Local school boards	No cap x	Authorizer's per-pupil revenue
			Schools that are members of the Oklahoma state system of higher education		
			Federally recognized Indian tribe		
Oregon	1999	Limited	Local school boards	No cap	AuthorizerâĂŹs per-pupil revenue y
Pennsylvania	1997	Limited	Local school boards	No cap	AuthorizerâĂŹs per-pupil revenue
			Pennsylvania department of education		
Rhode Island	1995	Very limited	Local school boards z	35 charters	StudentâĂŹs resident district per-pupil revenue
South Carolina	1996	Slightly limited	Local school boards	No cap	Single statewide formula
			The South Carolina public charter school district		
			Public or private 2 or 4 year colleges and universities		
South Dakota	N/A	N/A	N/A	N/A	N/A
Tennessee	2002	Limited	Local school boards	No cap	AuthorizerâĂŹs per-pupil revenue
			The achievement school district aa		
Texas	1995	Limited	Local school boards	255 charters ab	Single statewide formula
			The state commissioner of education		
Utah	1998	Slightly limited	Local school boards	No cap	Single statewide formula
			Utah charter school board		
			Designated universities and technical schools		
Vermont	N/A	N/A	N/A	N/A	N/A
Virginia	1998	No	Local school boards	No cap	Up to districtâĂŹs discretion
Washington	2012	Limited	Local school boards	8 charters per year	StudentâĂŹs resident district per-pupil revenue
			The Washington charter school commission	40 during the first 5 years	
			Unused quota rolled over to the next year		
West Virginia	N/A	N/A	N/A	N/A	N/A
Wisconsin	1993	Limited	Local school boards	No cap	Up to districtâĂŹs discretion
			The city of Milwaukee ac		
			The university of Wisconsin-Milwaukee ac		
			Milwaukee area technical college ac		
			The university of Wisconsin-Parkside ad		
Wyoming	1995	Very limited	Local school boards	No cap	Up to districtâĂŹs discretion

Notes: This table includes information from the National Center for Education Statistics (NCES), the Center for Education Reform (CER), and the National Alliance for Public Charter Schools.

Table 2.3 Students enrolled under inter-district and charter policies

State	Total	Inter-district	Charter
Arizona	1,018,457	-	89,877
Colorado	766,018	42,278	41,476
Connecticut	558,749	13,165	2,927
Georgia	1,591,307	-	26,440
Minnesota	808,648	35,731	19,877
Oklahoma	643,830	23,373	4,081
Utah	497,873	-	11,118
Washington	991,469	-	N/A
Wisconsin	867,409	28,029	27,088

Notes: Total number of students enrolled and number of students enrolled in charters are from the 2005-2006 common core data. Oklahoma and Wisconsin data on student enrollment are from 2008-2009 school year. Enrollment data on inter-district for Colorado are from the 2007-2008 academic year. Enrollment data from Connecticut, Minnesota, Oklahoma, and Wisconsin are from the 2008-2009 academic year. -States do not track data Washington passed a charter schools law in 2004 but the legislation was contested multiple times and it did not go into effect till 2012. Source of inter-district enrollment data: `http://s3.amazonaws.com/zanran_storage/www.senate.mo.gov/ContentPages/48422419.pdf`

CHAPTER

3

DO CHARTER SCHOOLS DECREASE THE SCHOOL QUALITY HOUSE PRICE PREMIUM?

3.1 Introduction

School quality is not uniform across schools. Parents that want access to higher quality schools have to pay either private school tuition or a school quality premium when buying a house. A higher house price guarantees admittance to a higher quality zoned public school. Households that cannot afford private schools or a house in a high-quality school zone are often forced to attend relatively lower-performing schools. To address this type of inequality and to improve school quality for all students, starting in 1991, states implemented legislation that allowed charter schools to operate. Charter schools provide an alternative

to traditional public schools. They also have the potential to increase competition in the education market and improve school quality in traditional public schools for all students [Hoxby, 2003].

Charter schools can impact housing prices through multiple channels. The first channel, which we will refer to later as the de-linking hypothesis, revolves around households' valuation of zoned school quality. Once charter schools are operational, households' valuation of access to zoned schools might decrease. Charter schools would impact housing prices indirectly by weakening the link between zoned school quality and residential choice. Other channels allow charter schools a more direct impact on house prices. The school quality of charters themselves can be capitalized in housing prices. We later refer to this channel as the amenity/disamenity hypothesis. The impact of charter schools on housing prices will depend on the charter school quality. Additionally, in areas with good quality charter schools where the charters provide priority to students residing within the same school zone or district as the charter, we might observe a stronger capitalization of charter school quality in housing prices within that area. In fact, there is evidence that access to charter schools is positively capitalized in housing prices in metropolitan Atlanta. Prices increased by six to eight percent for priority one zone homes (where households have a higher probability of admissions) compared to priority two zone homes after the opening of a new charter school [Andreyeva and Patrick, 2017].

The last channel, which we will refer to later as the information hypothesis, relies on the availability of information for home buyers. Households interested in buying a house usually have access to information on house characteristics (number of bedrooms, number of bathrooms, etc.) and school zones to which the house belongs. However the real estate market is not completely transparent, for example, there is no information provided on crime statistics or details about schools. [1] The information exists but it is not easily available. Given the search costs associated with finding out additional information about a neighborhood and charter schools' tendency to locate in urban areas with high concentrations of minority and low-income students [Epple et al., 2015], it is possible that homebuyers interpret the location of a charter as a signal to avoid a given neighborhood. The presence of charter schools could depress demand in that neighborhood. Households

[1] Certain details about a neighborhood or community can violate the Fair Housing Act, which was enacted in 1968 to eliminate housing discrimination.

tend to prefer to self-segregate on the basis of sociodemographic measures [Baum-Snow and Lutz, 2011; Bayer et al., 2007].

By examining the effect of charters on housing prices using data from 43 metropolitan areas, we add to the literature examining the impact of school choice on residential location. Economic literature studying the effect of different forms of school choice on residential location theorized that choice weakens the link between neighborhood school quality and housing prices [Epple and Romano, 2003; Ferreyra, 2007; Nechyba, 2000]. While empirical papers on the effect of vouchers and open enrollment have confirmed those predictions [Brunner et al., 2001; Brunner et al., 2012; Machin and Salvanes, 2016; Reback, 2005], less is known about the effect of charter schools on housing prices. The results from Los Angeles County suggest that neither the increase in the number of charter schools nor the expansion in charter enrollment relative to public school enrollment is capitalized into housing prices. However, an additional charter school operating in a school district and within 2 miles of a house reduces house prices by 1.9 percent when only considering charters located within the household's school district boundaries and excluding Los Angeles Unified School District [Brehm et al., 2017].[2] On the other hand in Metropolitan Atlanta, there is evidence that access to charter schools is positively capitalized in housing prices. Prices increased by six to eight percent for priority one zone homes (where households have a higher probability of admissions) compared to priority two zone homes after the opening of a new charter school [Andreyeva and Patrick, 2017].

In this chapter, we take advantage of the variation in when charter laws were implemented across states between 1985 and 2005. We estimate that charter schools decrease housing prices gradually over time. Once charter legislation has been in place for at least one year, the estimate from our preferred specification shows a 17 percent decrease in housing prices. There are at least two alternative explanations for these results: (i) the link between neighborhood school quality and residential choice has become weaker over time (de-linking hypothesis) or (ii) charter schools are negatively capitalized in housing prices (amenity/disamenity hypothesis or information hypothesis). The first explanation reflects

[2]Brehm et al. [2017] restricts the analysis to charters within the household's school boundaries because students who reside within the charter's authorizing school district (which is almost always the district they are located in) have admissions priority, thus generating a link between these charters and local district boundaries.

that households value public school quality less since charters act as cheaper substitutes to zoned public schools. The second explanation implies that charters decrease demand for houses in neighborhoods where they locate. Charters either adversely impact academic performance or are perceived as a negative signal that a neighborhood should be avoided. We present results that are consistent with the delinking hypothesis.

The results are robust to using different functional forms (log-level, level-level, and Box-Cox) as well as to using a repeated sales sample and to restricting the data to a shorter time period. When we examine the effect of charter schools on the distribution of housing prices, we find that the effect starts positive, gradually decreases, and then becomes negative as housing prices increase. Housing prices increase below the 20th percentile and decrease starting at the 30th percentile. The pattern observed using quantile regressions suggests that a delinking between public school quality and housing prices occurs once charters start operating.

We report a large effect of charter legislation on housing prices. Examining the literature to benchmark our results, we find that the effect of different school policies on housing prices is non-negligible. Following redistricting in a wealthy suburb of Cleveland to make schools more racially balanced, house prices decreased by 9 percent on average [Bogart and Cromwell, 2000]. Education finance reform in California increased housing prices by 8 percent in poorest school districts [Dee, 2000]. Once schools were graded according to their performance on standardized tests as part of a school accountability system reform, houses linked to schools receiving an "A" grade in Florida were associated with a 10 percent increase in housing prices [Figlio and Lucas, 2004]. Place-based "Promise" scholarship programs are capitalized in housing prices on the order of 4 to 6 percent and housing price effects are larger in neighborhoods with high quality schools and in the upper half of the house price distribution [LeGower and Walsh, 2014].

Focusing on papers examining the effect of school choice policies on housing prices, we find that after inter-district open enrollment was implemented, a percentage point increase in outgoing students was associated with a 1.5 percent increase in housing prices and a 1 percentage point increase in incoming students was associated with a 1.1 percent decrease in housing prices [Reback, 2005]. Once complete intra-district high school choice was in place in Oslo, the premium associated with living within the attendance zone of a high-quality school declined by approximately 50 percent [Machin and Salvanes, 2016].

While our most conservative estimate and quantile regression results fall within the range of effects estimated in the literature, some of our results are very large in magnitude. This might be due to the nature of our dataset and its limitations. Charters are more likely to locate in metropolitan areas and these areas are the source of our sample. In fact, 30 metropolitan areas (of which 25 are included in our dataset) account for 63 percent of total charter enrollment. Seven of those metropolitan areas (and in our dataset), each have more than 3 percent of national charter enrollment with Los Angeles leading with 6.5 percent of total U.S. charter enrollment [Epple et al., 2015]. Our sample of houses are from 43 metropolitan areas, 25 of which have really high charter enrollment. The nature of our sample possibly explains the large effects we estimate. In addition, we assume that all 43 metropolitan areas constitute one housing market. The hedonic model is based on a single housing market and there is a bias-variance trade-off in defining a housing market [Parmeter and Pope, 2009]. Our use of a large housing market might bias the results but it is not feasible for us to conduct the analysis with a smaller definition of a housing market since the AHS does not include detailed geographic information on houses.

Only seven states have not passed charter legislation so far. The number of students choosing charters over their zoned school keeps growing, and the number of charter schools keeps increasing. Figure 3.1 tracks charter schools from 1999 to 2014. Charter schools increased from 1.7 percent of all public schools in 1999 to 6.9 percent in 2014. Figure 3.2 illustrates charter student enrollment as a percent of total public school enrollment. Charter enrollment increased from 0.7 percent in 1999 to 5.4 percent in 2014. Given the prevalence of this policy, it is important to assess its effects. Looking at the housing market allows us to examine the valuation of charters by households. It also makes it possible to examine the valuation of charters by different groups through documenting the variation in capitalization effects across the housing price distribution. Households' valuation of charters can provide evidence on the effectiveness of charter school policy and shed light on any unintended effects.

3.2 Background on charter policies

The US has a decentralized schooling system unlike countries such as Japan or France where the central government controls education. A decentralized schooling system means that school boards are responsible for setting attendance zones. Students are assigned to a school based on their residential location, in other words the attendance zone in which they reside. A combination of geographic and historical conditions as well as a pursuit of property values created this zone-based school assignment system [Fischel, 2009]. [3] A consequence of zone-based assignment is that households that want to choose a school for their children to attend have two options. They can either pay private school tuition or "purchase" higher school quality by paying a higher price for a house, all else being equal. Black and Machin [2011] surveys the extensive literature on the capitalization of school quality in housing prices. The paper finds that a one standard deviation increase in student test scores increases house prices by 1 to 4 percent, ceteris paribus.

A variety of legislation starting in the 1970's offered parents and students more control over which school they attend.[4] Charter school policies allow charter schools to operate. Charters are public schools with public funding. However, they differ in the level of flexibility they are allowed by school districts regarding curricula and staffing decisions. States implemented charter school laws in different years, starting in the 1990s.

Initially, charters were championed by Albert Shanker, the president of the American Federation of Teachers, as means for teachers to create their own experimental schools under the district's supervision [Shanker, 1988]. Some policymakers rallied around the idea to apply a market-based approach to education. Increasing competition among schools would improve school quality [Lubienski and Weitzel, 2010]. Schools in a competitive market setting with multiple suppliers (schools) must provide high-quality education to attract and keep students. Other policymakers saw in charters an opportunity to provide access

[3] Fischel [2009] discusses how concern about property values drove the establishment of schools and school districts. The Land Act of 1785, which provided for the measurement and sale of land in the US also included a provision that a square mile of land in each township was to be set aside as an endowment for schools for residents of the township. The government's incentive to establish schools was to maximize the value of its land holdings. Schools made the land attractive to settlers and subsequent purchasers.

[4] Similar to the US, the following countries have been adopting school choice: England, Chile, South Africa, the Czech Republic, China, Australia, New Zealand, and Sweden (Plank and Sykes 2003).

to good quality schooling to all students regardless of their socio-economic background. Most urban charter schools are routinely oversubscribed [Hoxby et al., 2009]. The length of the average waiting list increased from 233 in 2009 to 277 in 2012 [Rebarber and Zgainer, 2014].[5] Oversubscription and the increase in the number of wait listed students imply there is strong demand for charter schools from students and parents.

Charter schools are public schools operating under a charter: a contract between the school and its authorizing agency. The span of the contract can be between one year and 15 years. The charter outlines specific educational outcomes (such as graduation rates and test scores benchmark) as goals for the charter school to achieve. In return, the charter school benefits from operational autonomy regarding setting the curriculum as well as staffing and budget decisions. Although charter schools are privately managed, they are still publicly funded.[6] Authorizing agencies are responsible for approving charter applications, negotiating contracts, and determining whether to renew a charter. The charter school closes at the end of the charter term if it fails at achieving its goals. [7] Additionally, for a charter school to remain open, there must be enough community demand.

Authorizers are mainly school districts. Higher education institutions, state boards of education, nonprofit organizations, independent charter boards, and municipal governments can also authorize charters depending on the state laws in place. Table 3.1 shows the different years in which the states implemented charter legislation. States do not only differ on which year they adopted charter school policy but also on which provisions of the law they adopted.

Theoretical papers [Epple and Romano, 2003; Ferreyra, 2007; Nechyba, 2000] examining the effect of school choice on residential sorting and housing prices predict that the capitalization of school quality in housing prices declines as school options available to parents increase. Nechyba [2000] uses a model to simulate the effect of introducing private school vouchers into a neighborhood school system. Ferreyra [2007] builds on the work of Nechyba [2000] by estimating a structural general equilibrium model of household sorting and simulates the effect of introducing universal school vouchers into the Chicago

[5] If the number of applicants to a charter exceeds the number of available seats, students are waitlisted.

[6] Authorizing agencies monitor charter schools through site visits to schools, financial audits, and academic reports (on enrollment, academic achievement, and student admission).

[7] A charter can be revoked before the charter end term if the authorizing agency identifies problems in the operation of a charter school and the charter does not remedy the identified problems.

metropolitan area. Epple and Romano [2003] develops a general equilibrium model to analyze the effects of district wide open-enrollment on housing values and community composition. These papers predict that the introduction of school choice would decrease housing prices in areas previously linked to high quality schooling. The papers also predict that housing prices would increase in areas previously linked to low quality schools. A household under a schooling system that allows choice can reside in an area linked to low quality schools thus paying less in housing prices. However, the household would still have access to higher quality level schools by either attending a school in a different zone or district (under inter-district and intra-district open enrollment policies), attending a private school (under voucher programs), or attending a charter school. Access to school choice would not guarantee equalization of school quality premium. Students would still be able to sort on characteristics. School priorities and constraints, for example transportation costs, can hinder school quality from equalizing across schools.

Most empirical studies on the effect of choice on housing prices focused on voucher programs, inter-district, and intra-district legislation. Fewer studies have examined the effect of charters on housing prices. Brehm et al. [2017] finds little evidence that charter schools affect housing prices on average using data from 76 districts in California from 2008 to 2011. However, the paper shows when restricting to districts other than Los Angeles Unified and counting only charter schools located in the same school district as the household, housing prices fall by 2 percent for each additional charter within two miles. The paper finds no evidence of differential impact by school quality. Brehm et al. [2017] interprets the negative effect of charters on housing prices as reflecting the weakening of the link between the availability of local schooling as a public good and housing prices. This chapter adds to the empirical literature investigating the effects of charter schools on housing prices by providing a national-level analysis incorporating policy changes in 19 states over 21 years. [8] We present results consistent with the literature's prediction on school choice weakening the link between zoned school quality and residential choice.

[8]The sample includes transaction prices for 25 states but we only observe policy changes for 19 states between 1989 and 2005.

3.3 Data and methods

3.3.1 Data

To estimate the effect of charter school policies on housing prices, we use data from the metropolitan American Housing Survey (AHS).[9] Since its establishment in 1973, the AHS has been composed of a national sample and metropolitan area samples. The national and metropolitan area samples generally received the same questionnaire. The national sample, which is currently conducted every two years, is designed to be representative of the national housing stock, while each individual metropolitan sample is designed to be representative of a metropolitan area's housing stock. The AHS metropolitan areas usually, but not always, coincide with the Office of Management and Budget (OMB) definitions of the Metropolitan Statistical Area (MSA).

The sample used in this paper includes residential unit sales from 43 metropolitan areas within 25 states from 1985 to 2005. Charters are more likely to locate in metropolitan areas and these areas are the source of our sample. In fact, 30 metropolitan areas (of which 25 are included in our dataset) account for 63 percent of total charter enrollment. Seven of those metropolitan areas (and in our dataset), each have more than 3 percent of national charter enrollment with Los Angeles leading with 6.5 percent of total U.S. charter enrollment [Epple et al., 2015]. Our sample of houses are from 43 metropolitan areas, 25 of which have really high charter enrollment. Our estimates using this metropolitan sample with high charter enrollment can be interpreted as an upper boundary of the effect of charters on housing prices.

The data includes the price at time of transaction (self-reported), the year the transaction occurred, house characteristics, and household characteristics. Using the Housing

[9]The American Housing Survey (AHS) is a housing unit survey produced by the Census Bureau for the U.S. Department of Housing and Urban Development. Data are from the metropolitan sample surveys that were fielded every year from 1985 to 1996 and the surveys in 1998, 2002, 2004, 2007, 2009 and 2011. The metropolitan areas surveyed change from wave to wave. The Metropolitan Survey cycles through a set of metropolitan areas, surveying each one about once every six years. Although we restrict our sample to houses bought before 2006, 11.3 percent of our sample is from the 2007,2009, and 2011 AHS waves. The AHS uses dependent interviewing; some answers do not change (e.g. price of house at date of transaction if a resale did not take place). We only keep information on housing units from the interview closest to the transaction date if no resale occurred.

Consumer Price Index from the Bureau of Labor Statistics, we express house prices in 2005 dollars throughout the chapter. To construct the data set, we pool the 1985-2011 AHS waves to obtain a sample of housing units.[10] We limit the analysis to units purchased before 2006 to avoid any bias from the housing market crash that started in the second quarter of 2006 and the recession that started in December 2007. The housing bubble peaked early 2006 and then housing prices started to decline that same year. Housing prices, before 2006, were on an upward trend with almost no interruptions. Figure 3.3 shows the yearly average National Case-Schiller home price index from 1975 to 2015. The Case-Schiller index measures change in the prices of single-family, detached residences using repeat sales method. The index compares the sales prices of the same properties over time. Looking at Figure 3.3, we observe that the only dip in housing prices was in the early 1990's when the index went from 76.94 in 1990 to 75.93 in 1991, but it quickly resumed increasing by the next year. That is a minor decrease compared to the decrease that occurred starting 2006. Once the index decreased from 183.49 in 2006 to 179.96 in 2007, the index kept decreasing till 2011 when the index reached 139.24. When estimating the effect of charters on housing prices, we include year fixed effects and state-specific (linear and quadratic) time trends to account for the upward trend in housing prices over the time period examined.

Next, we limit the maximum period length between transaction date and interview date to 10 years to avoid recall bias.[11] We also remove the lowest one percent of housing prices in our sample or prices below 21,000 dollars.[12] These prices are likely misreported or representing non-arms-length transactions, in other words transfer between relatives. While we do not have access to detailed geographic identifiers, we know in what county is a house located. We combine the dataset on housing prices with information on time-invariant county characteristics. Information on county land area, percent water area, and amenity scale are from the county characteristics study by the Inter-University Consortium for Political and Social Research. [13] The sample is 43,449 houses of which 84.63 percent are

[10]Table A.1 in appendix A lists the different steps to produce the data set used in this chapter

[11] Column (2) and column (3) in table A.2 in appendix A checks the sensitivity of the results to this decision. The results are robust to using a 5 year window and a 15 year window between transaction date and interview date.

[12] Column (4) and column (5) in table A.2 in appendix A checks the sensitivity of the results to this decision. The results are robust to including the lowest 1 percent of housing prices and to excluding the lowest and highest 1 percent of housing prices.

[13]The natural amenities scale is a measure of the physical characteristics of a county that enhance the

houses that only appear once while the rest are houses for which we observe more than one transaction. We supplement the data with information on charter school legislation through the National Center for Education Statistics and the National Alliance for Public Charter Schools. Table 3.2 presents the sample's descriptive statistics. The average house costs 208,708 dollars (in 2005 dollars) with three bedrooms, two baths and a unit size of 2,100 square feet. Most houses have a garage (87 percent), central air conditioner (63 percent), and a fireplace (60 percent).

Figure 3.3 illustrates the share of student enrollment in charters across states for the 2004-2005 school year. States in purple (15) states have no students enrolled in charters. Green states (15) have up to 1 percent of students in charters. Yellow states (4) have up to 2 percent of students in charters. Red states (7) and Hawaii have up to 3 percent of students in charters. Blue states (7) and Alaska have more than 3 percent of students in charters. States with an x in the middle are included in the analysis in this chapter.

3.3.2 Methods

Using a standard hedonic model, we can relate housing prices to housing and location characteristics (Rosen, 1974). The hedonic model is a way to decompose the equilibrium price of a product to get implicit prices of the attributes of that product. It is used to estimate prices or willingness to pay that is not measured in a straightforward way (e.g., valuation of clean air, a nice view, or a good school). The hedonic method relies on revealed preferences.[14] The basic hedonic price model we estimate to investigate the effect of charter school legislation on housing prices can be expressed as follows:

$$log(P_{hcst}) = \alpha + \beta_1 Charter_{st} + \beta_2 H_h + \beta_3 C_c + Year_t + State_s + \epsilon_{hcst}$$

Where P_{hcst} is the property price for house h in county c in state s at time t, H_h includes property characteristics, and C_c includes county characteristics. The charter variable is

location as a place to live. The measure combines six measures of climate, topography, and water area that reflect environmental qualities most people prefer. The measures are warm winter, winter sun, temperate summer, low summer humidity, topographic variation, and water area. We drop observation for two Colorado counties for which no amenity scale is available.

[14] An alternative way to get an estimate of the willingness to pay for any latent characteristics would be to rely on stated preferences.

an indicator variable equal to one if the charter has been in place for at least one year.[15] House characteristics (X_h) included in the regressions are lot size, unit size, house age, house age squared, number of baths, number of bedrooms, number of half baths, having a fireplace, having a garage, having a basement, having central air conditioner, and having a heating unit that uses gas as fuel. County characteristics (C_c) included in the regressions are land area, percent water area, and amenity scale. We weight the data by the inverse probability of selection provided by the AHS to insure that our estimates are consistent [Solon et al., 2015]. [16] When surveys sample different segments of a population at different probabilities, weighting allows us to reconfigure the sample as if it was a random draw of the total population which would yield accurate estimates for the parameters of interest.

The data include variation across states and variation within state across time. The sample includes housing transactions from 25 states over a 21-year period. The identification strategy relies on the exogenous variation from within-state changes in the policy over time. To apply a fixed effects estimation strategy, in addition to controls for house and county characteristics, we include state fixed effects, year fixed effects, and a state-specific linear or quadratic time trend. State fixed effects control for time invariant differences across states in housing prices. By including state fixed effects, we control for the average difference across states in any observable or unobservable characteristic. The remaining variation is the within state across time variation that is needed to identify the effect of charter school policy on housing prices. Housing prices are on an upward trend, therefore, we include time fixed effects to control for time-varying unobservables that affect housing prices identically across states (e.g., common economic fluctuations). The model also includes state-specific time trends (linear and quadratic). The state specific time trends allow us to control for differential population growth across states or demographic trends that are smooth over time. Finally, ϵ_{hst} is a random error term. The standard errors from the regressions are clustered at the state level to control for within-state cluster correlation [Bertrand et al., 2002].

The identification strategy assumes that unobservable factors that might simultaneously

[15] Table A.3 in appendix A checks the sensitivity of the results to this definition of the charter variable. The table includes a variable equal to one once charter policy is enacted and a variable equal to one once charter policy has been in place for at least 2 years.

[16] The universe of interest for the AHS metropolitan sample is the residential housing units in the given metropolitan areas that exist at the time the survey is conducted.

affect housing prices and charter implementation are time-invariant. A variety of other factors can affect housing prices, for example, crime rates or employment opportunities. But, as long as these factors are not systematically related to the year the laws passed, they will be absorbed by the state and year control variables.[17] Thus, the policy coefficient should reflect the causal effect of the charter school legislation on housing prices. Only seven states have not yet adopted any charter school laws. Therefore, we do not think states are self-selecting into treatment. The more plausible case is that all states will eventually adopt charter school legislation.

3.4 Results and sensitivity analysis

3.4.1 Results

We present a baseline set of results for house price transactions during the 1989-2005 period in table 3.3. In column (1), we regress the log of housing price on a charter variable equal to one when charter legislation has been in place for over a year. The regression also includes year and state fixed effects as well as house and county characteristics. House characteristics included in the regressions are lot size, unit size, house age, house age squared, number of baths, number of bedrooms, number of half baths, having a fireplace, having a garage, having a basement, having central air conditioner, and having a heating unit that uses gas as fuel. County characteristics included in the regressions are land area, percent water area, and amenity scale. The regression in column (1) is not weighted by the inverse probability of selection provided by the AHS. In column (2), we present the results from a weighted regression of log of housing prices on charter and the rest of the covariates. When weighted and unweighted estimates contradict each other, this may be a red flag that the specification is not a good enough approximation to the true form of the conditional mean [Solon et al., 2015]. Reassuringly, table 3 shows that unweighted and weighted regressions present consistently negative and significant effects of charter school laws on housing prices. The unweighted regression has less precise estimates which supports our decision to use the weighted regression to estimate the effects of charter school laws on housing prices in the

[17] In the next section, we test the robustness of the results to including unemployment rate, a variable that varies by state across time.

rest of the analysis.

In column (3), we include a state specific linear time trend, while column (4) includes a state-specific quadratic time trend. The state-specific trends account for economic, social, and demographic unobservables that vary with time but differently by state. Our preferred specification is column (4), the most saturated specification, which suggests that charter school policies decreased housing prices by approximately 17 percent, on average, once charter school policy has been in place for over a year.

The full set of estimated coefficients from the regression presented in table 3.3, column (4) are included in table A.2, column (1) in appendix A. Coefficients for house and county characteristics are in the expected direction and comparable magnitude to those found in the literature. Sirmans et al. [2006] provides a meta regression analysis of the nine housing characteristics that are present most often in hedonic pricing models. We compare the coefficients from this analysis to theirs. One additional bedroom increases housing prices by approximately 4 percent in this paper. The average coefficient in the literature is 3.8 percent. The coefficient on bathroom is positive and large (0.207) compared to the average effects in the literature (0.089) but that is common using AHS data as Sirmans et al. [2006] notes. A 1,000 square feet increase in the size of a house increases housing prices by approximately13.4 percent compared to 34 percent, the average effect in the literature. 1,000 square feet increase in lot size increases housing prices by approximately 0.04 percent compared to 3 percent on average in the literature. Having a garage increases housing price by approximately 16 percent compared to 11 percent in the literature. Having a fireplace increases housing prices by approximately 20 percent compared to 9 percent on average in the literature. Air conditioning has no effect in this analysis but has an average effect of 8 percent in the literature.

Table 3, column (5) and column (6) present the effect of charters on housing prices using the repeated sales sample. Column (5) includes state and year fixed effects as well as housing and county characteristics while Column (6) controls for house fixed effects and year fixed effects. The repeated sales sample includes houses that sold more than once between 1989 and 2005. Using this sample, we can control for house fixed effects which account for all unobservable house specific characteristics such as view or neighborhood. Using the repeated sales sample and including house fixed effects, we observe an approximately 8 percent decrease in housing prices after the charter policy has been in place for at least

one year.

In the last two columns, we aggregate housing prices to the state level, which is the level of the policy change. Column (7) presents results from a regression of state level house prices, so that each state is given equal weight. Finally, Column (8) shows the results from a weighted regression of state level house prices where the weights are derived by summing the AHS house weights in each state by year. The coefficient in Column (7) is consistent with the results in the other columns. Housing prices decrease by approximately 12 percent a year after charter policy is adopted. In Column (8), the results suggest that charter policies decrease housing prices by approximately 8 percent. For the rest of the analysis, we use the specification presented in table 3, colum (4) that includes year and state fixed effects as well as a state-specific quadratic time trend.

3.4.2 Hedonic functional form and stability of preferences over time

Using the hedonic method, we must deal carefully with omitted variable bias and the choice of a functional form. We use a log-level specification to present the results in this chapter. Simpler functional forms perform better in the presence of omitted variables [Kuminoff et al., 2010; Parmeter and Pope, 2009]. We test the robustness of the results to other functional forms and present the findings in table 3.4. In column (1), we present the results from the preferred specification, the log-level specification with controls for state fixed effects, year fixed effects, and a state specific quadratic time trend as well as house and county characteristics. Column (2) and column (3) present the results from a linear regression and a Box-Cox regression respectively. The mean housing price is 208,708 dollars. The log regression suggests the effect of charters was a decrease in housing prices of about 36,000 dollars once charter policy has been in place for over a year. The level regression shows a negative effect of about 52,000 dollars and the Box-Cox regression shows a negative effect of 28,000 dollars once the policy has been in place for over a year.

Column (5) presents the results from only the treated sample. When we restrict the sample to only treated states, the effect remains negative, significant and consistent with the previous results. The hedonic model assumes stable preferences across house characteristics over time. So far, we examined the effect across a 21-year time period. It is possible that preferences over house characteristics changed over that time period. In Column (6),

we restrict the time period examined to 1985-1997. We observe that the effect of the policies on housing prices is consistent when restricting to a 13-year period.[18] In Column (7), we include unemployment rate in the regression, a variable that varies at the state level with time, the results remain robust to including this covariate which gives us confidence that no economic shock occurred at the same time as the policy implementation which would bias the results. The hedonic model also assumes a single housing market. In this chapter, we assume a national metropolitan housing market. The estimated effect of charter schools on housing prices reflects the preferences of a metropolitan population rather than the subpopulation that lives in one city or local market.

3.5 Dynamic effect and heterogeneity

First we examine the dynamic effect of charter legislation on housing prices. Figure 3.2 illustrates the results from a non-parametric specification of the effect of charters on housing prices. We use the same specification as before, but instead of one indicator for the policy being in place, we use a series of indicator variables representing time relative to implementation of the laws. The regression includes two leads and three lags following Autor [2003]. The leads check for any anticipatory effects prior to the implementation of the policy. The lags estimate the dynamic effects of charter policy. Figure 3.5 shows that the leads are not statistically significant and are close to zero. Therefore, there is no evidence for anticipatory effects. The lags illustrate that the effect of charter school laws on housing prices is not immediate. This result is not surprising. Entities interested in operating a charter will need time to put together an application and it takes authorizing agencies 6 to 12 months on average to approve an application.[19] The effect of charter schools on housing prices is gradual, negative, and increases in magnitude with time.

Next in this section we examine the heterogeneity in the effect of charter policy on

[18] We do not have enough variation in the timing of the policy implementation to run a regression using the sample from 1998 to 2005. Three out of the Six states that adopt charter policy in that time frame adopt in 1998.

[19] Tennessee Department of Education(TDOE), for example, lists an application review timeline that starts with an applicant sending the local board or TDOE a letter of intent on February 1^{st}, 2017 . The earliest authorizers rule on an application is June 30th, 2017 and the latest is November 11^{th}, 2017. Louisiana Department of Education list June 1^{st}, 2017 as a deadline for local school board to make decisions on applications submitted by February, 24^{th}, 2017.

housing prices by house and household characteristics. Column (1) in table 3.5 reports the result form the preferred specification. Column (2) interact charter with number of bedrooms. Number of bedrooms is positively capitalized in housing prices. A house with a higher number of bedrooms is associated with a bigger negative effect of charter policy on housing prices. Column (3) interact charter with unit size. Unit size is positively capitalized in housing prices. A bigger house in term of unit size is associated with a bigger negative effect of charter policy on housing prices, although the coefficient on the interaction term is not statistically significant. Column (4) interact charter policy with amenity scale. Amenity scale is a measure of quality linked to the location of a house. It is a measure of the physical characteristics of a county that enhance the location as a place to live. The measure combines six measures of climate, topography, and water area that reflect environmental qualities most people prefer. [20] Amenity scale is positively capitalized in housing prices. A house located in a better county is associated with a negative bigger effect of charter policy on housing prices. In the AHS, we can identify if a house is located in a suburb or inside a primary or secondary metropolitan city. Charters are more likely to locate inside a city than in a suburb, 52.7 percent of all charters were located in a city in 2005-2006 compared to 24.5 percent of charters located in suburbs. Column (5) reports that locating in the suburb is positively capitalized in housing prices. A house located in a suburb is associated with a bigger negative effect of charter policy on housing prices, although the coefficient on the interaction term is not statistically significant.

In the rest of the columns, we examine the effect of charter policy on housing prices by household characteristics. Column (6) interact charter with married. Married households are associated with a higher house price. A house bought by a married household is associated with a bigger negative effect of charter policy on housing prices, although the coefficient on the interaction term is not statistically significant. Column (7) interact charter with non-white. Non-white households are associated with a lower house price. A house bought by a non-white household is associated with a bigger negative effect of charter policy on housing prices, although the coefficient on the interaction term is not statistically significant. Column (8) interact charter with older household. Buyers 60 or older at time of purchase are associated with a lower house purchase price. The interaction

[20] The measures are warm winter, winter sun, temperate summer, low summer humidity, topographic variation, and water area.

term between charter and older household is not statistically significant.

In the following section we present different hypotheses for the distributional pattern of housing prices that we might observe once charter legislation is in place for a year and then we examine the results from quantile regressions to determine which hypothesis holds ex-post. First, the information hypothesis postulates that charters would only negatively impact the left tail of the housing price distribution. Charter schools are more likely to locate in areas with low-performing school zones [Bifulco and Buerger, 2015; Epple et al., 2015]. Houses in low-performing schools zones are less expensive and in the lower part of the housing price distribution [Black and Machin, 2011]. Consequently, if the introduction of charter schools into a neighborhood is perceived as a clearer signal for households to avoid that neighborhood, we would only expect a negative effect of charter policy in the lower part of the housing price distribution.

Second, the de-linking hypothesis states that charters would positively impact the left tail of the housing price distribution and negatively impact the right tail of the housing price distribution. If charter schools are behaving as the literature on school choice predicts [Epple and Romano, 2003; Ferreyra, 2007; Nechyba, 2000], school choice would decrease housing prices in areas previously linked to high quality schools and increase housing prices in areas previously linked to low quality schools. Households under school choice can pay less for a house without being restricted to attend the zoned lower quality school. We would expect a positive effect of charter policy on housing prices in the bottom part of the distribution and a negative effect of charter policy in the upper part of the distribution.

Last, the amenity/disamenity hypothesis postulates that charters would only impact the left tail of the housing price distribution. If charter schools are impacting housing prices through the capitalization of charter school quality in those prices then charter policy would have a positive impact in areas where charters are positively impacting academic performance and a negative impact in areas where charters are adversely affecting academic performance. Given the heterogeneity that exists in charter schools' performance, it is not straightforward to predict the sign of the impact on housing prices but we expect the impact to be restricted to the bottom of the housing price distribution.

Figure 3.6 illustrates the effect of charter policy across the housing price distribution using quantile regressions. A standard linear regression minimizes the squared standard errors and summarizes the relationship between a set of regressors and the outcome variable

based on the conditional mean function. Quantile regression minimizes the absolute standard errors and presents the relationship between the regressors and outcome at different points of the conditional distribution of housing prices. We estimate quantile regressions using the generalized quantile regression method proposed by Powell [2016] that allows for the presence of covariates without including the covariates in the structural quantile function. The treatment variable, charter legislation in place for at least a year, is included in the structure quantile function but the control variables are only used to aid identification. If the control variables are included in the structural quantile function, the interpretation of the parameter of interest is altered and it can no longer be interpreted as the impact of a change in the treatment variable on the distribution of the outcome variable.[21]

Figure 3.6 illustrates how the effect of charter legislation varies across quantiles.The effect of charter legislation on housing prices is gradually decreasing across the housing price distribution. The effect is positive below the 20^{th} percentile and negative above the 30^{th} percentile. The pattern shown in figure 3.6 is consistent with the de-linking hypothesis. Figure 3.7 illustrate how the effect of charter legislation varies across quantiles using level quantile regressions. The pattern is consistent with the results from quantile regressions of log of housing price. The effect of charter legislation on the housing price distribution is consistent with the literature's predictions [Epple and Romano, 2003; Ferreyra, 2007; Nechyba, 2000]. We observe a positive effect of charter policy on housing prices in the bottom part of the distribution and a negative effect of charter policy in the upper part of the distribution.

Figure 3.8 graphs the housing price distribution before and after implementation of charter legislation. We run a regression of housing price on house characteristics, state fixed effects, year fixed effects and a quadratic state specific time trend and then plot the component plus residual. We use observations from states for which we have observations before and after charter legislation. Using this graph, we can not confirm that the housing price distribution narrows after charter legislation. These results suggest that charter

[21]Traditional conditional quantile models [Chernozhukov and Hansen, 2006; Koenker and Bassett Jr, 1978] assume that the relationship between the treatment variables and the outcome varies based only on unobserved factors and, consequently, the interpretation of the parameters changes as some of these factors become observed (covariates are added to the quantile function). The Powell [2016] Generalized Quantile Regression model assumes that the treatment effects vary based on a nonseparable term which is a function of both observed and unobserved factors.

legislation causes a location shift to the housing price distribution. Figure 3.9 presents the same graph plotted with the residual from the level regression. The figure shows a shift to the left in the distribution of housing prices.[22] The shift in figure 3.8 is equivalent to the 18 percent mean shift estimated using the log regression in column 4 of table 3.4 and the shift in figure 3.9 is equivalent to a 52,560 dollars mean shift.

Next, we investigate the changes in the distribution of housing prices following charter legislation by years and states using the residuals from the level regression on covariates and fixed effects. Figure 3.10 presents the distribution of housing prices for 1992-1993, 1994-1995, 1996-1997, and 1998-1999. The shift in the housing price distribution to the left is most evident in 1992-1993 and 1994-1995. The first two states to have charter legislation in place are the adopters in 1992-1993. In 1994-1995, a significant number of states, four states, became adopters of charter legislation.

Figure 3.11 present the change in distribution of housing prices by state. Most states follow the average pattern observed. Some states (Pennsylvania, New York, and Virginia) that adopted charter legislation later in our sample do not follow the same pattern. Focusing on New York as an example, our sample includes 2,234 observation from New York state of which 1,153 come from Buffalo, 163 from New York City, and 918 from Rochester. Only observations from Buffalo are available in our sample before and after charter legislation in New York State.

Currently, Buffalo has 17 operating charters. Although charter school legislation passed in New York state in 1999, the oldest charter in Buffalo, Charter School of Inquiry, opened in Fall 2002. The second charter to open, West Buffalo Charter school, began operating in 2005, the last year of our sample. While it is definitely possible for charter schools to be positively capitalized in housing prices, in this specific instance, we can not confidently claim that charters were positively capitalized in housing prices in Buffalo, NY due to the small number of post treatment periods that we observe.

[22] Figure A.1 presents the median. 10th percentile, and 90th percentile of the residual of the weighted and unweighted regression of housing prices on the covariates from our preferred specification. The pattern observed in both the unweighted and weighted panel suggest a decrease in housing prices following charter legislation.

3.6 Conclusion

This chapter estimates the effect of charter school legislation on housing prices. Using information on house transactions from the metropolitan American Housing Survey, we report that charter schools decrease housing prices by 17 percent. We explore two possible explanations for why housing prices decrease following the introduction of charters: either the link between neighborhood school quality and residential choice become weaker over time (de-linking hypothesis) or the capitalization of charters in housing prices reflects that households perceive charters as a disamenity or a negative signal (amenity/disamenity hypothesis and information hypothesis).

Charter school policy is part of an educational reform movement that aims to provide access to good quality schooling for students regardless of their socioeconomic background, increase competition among schools, and give parents a choice over where their children attend schools [Lubienski and Weitzel, 2010]. In the 2013-2014 school year, 2.5 million students attended charters compared to 0.8 million in the 2003-2004 school year.[23] As this trend continues, examining the impact charter school policy has on academic performance, the public-school system, residential sorting, and school segregation is essential. Studies examining charter schools have so far mainly focused on academic performance [Abdulkadiroğlu et al., 2011; Abdulkadiroglu et al., 2015; Hoxby et al., 2009]. In this chapter, we examine the effect of charter schools on housing prices to determine if charter school policy managed to weaken the link between public school and housing prices as it hoped to do or if it had unintended consequence by creating a willingness to pay among households to avoid charters. We provide results consistent with the decrease in housing prices reflecting a decrease in the school quality housing price premium.

[23] `http://nces.ed.gov/programs/coe/indicator_cgb.asp`

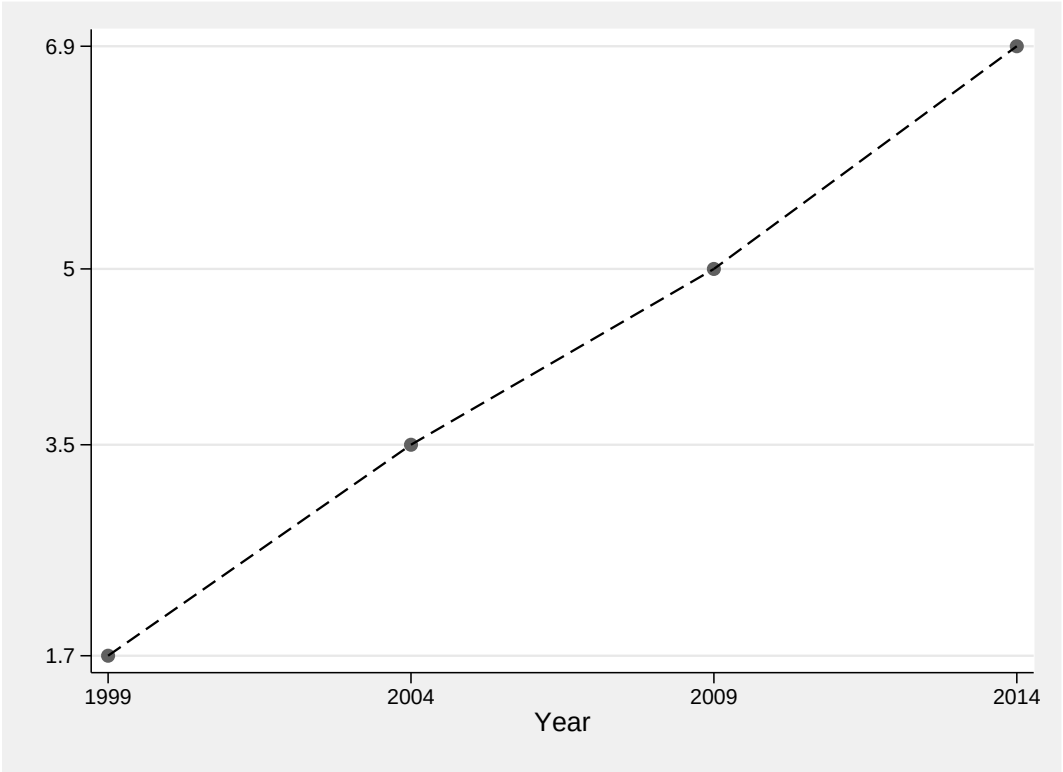


Figure 3.1 Charter schools as a percent of total public schools

Notes: The graph illustrates the number of operating charter schools over time as a percent of total operating public schools. Source of the data is the National Center for Education Statistics.

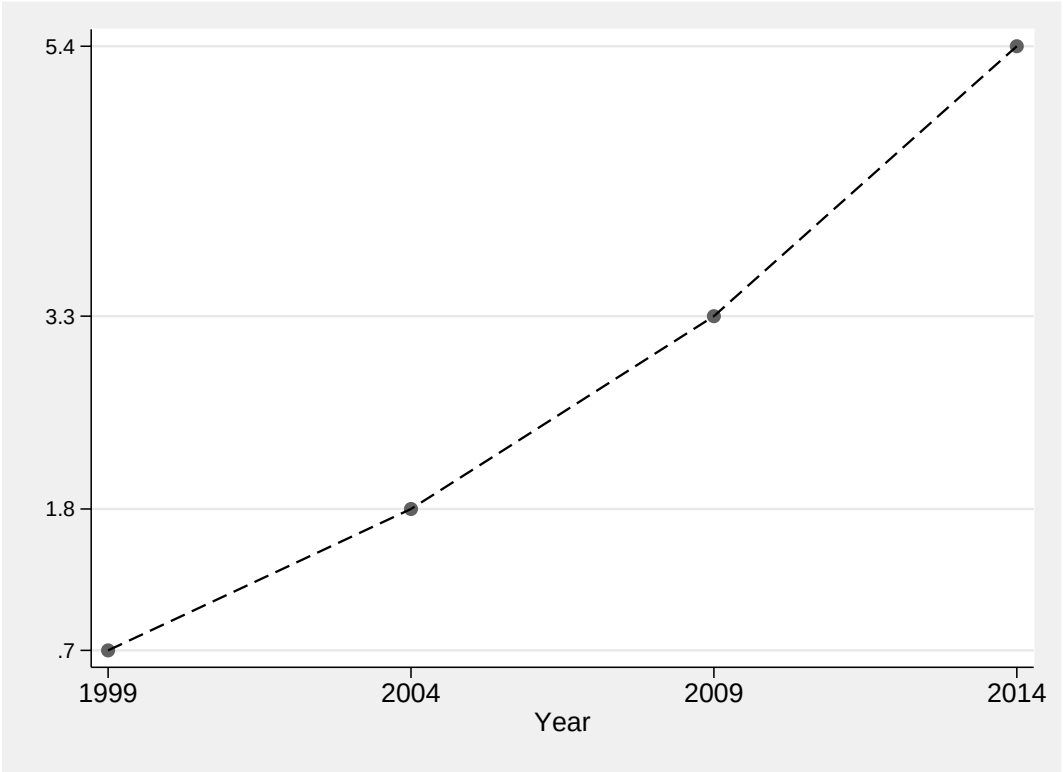


Figure 3.2 Charter enrollment as a percent of total enrollment

Notes: The graph illustrates charter enrollment as a percent of total student enrollment in public schools over time. Source of the data is the National Center for Education Statistics.

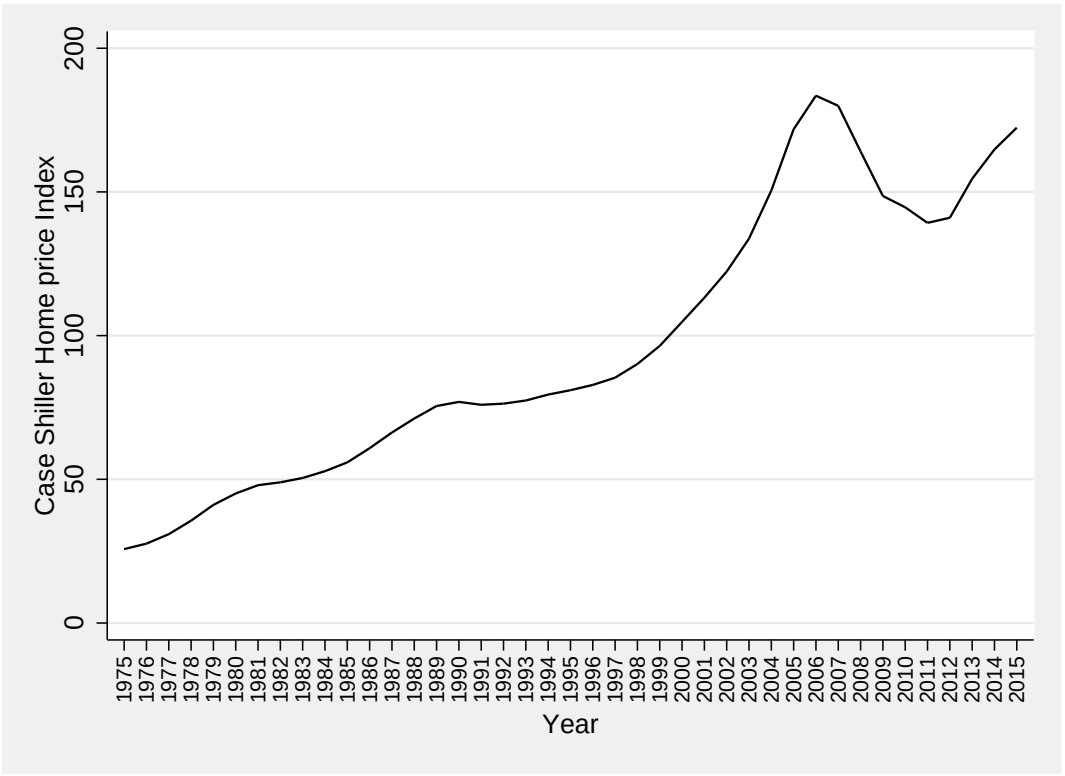


Figure 3.3 The CaseShiller Home price index 1975-2015

Notes: The graph shows the U.S. National Case-Schiller home price index from 1975 to 2015. The vertical reference line shows the cutoff for our sample in this paper. The index measures changes in the prices of single-family, detached residences using repeat sales method. Therefore, the index compares the sales prices of the same properties over time. Source: S&P Dow Jones Indices LLC, S&P/Case-Shiller U.S. National Home Price Index [CSUSHPINSA], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/CSUSHPINSA, July 18, 2016.

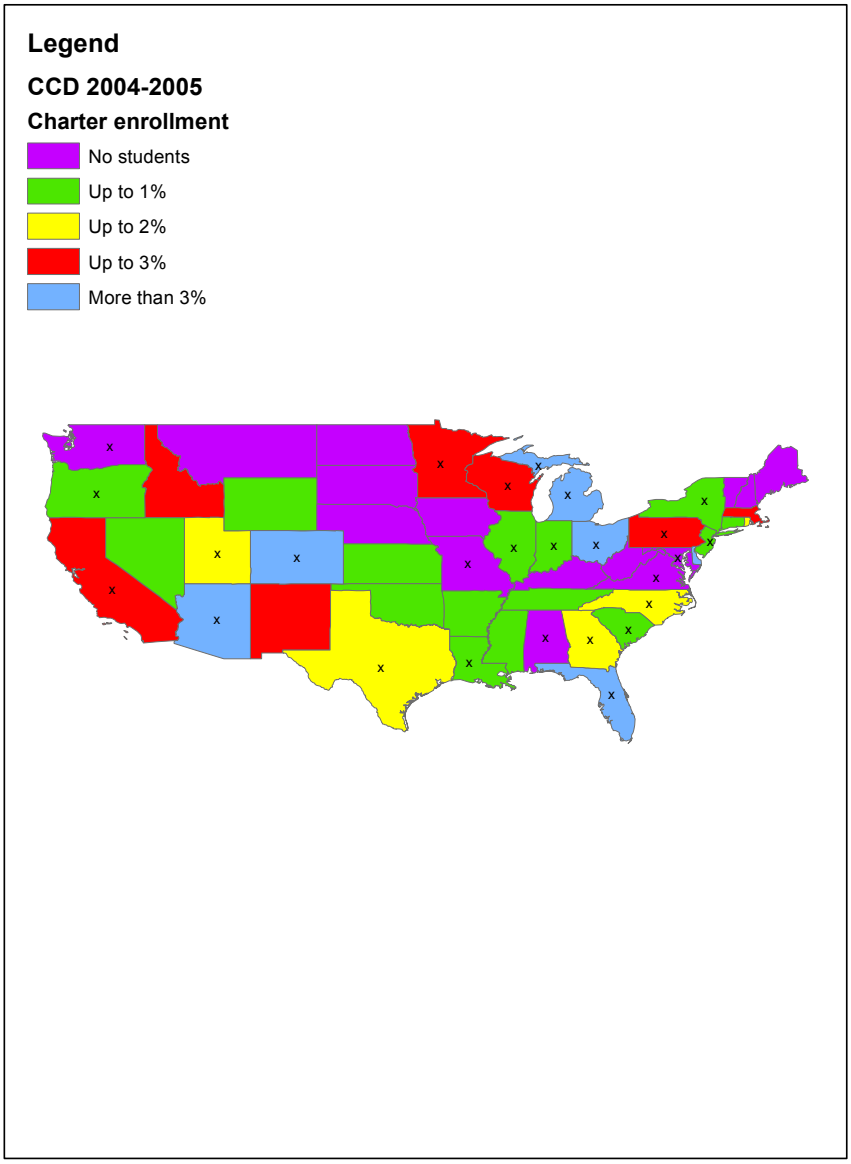


Figure 3.4 Charter enrollment by state 2004-2005

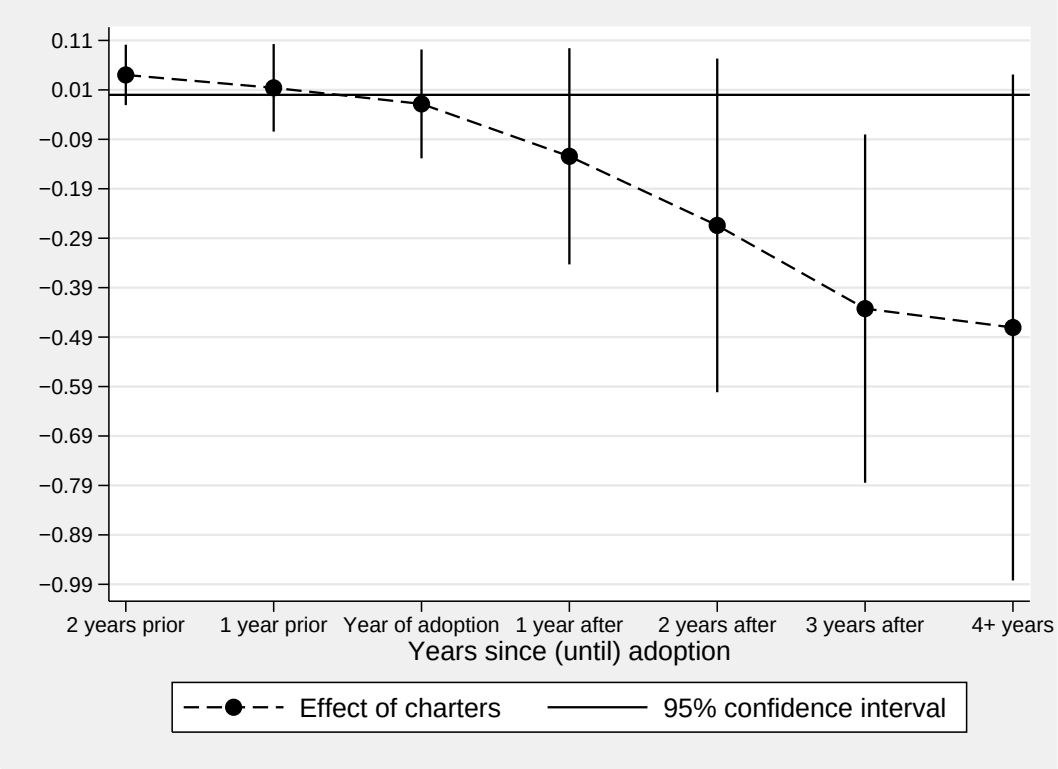


Figure 3.5 Dynamic effect of charter school policy on housing prices

Notes: The graph shows the dynamic effect of charter school laws on housing prices. The circles represent coefficients from a weighted regression of log of housing prices on dummy variables that represent how long the laws have been in place. The omitted category is non-adopters and adopters 3 or more years before adoption. The leads are not statistically significant and close to zero which shows no evidence for anticipatory effects. The lags show that the negative effect of charter school policy on housing prices is gradual and increases in magnitude with time. The regression includes year fixed effects, state fixed effects, state specific quadratic time trend, and house and county characteristics. The vertical bands represent ± 1.96 times the standard error of each point estimate. The standard errors are clustered at the state level. States included in this graph are those shaded in gray in Table 1.

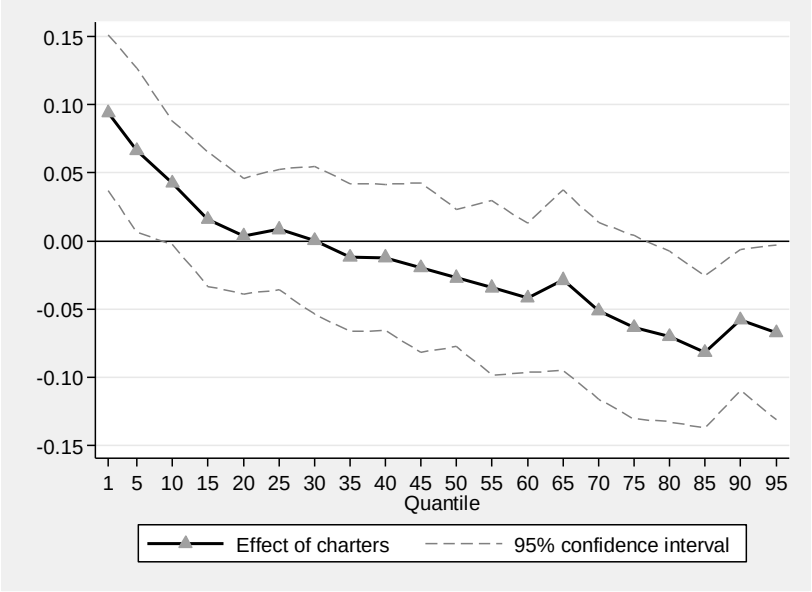


Figure 3.6 Effect of charter school policy on the housing price distribution (log)

Notes: The graph shows the effect of charter school laws on the distribution of housing prices. The triangles represent coefficients from quantile regressions of log of housing prices on a dummy variable that represent charter law in place for over one year. The regression includes year fixed effects, state fixed effects, state specific quadratic time trend, and house and county characteristics. The vertical bands represent ± 1.96 times the standard error of each point estimate. The vertical line is for reference at zero. States included in this graph are those shaded in gray in Table 1.

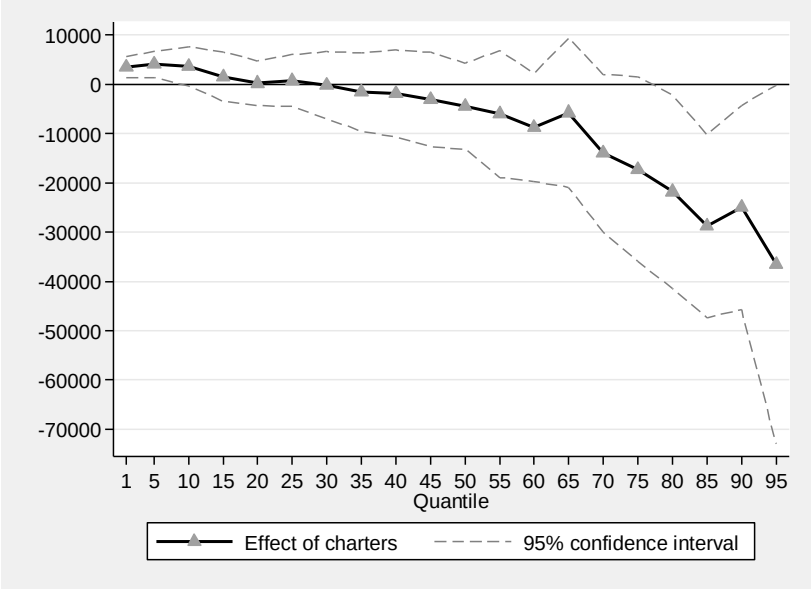


Figure 3.7 Effect of charter school policy on the housing price distribution

Notes: The graph shows the effect of charter school laws on the distribution of housing prices. The triangles represent coefficients from quantile regressions of housing prices on a dummy variable that represent charter law in place for over one year. The regression includes year fixed effects, state fixed effects, state specific quadratic time trend, and house and county characteristics. The vertical bands represent ± 1.96 times the standard error of each point estimate. The vertical line is for reference at zero. States included in this graph are those shaded in gray in Table 1.

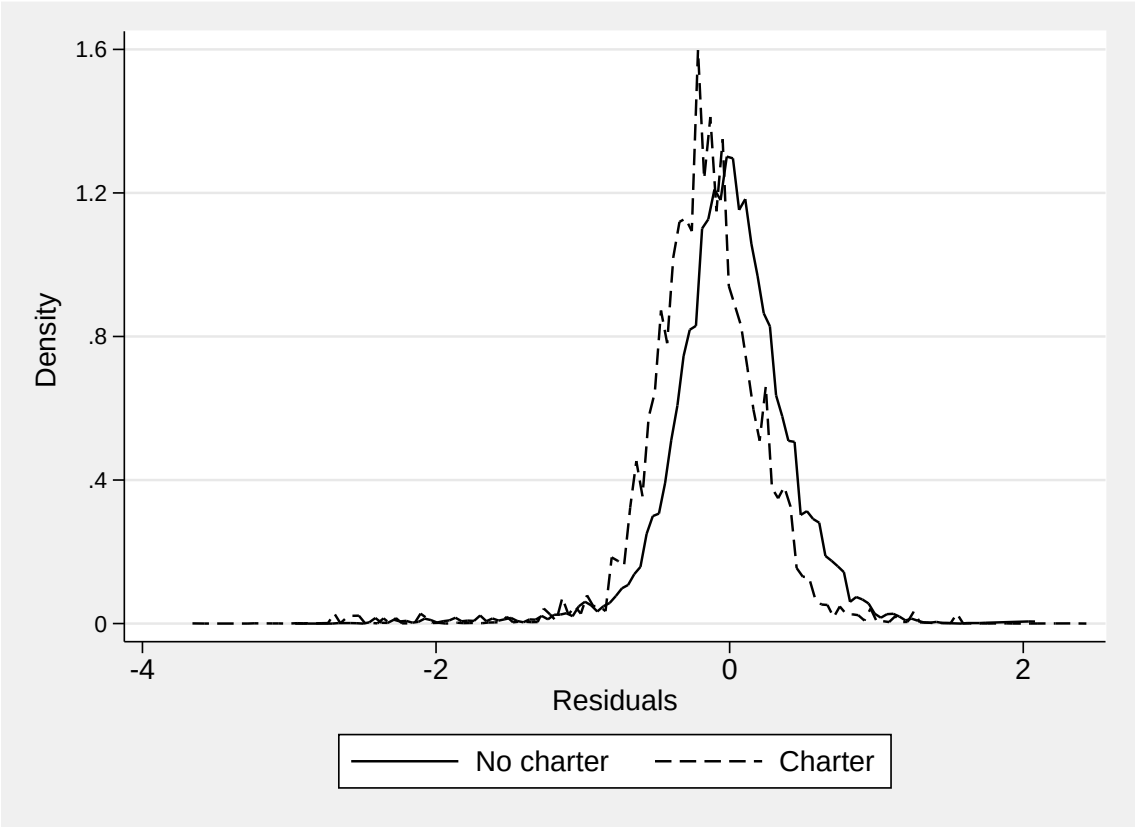


Figure 3.8 Housing price distribution (log)

Notes: The graph shows the distribution of log of housing prices before and after charter legislation has been in place for a year. The figure is produced from the sample of houses in states that adopted charter legislation between 1985 and 2005 (37,533 observations). We run a regression of housing price on house characteristics, state fixed effects, year fixed effects and a quadratic state specific time trend and then plot the component plus residual.

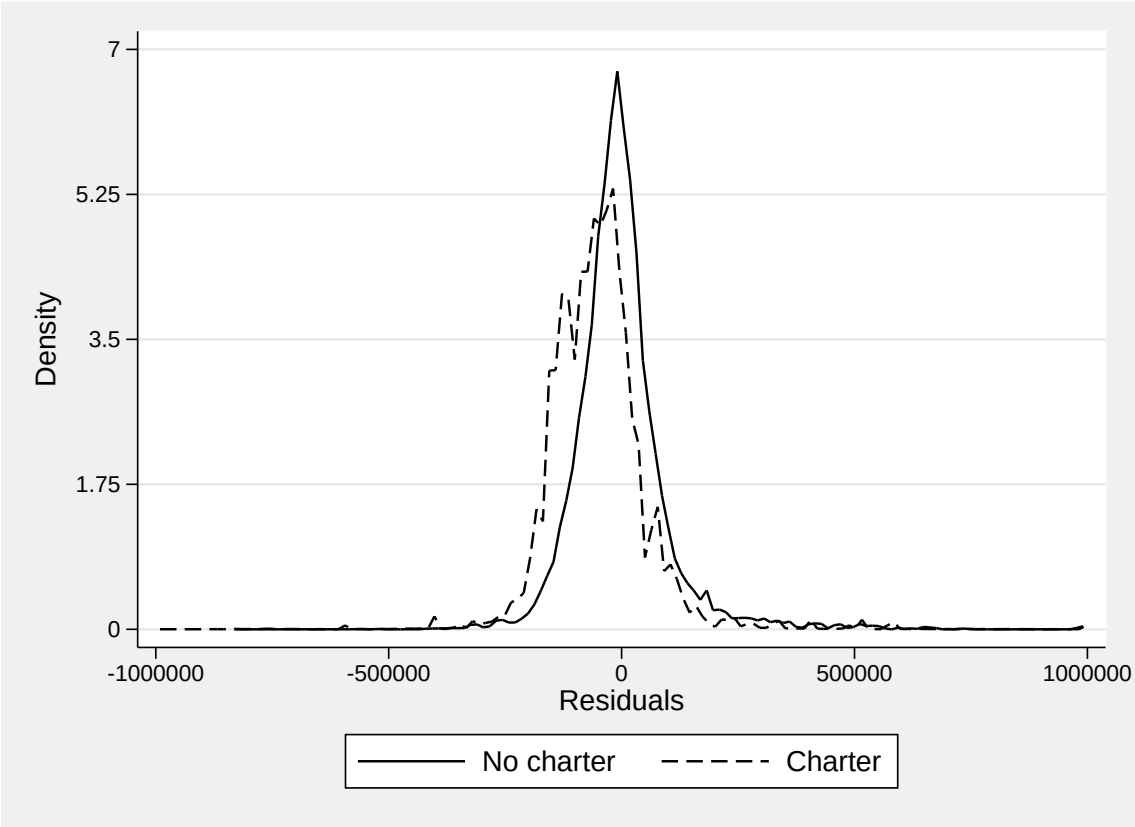


Figure 3.9 Housing price distribution

Notes: The graph shows the distribution of housing prices before and after charter legislation has been in place for a year. The figure is produced from the sample of houses in states that adopted charter legislation between 1985 and 2005 (37,533 observations). We run a regression of housing price on house characteristics, state fixed effects, year fixed effects and a quadratic state specific time trend and then plot the component plus residual. The right and left tails are truncated at 1 million.

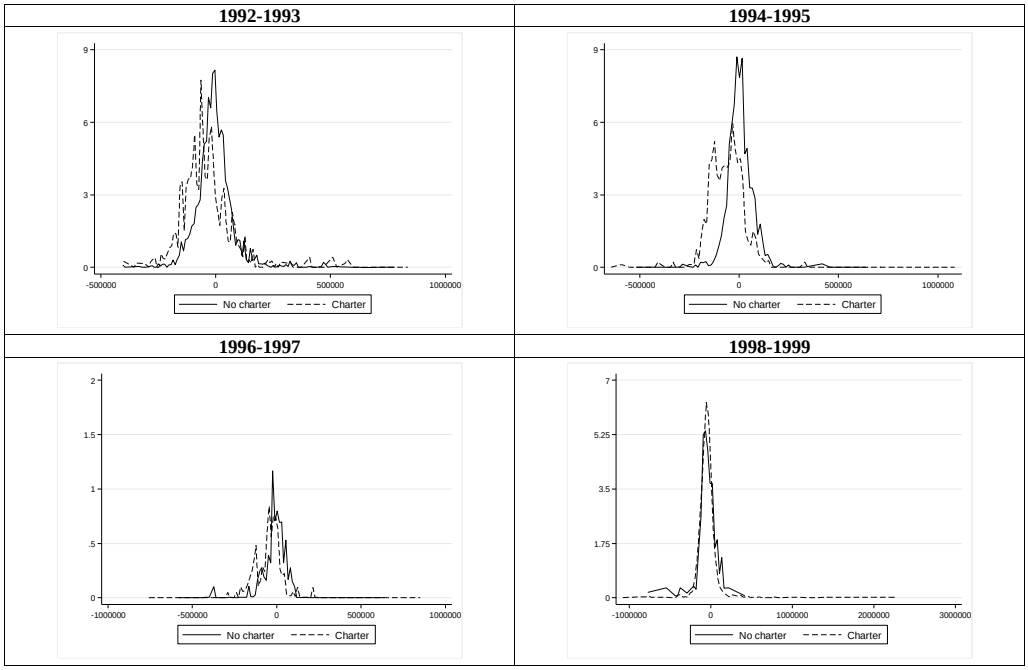


Figure 3.10 Distribution of housing prices by year (residual from level regression)

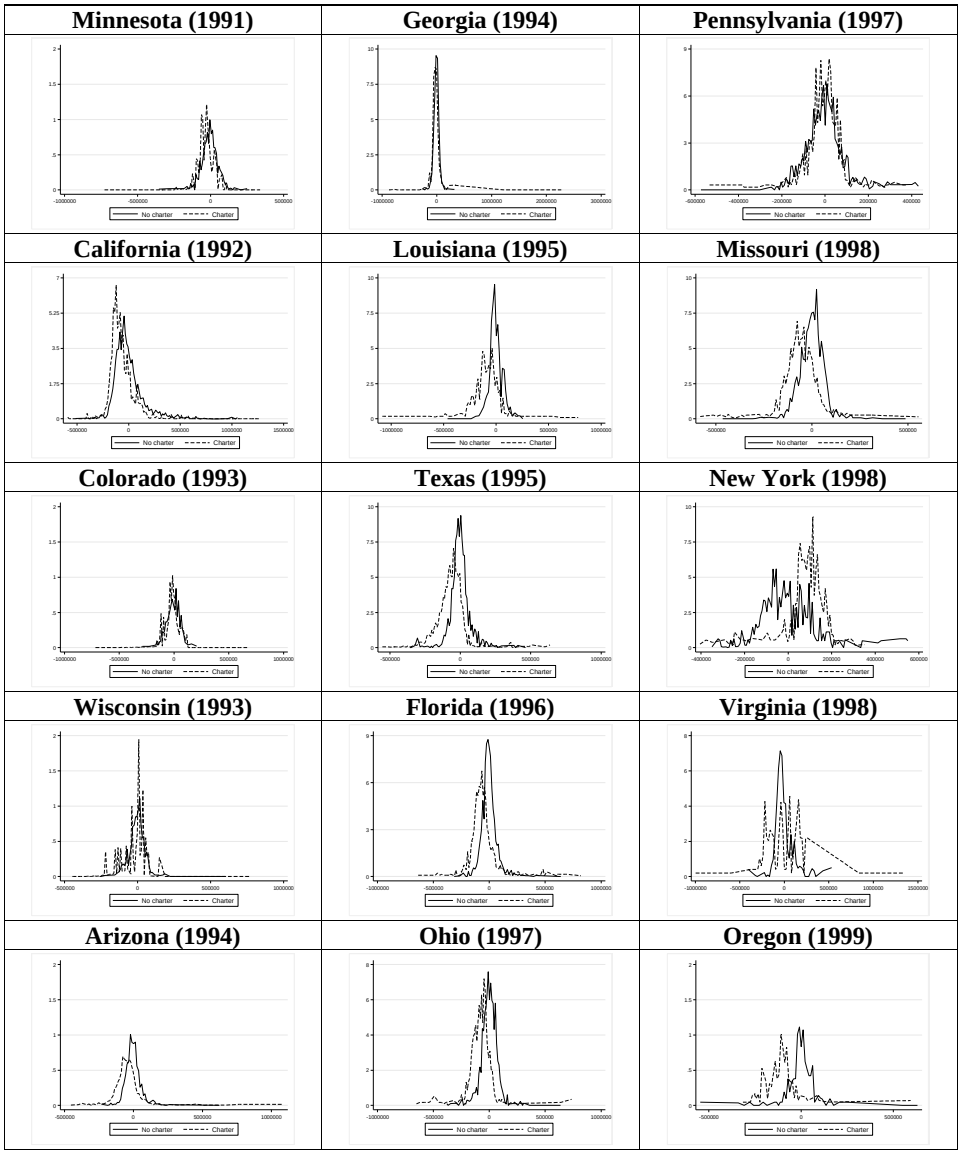


Figure 3.11 Distribution of housing prices by state (residual from level regression)

Table 3.1 Charter school legislation

State	Year charter policy passed
Alabama	2015
Alaska	1995
Arizona	1994
Arkansas	1995
California	1992
Colorado	1993
Connecticut	1996
Delaware	1995
Florida	1996
Georgia	1994
Hawaii	1994
Idaho	1996
Illinois	1996
Indiana	2001
Iowa	2002
Kansas	1994
Kentucky	No
Louisiana	1995
Maine	2011
Maryland	2003
Massachusetts	1993
Michigan	1993
Minnesota	1991
Mississippi	2010
Missouri	1998
Montana	No
Nebraska	No
Nevada	1997
New Hampshire	1996
New Jersey	1995
New Mexico	1993
New York	1998
North Carolina	1996
North Dakota	No
Ohio	1997
Oklahoma	1999
Oregon	1999
Pennsylvania	1997
Rhode Island	1995
South Carolina	1996
South Dakota	No
Tennessee	2002
Texas	1995
Utah	1998
Vermont	No
Virginia	1998
Washington	2012
West Virginia	No
Wisconsin	1993
Wyoming	1995

Notes: Information on policy years from NCES. The states shaded in gray are in the AHS.

Table 3.2 Summary statistics

	Mean	Standard Deviation	Minimum	Maximum
Panel A: Policy				
Charter	0.0475	0.2126	0	1
Panel B: House characteristics				
House price (2005 dollars)	208,708	143,458	21,349	2,649,647
Year house bought	1989	3	1985	2005
House age	22	20	0	86
Unit size (square feet)	2,100	890	100	26,598
Lot size (square feet)	20,301	41,108	200	981,377
Number of bedrooms	3.2381	0.8211	1	10
Number of baths	1.8108	0.7243	1	10
Number of half baths	0.4467	0.5675	0	10
Fireplace	0.6004	0.4898	0	1
Basement	0.4804	0.4996	0	1
Garage	0.8682	0.3382	0	1
Heating unit uses gas	0.6965	0.4598	0	1
Central air conditioner	0.6288	0.4831	0	1
Panel C: County characteristics				
Land area (square miles)	1,872	3,543	15	20,053
Percent water area	14	19	0.1	75
Amenity scale	2	4	-3	11

Notes: Data are from 43,449 house transaction in the AHS merged with data on county characteristics from the Inter-University Consortium for Political and Social Research. Results in the table are weighted.

Table 3.3 Regression results

	Baseline unweighted (1)	**Baseline weighted** (2)	**Linear time trend** (3)	**Quadratic time trend** (4)	**Repeat sales sample** (5)	**House fixed effects** (6)	**State-level unweighted** (7)	**State-level weighted** (8)
Charter	-0.101^{+}	-0.114*	-0.177^{+}	-0.174^{+}	-0.117	-0.076	-0.119^{+}	-0.075^{+}
	(0.053)	(0.046)	(0.092)	(0.086)	(0.093)	(0.077)	(0.068)	(0.044)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes	Yes	Yes		Yes	Yes
House and county characteristics	Yes	Yes	Yes	Yes	Yes			
State specific time trend			Yes					
State specific quadratic time trend				Yes	Yes	Yes		
House fixed effects						Yes		
Mean price (2005 dollars)	208,708	208,708	208,708	208,708	206,390	206,390	192,191	213,954
Adjusted R squared	0.620	0.560	0.566	0.571	0.599	0.900	0.737	0.887
Number of observations	43,449	43,449	43,449	43,449	6,678	6,678	458	458

Notes: In all columns, the dependent variable is the log of housing price. The sample used is of houses sold between 1985 and 2005. The regressions in col. (1)-col. (6) and col. (8) are weighted using the inverse probability of selection provided by the AHS. Col. (7) shows the results from a regression of the weighted mean of the log of housing prices on charter dummies as well as year and state fixed effects. Standard errors in parentheses are clustered at the state level. + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.

Table 3.4 Sensitivity checks

	Log (House prices) (1)	**House prices** (2)	**Box-Cox house prices** (3)	**Log (House prices)** (4)	**Log (House prices)** (5)	**Log (House prices)** (6)
Charter	-0.174^{+}	-51,705.245*	-1.128^{+}	-0.180^{+}	-0.119*	-0.145*
	(0.086)	(24,152.786)	(0.550)	(0.089)	(0.075)	(0.068)
Unemployment rate						-0.035**
						(0.012)
Sample	Full sample	Full sample	Full sample	Only treated states	Full sample 1985-1997	Full sample
Mean price (2005 dollars)	208,708	208,708	208,708	213,238	208,432	208,708
Adjusted R squared	0.571	0.535	0.583	0.573	0.574	0.572
Number of observations	43,449	43,449	43,449	37,533	29,969	43,449

Notes: The Full sample is of houses sold between 1985 and 2005. All the regressions in the table include year fixed effects, state fixed effects, state specific quadratic time trend, and house and county characteristics. Standard errors in parentheses are clustered at the state level.
$+$ p < 0.10, * p < 0.05, ** p < 0.01.

Table 3.5 Heterogeneity results

	(1)	**Bedrooms** (2)	**Unit size** (3)	**Amenity scale** (4)	**Suburb** (5)	**Married** (6)	**Non-white** (7)	**Older household** (8)
Charter	-0.174^{+}	-0.091	-0.144	-0.100	-0.140	-0.160^{+}	-0.170^{+}	-0.177^{+}
	(0.086)	(0.095)	(0.129)	(0.085)	(0.094)	(0.092)	(0.088)	(0.087)
Charter × Bedrooms		-0.025^{+}						
		(0.013)						
Charter× Unit size (10k)			-0.014					
			(0.028)					
Charter× Amenity scale				-0.022^{+}				
				(0.011)				
Charter× Suburb					-0.042			
					(0.043)			
Charter × Married						-0.019		
						(0.019)		
Charter × Non-white							-0.028	
							(0.027)	
Charter× Older household								0.070
								(0.048)
Suburb					0.074*			
					(0.032)			
Married						0.063***		
						(0.011)		
Non-white							-0.097***	
							(0.025)	
Older household								-0.101*
								(0.037)
Unit size (10k)	0.134***	0.134***	0.135***	0.134***	0.135***	0.133***	0.133***	0.135***
	(0.025)	(0.025)	(0.026)	(0.025)	(0.025)	(0.025)	(0.024)	(0.025)
Bedrooms	0.040**	0.041**	0.040**	0.040**	0.040**	0.037*	0.044**	0.036*
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.014)
Amenity scale	0.040^{+}	0.040^{+}	0.040^{+}	0.042^{+}	0.040^{+}	0.040^{+}	0.040^{+}	0.040^{+}
	(0.021)	(0.021)	(0.021)	(0.022)	(0.020)	(0.021)	(0.021)	(0.021)
Adjusted R squared	0.571	0.571	0.571	0.572	0.573	0.573	0.574	0.572

Notes: In all columns, the dependent variable is the log of housing price. The results are using the full sample of 43,499 houses sold between 1985 and 2005 with an average house price of 208,708 dollars. All the regressions in the table include year fixed effects, state fixed effects, state specific quadratic time trend, and house and county characteristics. Standard errors in parentheses are clustered at the state level. + p < 0.10, * p < 0.05, ** p < 0.01.

CHAPTER

4

CHARTER SCHOOLS AND PROPERTY VALUES IN NEW YORK CITY

4.1 Introduction

Public school quality is capitalized in housing prices [Black and Machin, 2011]. Charter schools, a form of school choice, can weaken the link between public school quality and housing prices [Epple and Romano, 2003; Ferreyra, 2007; Nechyba, 2000]. Prior literature has found little to no effect of charter schools on housing prices in Los Angeles county [Brehm et al., 2017] and positive effects in Atlanta for houses within a charter's priority zones [Andreyeva and Patrick, 2017]. We add to the limited literature on the topic by examining the impact of charter schools on housing prices in New York City (NYC). NYC has a robust demand for charter schools with 8 percent of total students enrolled in charter schools (106,600 students) and 44,400 students on wait lists in 2016. While not all charters positively

impact academic performance, results from papers using NYC data show that charter schools in the city significantly increase the achievement of students [Dobbie et al., 2011; Hoxby et al., 2009; Hoxby and Rockoff, 2004] and that those increases in achievement translate into gains in non-test score outcomes such as high school graduation and college enrollment [Dobbie and Fryer Jr, 2015].

The first NYC charter school opened in Harlem in 1999. By 2013, there were 183 operating charter schools in the city. Charters offer parents a choice of school other than the school to which their house is zoned. However, students in NYC applying to a charter located in their school district have priority in that charter which can create a link between charter school quality and housing prices. We use information on house sales from the NYC Department of Finance and school test scores from the NYC Department of Education. Using boundary fixed effects and a sample of houses around elementary school boundaries, we estimate that charter schools operating within 1 mile of a house are associated with about a 6 percent decrease in house prices while controlling for neighborhood and household characteristics.

Linking house transactions data to school attendance boundaries allows us to compare capitalization effects of charter penetration across the distribution of school quality in the city. When examining the heterogeneity of the effect of charter penetration by zoned school quality, we find no evidence that the effect of charter school varies with zoned school quality. The results in this chapter are preliminary and more work is needed to fully understand the impact of charter school penetration on the capitalization of zoned school quality in housing prices. Future work will focus on exploring different measures of charter penetration (distance to charter, number of charters) as well as different measures of school quality (English test scores, per-pupil expenditures). We will also consider the impact of charters on housing prices while accounting for the heterogeneity that exists when it comes to the effects of charter schooling on academic performance.

Examining the effect of charter schools on housing prices allows us to understand if households value this form of school choice by looking at their revealed preferences through their residential location decisions. Considering the effect of charters on student outcomes alone is not enough to evaluate the effectiveness of charter school policy. A comprehensive examination of the impacts of charter school policy must take into accounts the effects on household behavior, student sorting, housing prices and consequently property taxes and school funding.

4.2 New York City Schools

NYC is home to 1.1 million students as well as 1,700 public schools with a budget of nearly 25 billion dollars. The city spends 19,076 dollars each year per student. There are approximately 900 additional privately run secular and religious schools as well as 159 charter schools. NYC has a uniform property tax rate across attendance zones. Charter schools, unlike traditional public schools, are independent of the department of education.

Charter policy is a state level legislation. Charters in New York State can be authorized by local school boards, SUNY board of trustees, and the State Board of Education. Prior to 2010, District Boards of education could authorize charter schools, but now District Boards of Education are only able to approve conversions of schools from district schools to charter schools, with final approval given to the State Board. New York State has a cap on the number of new charter schools that can start operating in a given year. Only 460 new charters can be authorized to start operating per year. There is no cap on conversion schools. The basis for charter school funding in New York state is the student's resident district per-pupil revenue.

Attendance policies in NYC elementary and middle schools are administered at the district level with some schools offering school choice while others assigning schools based on geographic location. NYC has 32 districts divided into smaller attendance zones that vary by size. Figure 4.1 illustrates the different elementary school zones. The different blocks of color represent the 32 school districts that currently exist. NYC introduced school choice to high schools in 2004. High school students list their priorities and then attend a school that they are matched to through the deferred acceptance algorithm. Prior to that, the majority of students in the city were assigned a default school depending on their geographic location with the exception of citywide schools that had highly competitive entrance requirements.

Grades K-5 account for 63 percent of charter enrollment. In this chapter, we focus on the effect of elementary charter schools on housing prices and the link between public elementary schools and residential choice. Figure 4.2 tracks the number of elementary public and charters schools operating in NYC from 2005 to 2011. The growth rate of charter schools is higher than that of traditional public schools. From 2005 to 2011, the number

of elementary charter schools operating in NYC went from 19 to 73 while the number of elementary traditional public schools increased from 660 to 682. Figure 4.3 tracks the share of students across public schools and charter schools. Traditional public schools' share of students has been decreasing while the charter schools' share has been increasing. From 2005 to 2011, the share of elementary charter schools increased from 1.3 percent of NYC elementary students to 5.6 percent while the share of elementary traditional public schools decreased from 98.7 percent of NYC elementary students to 94.4 percent.

NYC has an online school application where the parent reports residential address, age of child, current grade, and the grade to which the child is applying. The applicant is then shown a page that lists their current community school district and all the available charters accepting students at the grade level to which the child is applying. The charters are listed by distance from the household's address. All charter schools give priority to students who reside in the community school districts where the school is located. There is no limit on the number of charters to which an applicant can apply. A charter school is not allowed to limit the admission of any student on the basis of ethnicity, national origin, gender, disability, intellectual ability, measures of achievement or aptitudes, athletic ability, race, creed, religion, or ancestry. A charter school cannot require an action by a student or family (admissions test, interview, essay, attendance at an information session etc.) in order to submit an application.

Once the applicant chooses which charter(s) she is applying to, she is reminded that the charter schools give priorities in their lottery to students who reside in the charter's school district and their siblings. If the charter school offers a lottery preference to students that meet other criteria, the applicant is given the option to answer questions that might increase, but not guarantee, chances of admission. The questions cover eligibility for free or reduced price lunch, SNAP or TANF benefits, if any siblings currently attend the charter school to which the application is being sent, if the child speaks a language other than English most of the time, if the student has special needs or if they reside in public housing or in a temporary living arrangement because of economic hardship, if they are not in the physical company of a parent or a guardian, and if they currently attend a school with a failing grade.

4.3 Literature on charter schools

Early research on the effect of charters on academic performance found mixed results. Some papers found negative impacts of attending a charter school [Bifulco and Ladd, 2006; Imberman, 2011b; Sass, 2006; Zimmer and Buddin, 2006], some found no effect [Hanushek et al., 2007], while others found a positive impact [Booker et al., 2007; Hoxby and Rockoff, 2004]. More recent work shows that the typical charter school is no more effective at increasing test scores than the typical traditional public school but high-performing charter schools can significantly increase the achievement of poor urban students [Gleason et al., 2010].

Students attending over-subscribed Boston-area charter schools scored approximately 0.4 standard deviations higher per year in math and 0.2 standard deviations higher per year in reading [Abdulkadiroğlu et al., 2011]. Promise Academy students in the Harlem Children's Zone (HCZ) scored 0.229 standard deviations higher per year in math and 0.047 standard deviations higher per year in reading [Dobbie et al., 2011]. The Knowledge is Power Program (KIPP) schools -America's largest network of charter schools - and the SEED urban boarding school in Washington D.C. experienced similar test score gains [Angrist et al., 2011; Curto and Fryer Jr, 2014; Tuttle et al., 2010].

Hoxby et al. [2009] examines the effect of charters on student achievement in NYC and the characteristics of the students that enroll in charters. The paper finds that charters tend to locate in disadvantaged neighborhoods and serve students who are poorer than the average public school student in NYC. Dobbie et al. [2011] examines if increases in student achievement translates into gains on non-test score outcomes such as high school graduation, college enrollment, drug-use, teen pregnancy, or incarceration using survey data from the Promise Academy in the Harlem Children's Zone. Six years after the random admissions lottery, youth offered admission to the Promise Academy middle school score 0.283 standard deviations higher on a nationally-normed math achievement test and are 14.1 percentage points more likely to enroll in college. Admitted females are 12.1 percentage points less likely to be pregnant in their teens, and males are 4.3 percentage points less likely to be incarcerated.

Chabrier et al. [2016] examines the effect of charter school attendance at 113 schools

using lotteries. On average, each year enrolled at one of these schools increases math scores by 0.08 standard deviations and English/language arts scores by 0.04 standard deviations. The paper finds wide variation in impact estimates. The differences in effects are due to school practices, inputs, and characteristics of fallback schools. In line with the earlier literature, the paper finds that schools that adopt an intensive "No Excuses" attitude towards students are correlated with large gains in academic performance, with traditional inputs like class size playing no role in explaining charter school effects. After accounting for performance levels at fallback schools, the relationship between the remaining variation in school performance and the entire "No Excuses" package of practices weakens. Intensive tutoring is the only "No Excuses" characteristic that remains significant (even for nonurban schools) once the performance levels of fallback schools are taken into account.

Winters [2012] examines the impact of students exiting a public school to enroll in charters on the students that remained enrolled in a public school. The paper uses student level data from New York City and finds evidence that students in schools losing more students to charter schools either are unaffected by the competitive pressures of the choice option or benefit mildly in both math and English. Competition from charter schools can improve zoned schools' performance. Charter school competition made Michigan public schools improve their productivity relative to their own trends [Hoxby, 2003].

The effect of charters on housing prices has not been thoroughly investigated in the literature. Brehm et al. [2017] finds little evidence that charter schools impact housing prices using data on single family home-sales from Los Angeles County from 2008 to 2011. The identification strategy in the paper relies on census block fixed-effects and the variation in charter penetration over time. The paper examines the impact of both number of charters and the share of public enrollment in charters within various distances of a property up to two miles. To account for endogenous charter locations and changes in the geographic distribution of sales they include census block fixed effects along with a set of housing and school characteristics to account for the non-random location of charter schools. The results suggest that neither the increase in the number of charter schools nor the expansion in charter enrollment relative to public school enrollment is capitalized into housing prices on average. This holds both for Los Angeles Unified School District (LAUSD) and other parts of Los Angeles County. It also holds for both startup charters and conversion charters. The paper finds no evidence that capitalization varies with income level, minority population,

or achievement levels of the local public elementary school.

However, Brehm et al. [2017] finds that when the sample is restricted to charters located only within the household's school district's boundaries and excluding LAUSD there is a significant negative effect of additional nearby charter schools on housing prices. The paper explains this finding as reflecting that the opening of a nearby charter school reduces the value of a local community school, thus weakening the link between the availability of local schooling as a public good and house prices. The restriction is reasonable as students who reside within the charter's authorizing school district have admissions priority.

Results presented by Andreyeva and Patrick [2017] suggest that homebuyers are willing to pay more for a house to obtain access to a charter school. The paper's findings indicate households value geographically-based increases in the probability of admission to an oversubscribed charter school. Andreyeva and Patrick [2017] uses a unique characteristic of ten charter schools in the Atlanta metro area to study whether households are willing to pay a premium for a house located in priority one zone as opposed to priority two zone. Even though students residing in either priority zone are eligible to attend corresponding charter school, the probability of enrollment is substantially larger for the residents of priority zone one. The identification strategy used is based on the differences in sales prices for homes in priority one and two zones before and after the opening of a charter school. The paper finds that homebuyers are willing to pay about 6%-8% or $9,092-$12,332, on average, more for houses located within 0.3 miles from the border in priority zones that more than double the probability of an admissions offer following the charter school opening.

Although very few papers have examined the effect of charters on housing prices, papers that examine the effect of a change in attendance zone school quality on housing prices are more prevalent [Black and Machin, 2011; Machin and Salvanes, 2016; Reback, 2008]. Kane et al. [2006] studies the relationship between school characteristics and housing prices in Mecklenburg, NC between 1994 and 2001 and examines the change in that relationship once school boundaries are redrawn. The paper uses two different sources of variation to disentangle the effect of schools and other neighborhood characteristics: differences in housing prices along assignment zone boundaries and changes in housing prices following the change in school assignments. The paper finds that houses prices react to changes in school assignment. The measure of school quality used is the average scaled test score for grades 3-5. Kane et al. [2006] finds that a one student-level standard deviation in a

school's mean test score was associated with a 10-percentage point difference in house value. When neighborhoods are reassigned to different schools, the population living in those neighborhoods seems to respond. The impact of schools on housing values appears to be largely indirect, through the residential sorting that goes hand-in-hand with school boundaries and reassignment. Similarly, Bayer et al. [2004] finds that much of the apparent difference in housing value associated with schools is the result of residential sorting.

Using boundary fixed effects and a sample of houses around elementary school boundaries, we estimate that charter schools operating within 1 mile of a house are associated with about a 6 percent decrease in housing prices. Our results fall within the range of estimates produced in the literature when studying the impact of school policies on housing prices. However we note that our estimates are preliminary. Our future work using these data will investigate the effects of different measures of school quality and different measures of charter penetration. We also plan to use the Longitudinal Tract Database (LTDB) to include a measure of neighborhood conditions that vary with time. The LTDB interpolates data for years where census data is not available. Finally, we will also consider the heterogeneity that exists when it comes to the performance of charters themselves and their impacts on students.

4.4 Data and empirical strategy

4.4.1 Data

We obtained data on sales in New York City from the NYC Department of Finance, which offers access to a list of annual sales by borough starting in 2003. The information includes date of sale, sale price, year built, building type, square footage and a detailed address. We limit the sample to sales between 2007 and 2013. These are the years for which we have information on test scores. We trim the data by removing prices below 10,000 dollars and above 10 million dollars.[1] We also remove sales where the unit size, lot size, and year built are not reported as well as sales of a nonresidential property.

New York City is divided into 32 geographic districts. Those districts are divided into

[1]Table B.1 in appendix B includes all the steps required to produce the data set used in chapter 4.

smaller zones that determine the area served by local schools. Zones vary in size as seen in figure 4.1, which shows the different NYC elementary school zones. The map of the school zones is from the NYC Department of City Planning. We focus on elementary schools because of the strong tie between household residential choice and the corresponding elementary school [Schwartz et al., 2014]. We obtain data on the elementary schools from the NYC Department of Education. We link these schools to the school level Common Core Data to obtain geographic identifiers that enable us to match schools to the appropriate zone and houses.

After combining the school location and boundary information with the exact location of each property, we calculate the distance of each property to the properties in a different school assignment zones within 0.35 miles. The last restriction we make on the dataset is dropping sales in school districts with no school zones.[2] Table 4.1 compares the characteristics of property sales in NYC from 2007 to 2013 for the full sample, and the samples of houses centered around school zone boundaries. On average the sale price in the full sample is 650,245 dollars with a sale year of 2010, a unit age of 69 years, a unit size of 3,231 square feet and a lot size of 3,215 square feet. The average property is linked to a zone where the average score on the New York State Mathematics test is 688. Looking at housing location by borough, we find that 41.2 percent of houses in the sample are located in Queens, 31.2 percent in Brooklyn, 9.7 percent in Bronx, and 2.3 percent in Manhattan. Most of the sales in our sample are located in Brooklyn or Queens because these boroughs include a large share of smaller properties which sell more frequently than apartment buildings [Schwartz et al., 2014]. The sale price for the 0.35 mile sample is slightly less than the sale price for the full sample at 607,294 dollars but the rest of the statistics are very comparable across samples.

4.4.2 Empirical strategy

Economic literature has documented that charters locate in lower income neighborhoods, which we also observe by looking at figure 4.4. We define lower income neighborhoods as neighborhoods where median household income is lower than 40,000 dollars. Middle income neighborhoods are neighborhoods where median household income is between

[2] School district 1, 7, and 23 do not have any school zones.

40,000 dollars and 100,000 dollars. While some charters locate in middle income neighborhoods, the majority of charters locate in lower income neighborhoods. In figure 4.4, we show the distribution of charter schools throughout New York City. We see that these charter schools are operating across the city during our study period (2007-2013). This figure also shows us that charter schools are heavily concentrated in Manhattan, Bronx, and Brooklyn. Thus, other than in Staten Island and Queens, each borough has a significant number of charter schools during our study period.

Due to charter schools' tendencies to locate in lower income neighborhoods, which has been documented in the literature and can be seen in figure 4.4, lower house prices will be correlated with charter penetration. Instead of only looking at the direct effect of charters on housing prices, we examine the change in capitalization of zoned school quality once charters are operating within a 1 mile radius of a house. Interacting charter penetration and zoned school quality can be interpreted as the change in capitalization of zoned school quality once charters are operational. But, the interaction term can also be interpreted as the different capitalization of charter schools in housing prices depending on the corresponding zoned school quality.

NYC determines that students are considered living close enough to a school to walk and are not eligible for transportation if they live less than 1 mile away from a zoned school. Therefore, we define charter penetration as charters operating within less than a one mile radius of a house. Our results vary depending on the distance chosen to define charter penetration but they are generally not statistically significant. In 2007, the first year in the sample period, 22 elementary charter schools were operational in the school zones included in the sample. By 2013, the last year of the sample period 78 elementary charter schools were operational in the school zones included in the sample.

When examining the capitalization of an amenity in housing prices, the challenge is to distinguish between the impact of that amenity and other factors, such as neighborhood characteristics, that can be correlated with the amenity of interest. Following Black [1999], we focus on differences in housing values near elementary school boundaries (properties within 0.35 miles of a school boundary). This allows us to differentiate between the effect of school quality and other neighborhood characteristics. Exploiting the presence of discontinuities at the geographic level allows us to estimate the willingness to pay for good schools. Charter penetration might change the house price school quality relation over time. To

identify the change in the capitalization of school quality once charters are operational, we estimate the following equation:

$$log(P_{izbt}) = \alpha + \beta_1 SQ_z + \beta_2 Charter_{it} + \beta_3 Charter_{it} * SQ_z + \beta_4 H_i + QFE_t + BFE_b + \epsilon_{izbt}$$

$log(P_{izbt})$ is the log of the sale price of property i in zone z and boundary b at time t. SQ is zoned school quality. In this chapter, we measure school quality by averaging grade 3 test scores on the NY State standardized math test over the 2007-2013 time period. [3] The averaging of the math score helps reduce any year to year noise in the school quality variable. We define the school quality measure at the school level and express it in standard deviations from the mean.

Our main regressions include a binary variable equal to one if there is a charter operating within less than 1 mile of a house. We interact charter penetration with school quality to examine the varying effect of charter penetration. H includes house specific characteristics (age, square footage, and building type) as well as neighborhood characteristics (median household income in a census tract and percent black in a census tract). Including house characteristics captures changes in the composition of housing stock within a boundary over time. We control for neighborhood characteristics to capture differences within a boundary and across neighborhoods in house values. We include building type fixed effects in the regression. Building type can be Cape Cod, two stories/detached, one story, large suburban, city residence etc. The model also includes boundary fixed effects and year by quarter fixed effects. Figure 4.5 presents the Case-Shiller House Price Index for the NYC area from 2006 to 2012. Housing prices are decreasing throughout that period. We include year by quarter fixed effects to control for common time trends. Boundary fixed effects control for time-invariant neighborhood quality. Fixed effects are included for every unique

[3] Students in New York State grades 3-8 take the State Mathematics Test each spring. These assessments measure the Common Core Learning Standards (CCLS). The math test is a timed test that contains a mixture of different types of questions. The number of correct answers a student gives on a test is converted into the student's "scale score". The range of the raw score is 0-68. The range of the scale score is 150-409. The scale score makes it possible to compare performance on the tests across different grades. Scale scores are divided into four performance levels. Educators use individual student test results to assign students to the appropriate classes and to identify areas where the student needs extra help, or where he or she may be ready for more challenging material. Teachers and principals also use the results from the whole class, grade, or school, to identify areas where they can improve instruction.

boundary. Including boundary fixed effects allows us to compare sale prices of properties that are in close geographic proximity.

We use boundary fixed effects with a sample of houses at most 0.35 miles of a boundary. Our choice of 0.35 mile as the buffer distance around the school boundary follows the convention in the literature. Bayer et al. [2007] notes that in an idealized setting, researchers would be able to compare a vast number of houses facing each other directly but on opposite sides of the same boundary but in practice, researchers are forced to compare houses in bands- often over 0.3 mile wide- on either side of school boundaries in order to have sufficient sample sizes for inference. Buffers around a boundary used in the literature vary from a maximum of 0.35 to 0.4 miles [Black, 1999; Kane et al., 2003; Machin and Salvanes, 2016] to a minimum of 0.08 miles [Kane et al., 2006]. In future work, we will check the robustness of our results to narrower buffers around the elementary school boundaries. By using a boundary fixed effects, our identification strategy assumes that there are no changes in neighborhood conditions over time that are correlated with housing prices and charter penetration. The regressions also include year-by-quarter indicators to account for general changes in house prices related to overall market conditions. We include median household income in a census tract to control for the economic conditions in a neighborhood. The census variables are measured in 2000 and they do not vary with time. Charters are more likely to locate in areas with a higher percentage of black residents. We include percent black in census tract to reduce any correlation between housing prices and charter entry that is due to the charter's location decision.

Figure 4.6 illustrates the variation in school quality across school zones. The white zones on the map are parks, airports, zoos, and cemeteries. The dark gray zones are zones that are excluded from the analysis because they had a boundary change in the period we are examining. Light gray zones are zone that already offer a choice. We do not expect these zones to be impacted by the introduction of charter schools so we remove them from our sample. Light blue zones have the lowest school quality and dark blue zones have the highest school quality. Triangles on the map are charter locations.

Including boundary fixed effects allows us to compare the sale prices of houses that are geographically close where the only difference is the zoned school quality. The estimates rely on variation in prices within narrow geographic areas separated by an elementary school boundary. A key assumption of this strategy is that only school quality changes

discontinuously at boundaries but all other neighborhood characteristics change smoothly.

4.5 Capitalization of zoned school quality in housing prices

We begin by establishing that school performance of zoned schools is capitalized into housing prices. Table 4.2 presents the coefficients on zoned school quality using the full sample and the sample of houses within 0.35 miles of a school zone boundary. Column (1) reports that school quality is positively capitalized in housing prices. The coefficient on school quality is the school quality house price premium and represents the percentage change in house prices from increasing math test scores by one standard deviation. We include the standardized test score and a quadratic in the regression to relax the assumption that the relationship between house price and school quality is linear. The coefficient on the standardized test score represents the slope between housing price and school quality only at school quality equal to the mean. Adding a quadratic in the regressions implies that the capitalization of zoned school quality in housing prices changes with higher zoned school quality.

When the zoned school quality linked to a house is equal to the mean zoned school quality, housing prices increase by 14.8 percent when math test scores increase by one standard deviation. Each additional standard deviation increase in test scores is associated with 0.9 percent increase in housing prices. This regression uses the full sample, which is not limited to houses on opposite sides of an attendance zone boundary. All regressions include year by quarter fixed effects, building type fixed effects, borough fixed effects, and accounts for lot size, unit size, unit age. The standard errors in all regressions are clustered at the school zone level. Column (2) reports the results once we account for median census tract household income and percent black in census tract. The magnitude of the coefficient on school quality decreases, as expected.

School quality and neighborhood socio-economic characteristics are correlated with unobserved neighborhood characteristics, which creates an endogeneity problem. The identification strategy that we use which has been used in a seminal paper in the literature [Black, 1999] is based on the regression discontinuity design idea. The treatment is school quality or test scores and it is a function of a continuous variable, distance. The treatment

changes discontinuously at the boundary. By using this identification strategy, we are assuming that unobservables do not change discontinuously at the boundary. If houses are close to the boundary, we assume that unmeasured characteristics are similar. Boundary fixed effects control for the presence of a park, the view, the amenities of an area that we can not observe but that are likely to be similar for houses that are in close proximity to each other. However, households on different sides of a boundary are not identical. Households locate on different boundary sides because of differences in income or preferences. A location decision is a consequence of households maximizing their utility given their budget constraint. In this paper, I use census tracts (geographic zones smaller than school zones) to proxy for a neighborhood. Accounting for census tract household characteristics (median household income and percent black) can reduce bias and variance in the regressions.

Once we account for neighborhood characteristics, when the zoned school quality associated with a house is equal to the mean zoned school quality, housing prices increase by 2.1 percent for a one standard deviation increase of math test scores. Each additional standard deviation increase on the test is associated with a 1.3 percent increase in housing prices. A 1,000 dollars increase in the median household income in a neighborhood (census tract) is associated with a 0.8 percent increase in housing prices. A one percent increase in the percentage of black households in a neighborhood is associated with a 0.5 percent decrease in housing prices.

Column (3) shows that school quality is positively capitalized in housing prices when using a sample that is limited to houses on opposite sides of an attendance zone boundary. The houses included in the sample in column (3) are 0.35 miles from a school zone boundary. The regression does not include boundary fixed effects and reports similar results to column (1). When the zoned school quality associated with a house is equal to the mean zoned school quality, housing prices increase by 14.7 percent when math test scores increase by one standard deviation. A standard deviation increase is equivalent to an increase of 1.8 percent in the average math score. Each additional standard deviation of test scores is associated with 0.9 percent increase in housing prices. Once we include boundary fixed effect in column (4), the magnitude of the coefficients drastically decreases. When the zoned school quality associated with a house is equal to the mean zoned school quality, housing prices increase by 3.1 percent for one standard deviation increase of math test scores. Each additional standard deviation of test scores is associated with a 1.1 percent

increase in housing prices.

Column (3) provides evidence that the change in the sample size is not driving the results. The decrease in the magnitude of the coefficients on school quality once boundary fixed effects are accounted for is not surprising. Boundary fixed effects control for unobserved or unmeasured neighborhood characteristics. The coefficient on charter penetration in column (4) is smaller than the coefficient from the specification with standard controls for house characteristics in column (3) because when boundary fixed effects control for characteristics of houses in the same neighborhood but on opposite side of attendance district boundaries, they reduce the omitted variable bias that exists otherwise. Column (5) reports the results once we account for median census tract household income and percent black in census tract while including boundary fixed effects. When the zoned school quality associated with a house is equal to the mean zoned school quality, housing prices increase by 0.2 percent for a one standard deviation increase of math test scores but the coefficient on school quality is not statistically significant. Each additional standard deviation of test scores is still associated with a 1.1 percent increase in housing prices. A 1,000 dollars increase in the median household income in a neighborhood (census tract) is associated with a 0.4 percent increase in housing prices. A one percent increase in the percentage of black households in a neighborhood is associated with a 0.5 percent decrease in housing prices.

We turn to the literature on the capitalization of school quality in housing prices that apply discontinuity methods using administrative boundaries. First we examine a paper that models a nonlinear relationship between school quality and housing prices. Using over 10,000 observations from the St Louis metropolitan area in Missouri from 1998-2001, elementary school attendance zone boundaries (0.1 mile buffer), and fourth grade math scores from the Missouri Department of Education, Chiodo et al. [2010] reports that when the zoned school quality associated with a house is equal to the mean zoned school quality, housing prices increase by 6.3 percent for one standard deviation increase of test scores. Each additional standard deviation in test scores is associated with 2.7 percent increase in housing prices. Once the paper includes controls for census block variables and the zoned school quality associated with a house is equal to the mean zoned school quality, housing prices increase by 3.6 percent for one standard deviation increase of test scores. Each additional standard deviation in test scores is associated with 2.2 percent increase in

housing prices.

Next, we turn to the remaining papers that study the capitalization of zoned school quality in housing prices using boundary fixed effects while modeling a linear relationship between school quality and housing prices. Using housing price data on 22,679 transactions from 1993 through 1995 for Middlesex, Essex, and Norfolk counties in Massachusetts (all suburbs of Boston), elementary school zone boundaries (0.35 mile buffer), and fourth grade math and reading scores, Black [1999] reports that a one standard deviation in school quality increases prices by 2.5 percent. This regression does not include census variables. Using over 100,000 real estate transactions from 1997-2004 from Paris, middle school zone boundaries (350 meters or 0.22 mile buffer), and middle test scores, Fack and Grenet [2010] reports that one standard deviation increase in school quality increases prices by 2 percent while accounting for census variables.

Our estimates fall within the range of estimates present in the literature on the capitalization of school quality in housing prices. In fact, when examining the results from a paper using NYC housing data from the Department of Finance, which is the source of the data in this chapter, we find that our results are very similar. Schwartz et al. [2014] estimates that a one standard deviation increase in school performance is associated with a 3 percent increase in housing values. Their regression does not include census tract variables so we compare it to the regression in table 4.2 column (4) on page 94. We estimate that when the zoned school quality associated with a house is equal to the mean zoned school quality, housing prices increase by 3.1 percent for one standard deviation increase of math test scores.

4.6 Charter penetration

Table 4.3 examines the impact of charter penetration on housing prices while accounting for zoned school quality and boundary fixed effects. Column (1) in table 4.3 uses the same specification as column (5) in table 4.2, the most saturated specification, but also includes our measure of charter penetration. The coefficients on standardized test scores are consistent with the results in column (5) of table 4.2. A charter operating within less than 1 mile of a house is negatively capitalized in housing prices on average. Having a

charter operating within a mile of a house is associated with a 5.7 percent decrease in the price of that house.

Column (2) interact charter penetration with the standardized test score variables. The coefficients on standardized math score and standardized math score squared are unchanged. A charter operating within less than a mile of a house is associated with a 6.1 percent decrease in the price of a house when we interact charter penetration and school quality. The interactions between charter within a mile of a house and school quality variables are not significant.

In the rest of the columns, we attempt a different approach to examine whether the overall mean charter impacts are hiding heterogeneous effects. Instead of using a continuous measure of school quality, we interact charter penetration with high and low performing school zone indicators. We define high performing school zones as school zones in the top tercile of school zones. Low performing school zones are school zones in the bottom tercile of school zones. In column (3), we include tercile 1 and tercile 3 in the regression with the preferred specification. Tercile 1 is not capitalized in housing prices. A house located in a top tercile school zone is associated with a 4 percent increase in housing prices compared to a middle tercile school zone, the omitted category. A charter operating within less than a mile of a house is associated with a 6.1 percent decrease in the price of a house when including categorical measure of school quality.

In column (4), we interact the categorical measures of school quality with the charter penetration variable. Tercile 1 is not capitalized in housing prices. A house located in a top tercile school zone is associated with a 4 percent increase in housing prices. A charter operating within less than a mile of a house is associated with a 4.2 percent decrease in the price of a house when interacting categorical measures of school quality and charter penetration. However, the coefficient is no longer significant. The interactions between charter within a mile of a house and school quality variables are not significant.

School choice was predicted to decrease housing prices in areas previously linked to high quality schools and increase housing prices in areas previously linked to low quality schools[Epple and Romano, 2003; Ferreyra, 2007; Nechyba, 2000]. Charters can impact housing prices by influencing residential choice. Households that would have paid more for a house when charters were not operating to guarantee access to a good school can now pay less and have access to charters. We are unable to confirm that prediction in this chapter.

Note that the results are somewhat sensitive to the definition of charter penetration but are mostly not statistically significant. Future work is discussed in the next section.

4.7 Conclusion

Using information from NYC with detailed geographic identifiers allows us to examine the impact of charter penetration on housing prices while controlling for neighborhood unobservables that would otherwise bias the results. Using the 0.35 mile sample we confirm that zoned school quality is capitalized in housing prices. We present results that a charter operating within less than a mile of a house is associated with a 6 percent decrease in the price of the house.

We were not able to confirm that the capitalization of zoned school quality in housing prices is altered once charters are operating. However, the work in this chapter is preliminary. In future work using this dataset, we plan to examine the effect of charter schools on the capitalization of school quality in housing prices using different measure of charter penetration (distance from charter, number of charters) and school quality (English test score, per-pupil expenditures). We also plan on investigating the capitalization of charter characteristics in housing prices. Charters provide priority to student residing in the same district as the charter, which can create a link between charter schools and residential choice. The school quality of charters might also be capitalized in housing prices similarly to the zoned school quality. Finally, we also plan on examining the effect of charters on the capitalization of zoned school quality in housing prices while accounting for the heterogeneity that exists when it comes to the performance of charters schools and their impact on student performance.

In prior literature, the impact of charter schools on academic performance in the case of NYC suggested that charter schools play a positive role in providing students with choice and higher quality education regardless of socio-economic background. Examining households' behavior following charter penetration can provide evidence on how households perceive charter schools. Recovering households' valuation of charters is essential to determining the effectiveness of charter school policy.

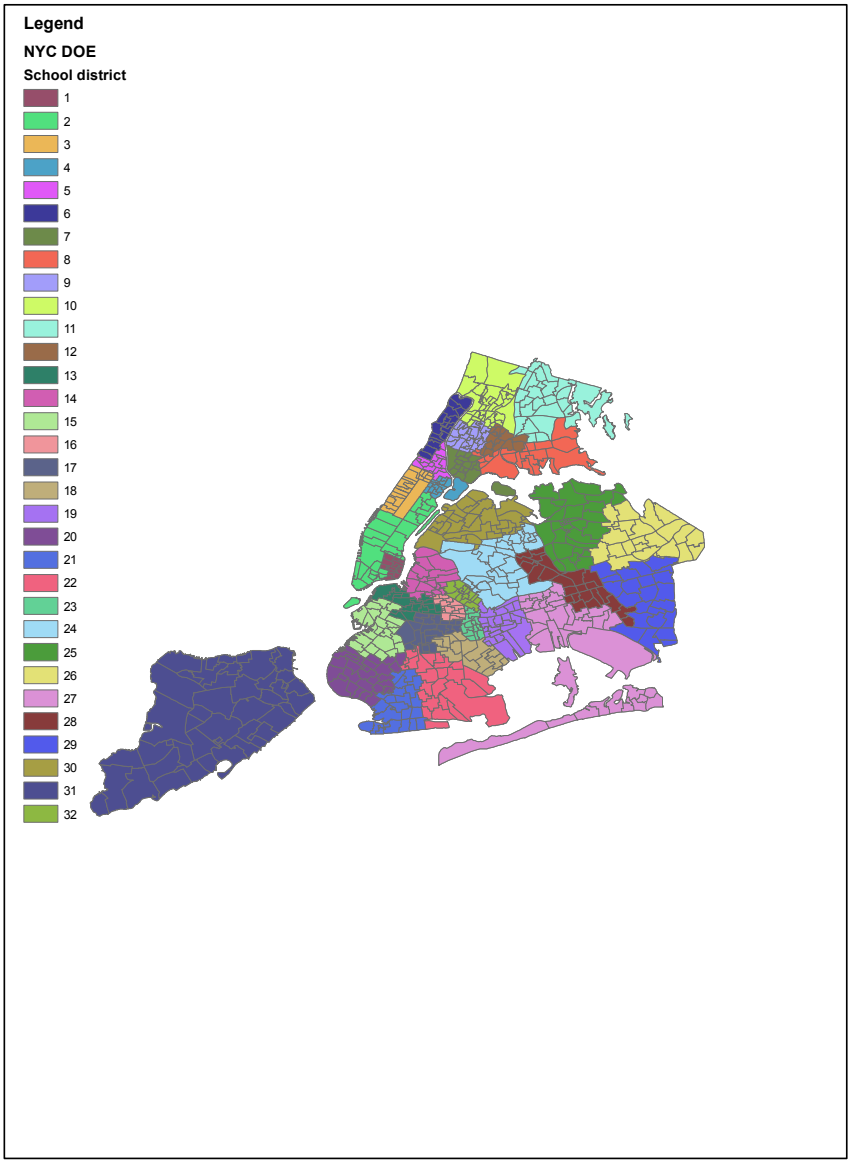


Figure 4.1 Map of NYC elementary school zones

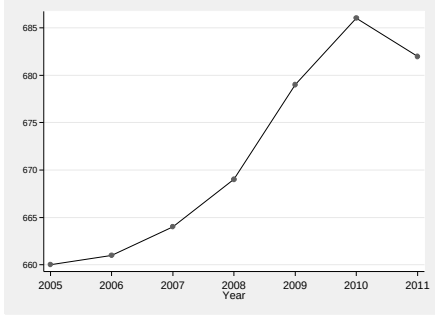
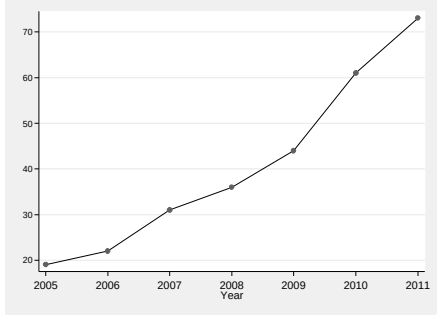
Panel A: Public schools	Panel B: Charters
	
Note: Panel A shows the number of elementary public schools in NYC from 2005 to 2011.	Note: Panel B shows the number of elementary charter schools in NYC from 2005 to 2011.

Figure 4.2 Number of elementary schools operating in NYC

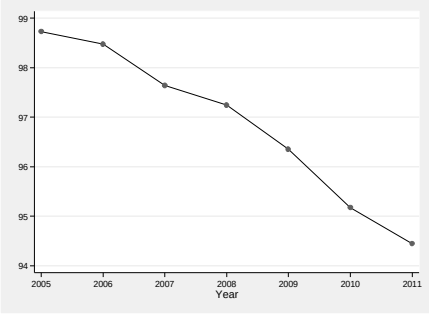
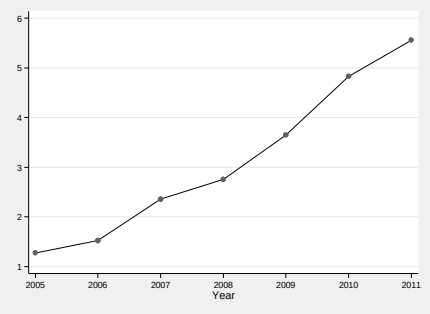
Panel A: Public schools	Panel B: Charters
	
Note: Panel A shows the share of students attending elementary public schools in NYC from 2005 to 2011.	Note: Panel B shows the share of students attending elementary charter schools in NYC from 2005 to 2011.

Figure 4.3 Student enrollment in NYC elementary schools

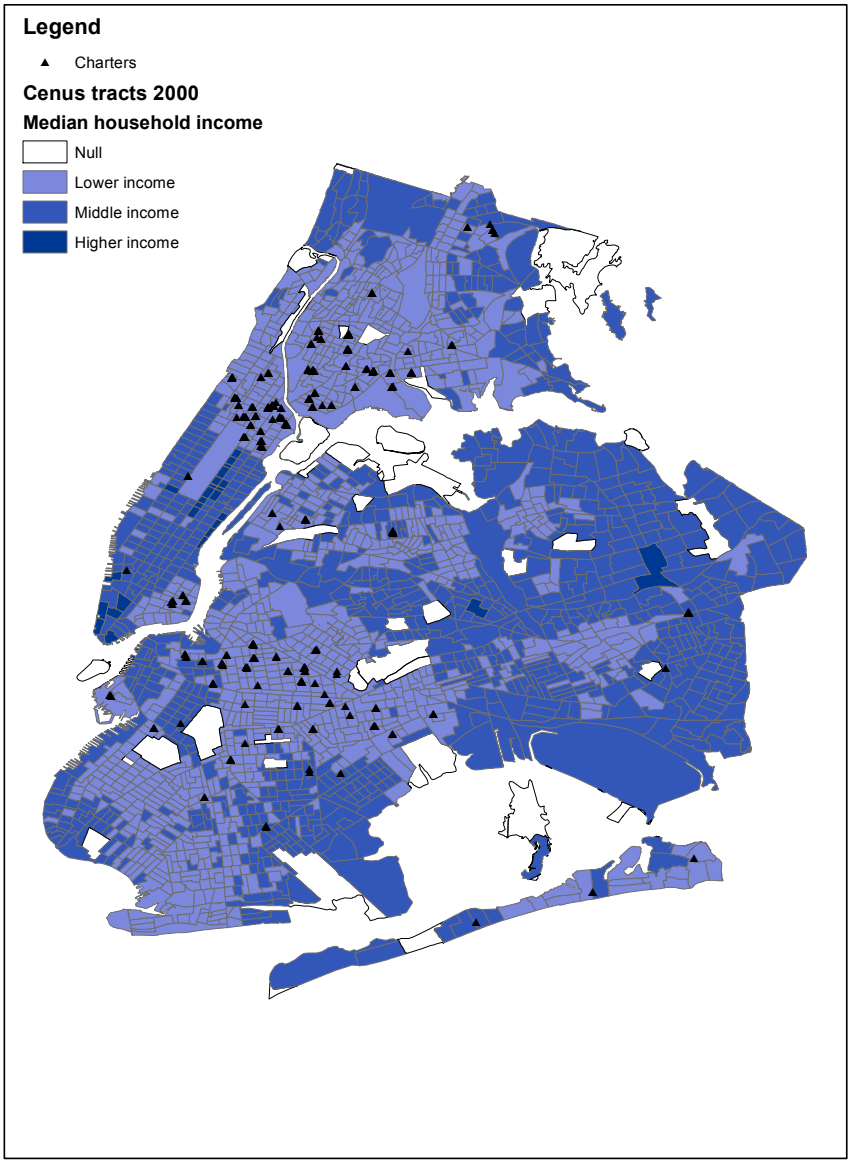


Figure 4.4 Charter location and median household income

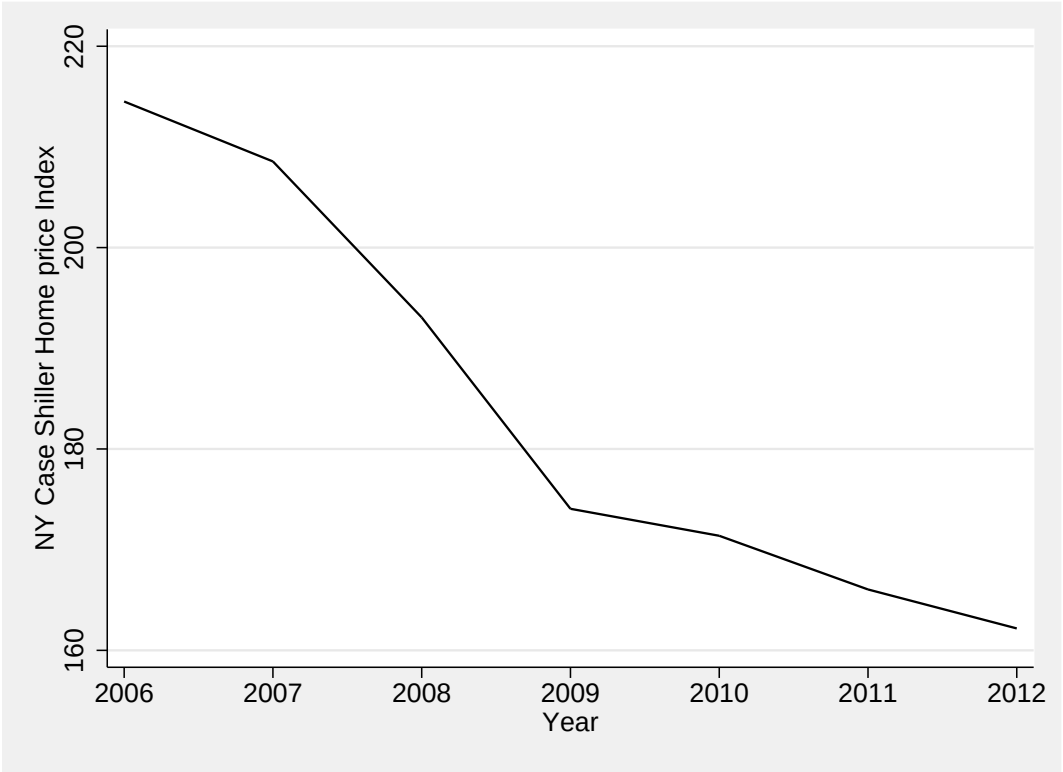


Figure 4.5 Case-Shiller New York Home Price Index

Note: The graph tracks changes in housing prices in NYC for the sample period.

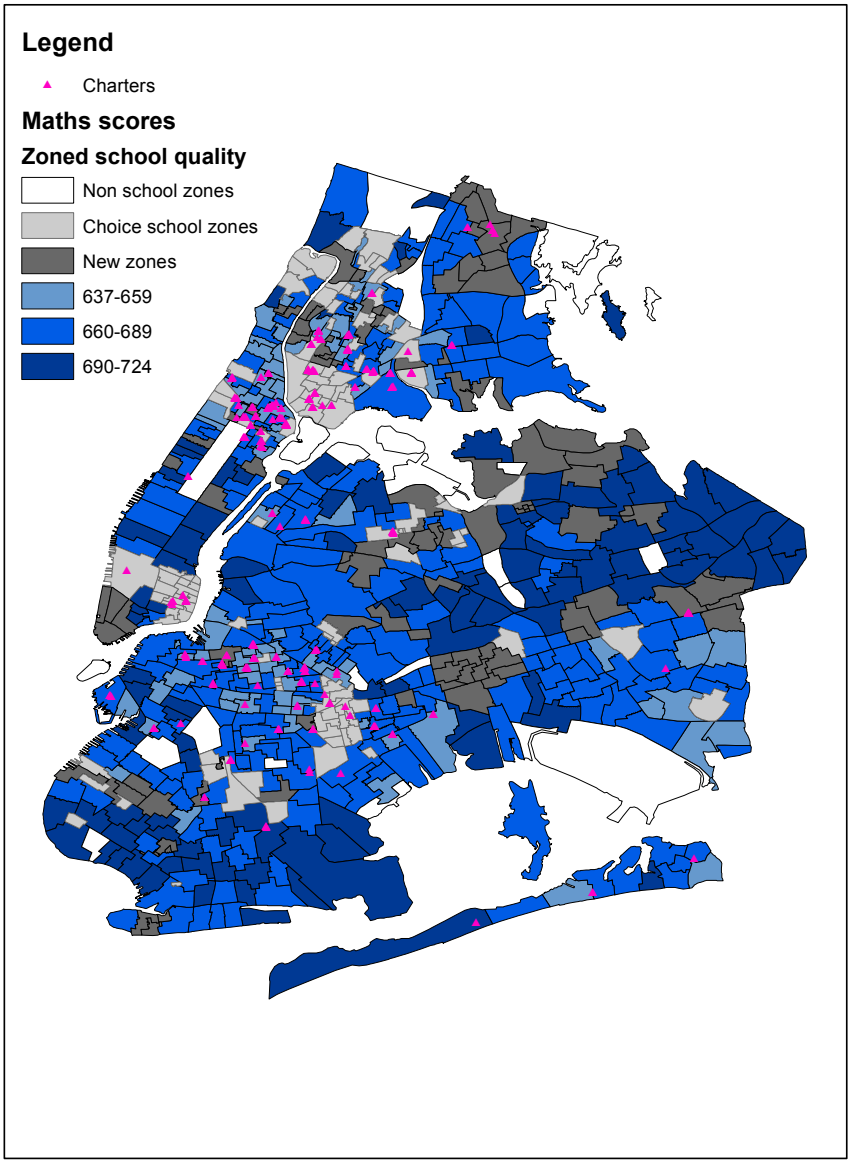


Figure 4.6 Charter location and zoned school quality

Table 4.1 Characteristics of residential properties sold

	Full sample	**0.35 mile**
Sale price	$650,245	$607,294
Sale year	2010	2010
Unit size (square feet)	3,231	2,792
Lot size (square feet)	3,215	3,020
Unit age	69	70
Median census tract household income	$44,972	$44,227
Percent black in census tract	28.26%	30.61%
Math score on grade 3 NY state test	688	688
Borough		
Manhattan	2.32%	1.12%
Bronx	9.67%	7.59%
Brooklyn	31.21%	34.81%
Queens	41.20%	42.84%
Staten Island	15.59%	13.65%
Charter operating within less than 1 mile	4.97%	3.47%
N	143,977	100,866

Notes: Summary statistics are produced using NYC house sales from 2007 to 2013 and data on zoned school quality and charters from the NYC Department of Education (NYCDOE) and the Common Core Data (CCD).

Table 4.2 Capitalization of zoned school quality in housing prices

	Full sample (1)	**Full sample** (2)	**0.35 mile** (3)	**0.35 mile** (4)	**0.35 mile** (5)
Standardized math score	0.1482**	0.0213**	0.1474**	0.0310**	0.0018
	(0.0078)	(0.0072)	(0.0085)	(0.0053)	(0.0053)
Standardized math score squared	0.0090**	0.0131**	0.0095*	0.0111**	0.0106**
	(0.0035)	(0.0024)	(0.0039)	(0.0020)	(0.0018)
Unit size (1,000 square feet)	0.0038**	0.0039**	0.0081**	0.0081**	0.0082**
	(0.0011)	(0.0011)	(0.0019)	(0.0019)	(0.0019)
Lot size (1,000 square feet)	0.0028	0.0021	-0.0000	-0.0001	-0.0002
	(0.0026)	(0.0022)	(0.0025)	(0.0021)	(0.0020)
Unit age	-0.0020**	-0.0019**	-0.0018**	-0.0026**	-0.0027**
	(0.0002)	(0.0002)	(0.0003)	(0.0001)	(0.0001)
Median census tract household income (1,000 dollars)		0.0080**			0.0044**
		(0.0007)			(0.0005)
Percent black in census tract		-0.0047**			-0.0046**
		(0.0002)			(0.0003)
Boundary fixed effects	No	No	No	Yes	Yes
Mean Housing price	650,245	650,245	607,294	607,294	607,294
Adjusted R-squared	0.331	0.379	0.291	0.413	0.421
Number of observations	143,977	143,977	100,866	100,866	100,866

Notes: The dependent variable is log of housing prices. All regressions include year by quarter fixed effects, borough fixed effects, and building type fixed effects. The data includes 45 building types. Source of the data is NYC house sales from 2007 to 2013 and data on charters is from the NYCDOE and the CCD. Standard errors in parentheses are clustered at the elementary school zone level. + p <0.10, * p <0.05, ** p <0.01.

Table 4.3 Charter penetration

	Standardized test score	**Standardized test score**	**Standardized test score**	**School quality: terciles**	**School quality: terciles**	**School quality: terciles**
	(1)	(2)	(3)	(4)	(5)	(6)
Charter operating within less than 1 mile		-0.0566*	-0.0607*		-0.0609**	-0.0422
		(0.0230)	(0.0262)		(0.0230)	(0.0337)
Standardized math score	0.0018	0.0024	0.0027			
	(0.0053)	(0.0053)	(0.0054)			
Standardized math score squared	0.0106**	0.0105**	0.0105**			
	(0.0018)	(0.0018)	(0.0018)			
Charter operating within less than 1 mile X Standardized math score			-0.0207			
			(0.0294)			
Charter operating within less than 1 mile X Standardized math score squared			-0.0079			
			(0.0129)			
Tercile 1				-0.0028	-0.0029	-0.0022
				(0.0099)	(0.0099)	(0.0100)
Tercile 3				0.0388**	0.0390**	0.0403**
				(0.0103)	(0.0103)	(0.0103)
Charter operating within less than 1 mile X Tercile 1						-0.0199
						(0.0437)
Charter operating within less than 1 mile X Tercile 3						-0.0808
						(0.0593)
Median census tract household income (1,000 dollars)	0.0044**	0.0044**	0.0044**	0.0044**	0.0044**	0.0044**
	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)
Percent black in census tract	-0.0046**	-0.0046**	-0.0046**	-0.0044**	-0.0044**	-0.0043**
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Adjusted R-squared	0.421	0.421	0.421	0.420	0.421	0.421

Notes: The dependent variable is log of housing prices. All regressions include year by quarter fixed effects, borough fixed effects, building type fixed effects and boundary fixed effects. The regressions include all the covariates from table 4.3. Source of the data is NYC house sales from 2007 to 2013 and data on charters is from the NYC Department of Education and the Common Core Data. Standard errors in parentheses are clustered at the elementary school zone level. + p <0.10, * p <0.05, ** p <0.01.

CHAPTER

5

CONCLUSION

We postulate that there are three channels by which charters can impact housing prices: (1) the de-linking hypothesis: charters weaken the link between zoned school quality and residential choice (2) the information hypothesis: charters act as a signal that households should avoid a neighborhood (3)the amenity/disamenity hypothesis: charters' characteristics are capitalized in housing prices. Under a zoned school system, a household that wants to access higher quality schools, has to locate in that school's zoned area. Introducing charters makes it possible for a household to locate in an area with a lower quality zoned school but still access a charter school that substitutes for the higher quality zoned school. This is the de-linking hypothesis. The residential sorting that follows the introduction of charters would lead to an increase in housing prices in areas previously linked to lower quality schools. House prices in areas with higher quality school zones would decrease.

The information hypothesis is a consequence of charters' location decisions. Charters locate in areas with lower housing prices. If the presence of a charter acts as a transparent signal to households to avoid residing in an area, the effect of charters on housing prices

would be limited to areas where charters locate. The capitalization of charters' characteristics in housing prices, the amenity/disamenity hypothesis, depends on the effect of charters on academic performance and the link that charter priorities create with houses. The effect of charters would again be limited to where they locate but it can be positive or negative depending on their effect on academic performance.

We empirically investigate the impact of charters on housing prices. We document a pattern that suggests that charter schools impact housing prices by acting as substitutes to zoned schools. In chapter 3, we use data from multiple metropolitan areas to examine the effect of charter policy in general and not just the impact of one intervention. We find that the effect of charter policy is positive in the bottom part of the distribution and negative in the upper part of the housing price distribution. We also report that the negative effect of charter policy is larger in counties with a higher amenity scale. These results do not support the information hypothesis or the amenity/disamenity hypothesis but rather they suggest that charters are weakening the link between zoned school quality and residential choice (de-linking hypothesis).

In chapter 4, we explore whether charter schools weakened the link between school quality and housing prices using a more direct approach. Using NYC data with detailed geographic identifiers which allows us to control for boundary fixed effects and zoned school quality, we find that charters operating within 1 mile of a house are associated with a decrease in housing prices. Using a sample of houses 0.35 miles from elementary school zone boundaries and interacting zoned school quality and charter penetration, we are unable to confirm the heterogeneous impact of charter schools on housing prices by zoned school quality.

In this dissertation, we present results that suggest that charter schools impact housing prices by weakening the link between public school quality and residential choice. The pattern of the effect of charters on housing prices suggest that households do not view charters as a disamenity. Changes in housing prices are important because housing equity is a form of wealth so any change in that wealth is going to affect household's welfare. Additionally, changes in housing values would impact property taxes and consequently impact zoned and charter school funding. Further research on these unintended consequences is necessary.

The effect of charter school on academic performance varies by school which creates

controversy over the effectiveness of this policy intervention on average. By examining another outcome of interest, housing prices, we are able to learn more about households' valuation of charters. Households regardless of their socio-economic background take advantage of charters. Charters locate in low-income neighborhoods which makes them accessible to students in those neighborhoods. A well-performing charter is able to attract high-income students. Unlike open enrollment policies, charter allow low-income students to take advantage of choice with little or no transportation costs.

Charter school policy seem to have achieved its goal of providing students with choice. Households perceive charters as a substitute to zoned schools. However charter school quality is still very heterogeneous. Future research on what elements of charter schools positively impact academic performance can help improve and streamline charter schools' design. With proper adjustments to the charter school model, charter school policy has the potential of being effective at achieving its goals.

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Appendix

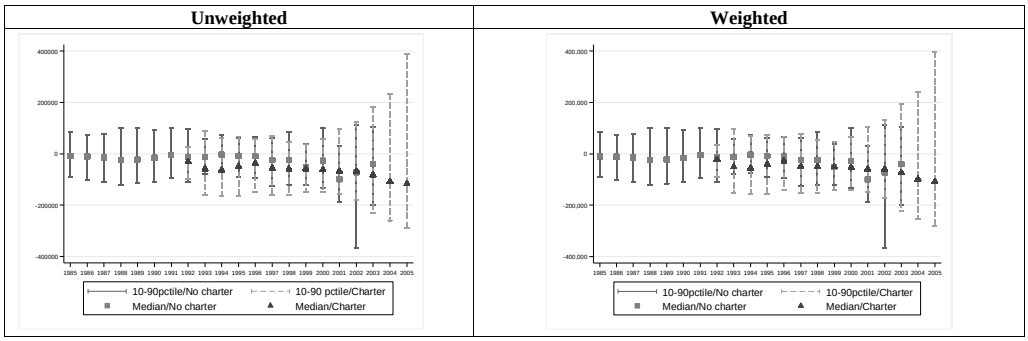

Figure A.1 Median, 10th, and 90th percentile (residual from level regression)

Table A.1 Data set construction

Pool owned units in AHS 1985 to 2011	397,185
Remove if inherited, not bought or date of transaction not reported	377,428
Remove duplicates\keep interview closest to transaction date	295,997
Remove county and state not disclosed or located in D.C.	173,266
Keep House, apartment, or flat	166,302
Keep Price reported	146,298
Keep square footage and lot size reported and not top-coded	98,847
Remove date of transaction before 1985 or after 2005	50,943
Remove if Interview date -Transaction date >10	44,418
Remove the lowest 1% of the price distribution	43,974
Keep number of bedrooms reported and at least 1 bedroom and 1 bathroom	43,927
Keep if amenity scale available	43,449

The table presents the different steps needed to produce the sample used in chapter 3.

Table A.2 Sensitivity to sample selection criteria

	(1)	(2)	(3)	(4)	(5)
Charter	-0.174^{+}	-0.166^{+}	-0.175^{+}	-0.168^{+}	-0.166^{+}
	(0.086)	(0.081)	(0.085)	(0.094)	(0.083)
House age	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
House age quadratic	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Lot (10k sqft)	0.000*	0.000*	0.000*	0.000*	0.000*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Unit size (10k sqft)	0.134**	0.135**	0.133**	0.134**	0.132**
	(0.025)	(0.026)	(0.025)	(0.026)	(0.025)
Bedrooms	0.040**	0.036*	0.041**	0.050**	0.042**
	(0.013)	(0.014)	(0.013)	(0.015)	(0.012)
Baths	0.207**	0.208**	0.207**	0.199**	0.200**
	(0.017)	(0.017)	(0.016)	(0.016)	(0.017)
Half baths	0.143**	0.140**	0.143**	0.152**	0.139**
	(0.013)	(0.013)	(0.013)	(0.012)	(0.011)
Fireplace	0.200**	0.196**	0.200**	0.211**	0.205**
	(0.019)	(0.018)	(0.019)	(0.020)	(0.020)
Basement	0.042	0.041	0.043	0.063*	0.044
	(0.027)	(0.026)	(0.027)	(0.029)	(0.027)
Garage	0.157**	0.161**	0.157**	0.213**	0.156**
	(0.012)	(0.013)	(0.012)	(0.025)	(0.012)
Heating unit: gas	0.004	-0.005	0.004	0.012	0.006
	(0.044)	(0.047)	(0.044)	(0.043)	(0.045)
Central air	0.086	0.088	0.087	0.098	0.087
	(0.060)	(0.056)	(0.060)	(0.066)	(0.059)
Amenity scale	0.040^{+}	0.032	0.040^{+}	0.039^{+}	0.038^{+}
	(0.021)	(0.027)	(0.021)	(0.023)	(0.021)
Land area (10k)	-0.245**	-0.283**	-0.244**	-0.272**	-0.240**
	(0.037)	(0.037)	(0.037)	(0.036)	(0.036)
Log (Percent water area)	-0.007	-0.009	-0.006	-0.005	-0.007
	(0.020)	(0.023)	(0.020)	(0.021)	(0.020)
Mean price (2005 dollars)	208,708	212,295	208,523	206,573	205,,293
Adjusted R-squared	0.571	0.575	0.570	0.444	0.566
N	43,449	31,428	47,920	43,888	43,009

The results are using the sample of houses sold between 1985 and 2005. All the regressions in the table include year fixed effects, state fixed effects, state specific quadratic time trend, and house and county characteristics. Standard errors in parentheses are clustered at the state level. Column (1) includes results from the sample of houses that reported sale price within 10 years of sale date. Column (2) includes results from the sample of houses that reported sale price within 5 years of sale date. Column (3) includes results from the sample of houses that reported sale price within 15 years of sale date.Column (4) included results from the sample of houses that includes the lowest 1 percent of houses. Column (4) includes results from the sample of houses that excludes the lowest and highest 1 percent of house prices.+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.

Table A.3 Sensitivity to charter definition

	(1)	(2)	(3)
Charter policy in place for at least one year	-0.174^{+}		
	(0.086)		
Year charter policy enacted		-0.074^{+}	
		(0.042)	
Charter policy in place for at least 2 years			-0.231*
			(0.093)
Adjusted R-squared	0.571	0.570	0.571

The results are using the full sample of 43,499 houses sold between 1985 and 2005 with an average house price of 208,708 dollars. All the regressions in the table include year fixed effects, state fixed effects, state specific quadratic time trend, and house and county characteristics. Standard errors in parentheses are clustered at the state level. + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.