A HEDONIC ANALYSIS OF SCHOOL QUALITY VALUATION UNDER THE
UNIVERSAL LOTTERY SYSTEM IN WASHINGTON, D.C.

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By

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ABSTRACT

School quality is one of many characteristics that impact the price of a house. Though public schooling in the United States is a “free” public good, the quality of the local public schooling options is capitalized in the price of the house. Scholars estimate that an increase in school quality equivalent to a 5 percent increase in test scores increases housing prices by 2.5 percent (Black 1999). This thesis seeks to clarify how this relationship is changed under My School DC; a universal lottery system implemented in the District of Columbia. With the inclusion of variables that capture school competition, the house premium for high quality schools shrinks, mostly driven by catchment areas with low boundary participation (low competition). This pattern varies by ward and type of school. This study opens the door to better evaluation of school capitalization under a universal school lottery through novel application of competition data, while providing suggestions for future research and improved data collection.

Key words: hedonic analysis, housing prices, school choice, universal lottery, Washington, D.C.

JEL: I21, I24, R3, O18
This thesis is dedicated to everyone who believed in the importance of this research and guided me along the way. To my advisor Professor Catilina, who encouraged me to highlight the novel contributions of this work. I am so grateful to all my professors at the McCourt School; they recognized my strengths and helped me to grow in ways I could not have imagined. This thesis would not be possible without my parents, who always support me as an academic and an individual. To John, the best partner in life and quarantine.

Many thanks,
Lucy Hadley
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Introduction

In 2014, at the press conference announcing Promise Zones, President Obama declared, that a “child’s course in life should be determined not by the zip code she’s born in” (Slack & Oken, 2014). Though this has become a common refrain among candidates for office, divorcing education quality from wealth and geography is an unfulfilled promise in America. Though public education is supposed to be “free and appropriate” for all, wealthy families buy access to high-quality schools through the purchase of a home in a high-quality catchment area. As a result, American communities experienced Tiebout-like sorting,¹ where those with a high willingness to pay for a public good sort into neighborhoods based on these preferences. In Tiebout’s theory, the quality of the public goods is necessarily capitalized into the housing prices as a way to exclude freeloaders and raise extra revenue for public goods (Gruber, 2016). This relationship has been quantified in the rich body of hedonic analysis research. As a result, in practice the American education based on neighborhood assignment means the quality of school is based on the quality of a student’s house. These economic disparities are closely mirrored by racial inequality (Condron & Roscigno, 2003; Baker & Green, 2005; Vaught, 2009). Tying school enrollment to neighborhoods has driven race and income-based disparities in enrollment, funding, teacher quality, academic performance, and later-life outcomes (Darling-Hammond, 1998; Johnson, 2014).

School choice policies can “uncouple” students from their neighborhood by conducting school assignment based on parent preferences rather than zip code (Coffin, 2019). This research aims to identify whether the new form of assignment disrupts the correlation between housing

¹ Charles Tiebout (1924–1968) postulated that “competition” between local entities results in the proper provision of public goods based on the citizens’ preferences. He did not state that this sorting led to equitable distribution of public goods. Indeed, one result of his theory is inequal access to services (Gruber, 2016)
prices and school quality. This research aims to address this question in the District of Columbia (D.C.) under My School DC, a universal lottery system. The methods build on previous models of parent-preference and housing costs, but with the additional condition of school choice policy (Oates, 1969; Black, 1999; Kane et al., 2006; Downes & Zabel, 2002).

**Background**

D.C. has an innovative and widely used choice policy. Students in all grades PK3-12² have the option to enter a unified lottery to apply to all traditional public and charter schools administrated by the District of Columbia Public Schools (DCPS) (My School DC, n.d.). To apply to most schools, parents simply include them in a ranked list of their top 12 schools. Some specialty high-school programs require an application, interview, or portfolio. If a student/parent does not fill out the lottery, the student is automatically assigned to their neighborhood school. During the SY 2019-2020 application cycle, 24,996 students submitted an application, consistent with a constant upward trend in participation (Austermuhle, 2019). The lottery and selection process is widely seen as fair and transparent (Office of the District of Columbia Auditor, 2018). Only 26% of D.C. public school students attend their in-boundary school (Keenan, 2019).

One outcome we expect from lotteries is increased competition between schools. In a system of parent choice, rather than geographic assignment, there is high demand for seats at high quality schools. Subsequently there is decreased demand for underperforming schools, leaving the city with uniformly high-quality schools (Hoxby, 1994). Currently this prediction is not playing out, and D.C. students perform below the national average on standardized math and reading exams (National Assessment of Educational Progress, 2019). Furthermore, D.C.’s

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² All PK3 and PK4 students must enter the lottery for a seat; they are not guaranteed a spot at their local elementary school (My School DC, n.d.).
“priority” schools are disproportionately located in D.C.’s poor and black neighborhoods (Office of the State Superintendent of Education, 2017). While DCPS has closed almost 40 schools since 2008, these closures have not necessarily created positive academic outcomes or mobility for students (Ozek, Hansen & Gonzalez, 2012). Furthermore, these closures disproportionately affect families of color in the District, negatively impacting the academic and economic success of their neighborhoods (McMillian, 2018). Conversely, there is a long waitlist at some neighborhood schools in Northwest, suggesting that some families may continue to pay the housing premium for a guaranteed seat. Without prompt closures of underperforming schools, the competition created by the school choice model will not necessarily increase educational access for all.

Given the high participation in the My School DC lottery scheme, some scholarship suggests that D.C. students are generally “uncoupled” from their neighborhood school (Coffin, 2019). If this is true, we can expect several outcomes. First, sorting around preferred school districts will decrease, as families do not need to live near a good school in order to send their child to one. Second, and related, housing prices around high-quality schools will decrease, or at least increase less rapidly. As demand for housing in high-quality catchment areas decreases, the willingness to pay decreases accordingly. Approaching this statistically, we would expect that the effect size of academic indicators becomes smaller as parents can access high quality schools without buying into catchment areas.

Third, if schools are truly uncoupled, we would see a decreased correlation between the demographics of school and those of the neighborhood where the school is located. The effect on

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3 The D.C. Office of the State Superintendent of Education (OSSE) defines a priority school as a school that fails certain thresholds of quality on a school quality index, graduation rates, or low standardized assessment participation (Gaskins, n.d.).
residential segregation is less clear. Although it is possible that a wider distribution of high-quality schools would increase segregation, many factors impact neighborhood preference, and therefore it is hard to determine whether school choice has an impact.

Research suggest that this policy has impacted school demographics: D.C. schools have become less segregated since the policy was initiated (Mordechay & Ayscue, 2017). Public schools are integrating faster than charter schools. Wards 1 & 3 are the most integrated while Wards 7 & 8 remain majority black and racially isolated (Mordechay & Ayscue, 2017). The effect of choice on these patterns is arguable: since 2006, D.C. has seen an influx of population that is richer, whiter and younger than the previous residents. This caused a surge in school-aged white children, providing a potential avenue for integration (Coffin, 2019). In some of the fastest-gentrifying areas, white enrollment jumped from one percent of enrollment to eight percent (Mordechay & Ayscue, 2017). However, the fact that integration was best accomplished in gentrifying areas suggests that white gentrifiers are not uncoupled from their school and might still buy homes in order to access schools in these improving neighborhoods.

Understanding the effect of this lottery has relevance for future choice and housing policy decisions. This study sheds light on the efficacy of universal school lotteries with respect to residential segregation and parental preferences. Several other school districts are testing similar lottery systems, and this methodology may be used to make predictions about possible impacts. Finally, districts must be aware of the impact of these polices on tax revenue. If parents no longer have to pay a premium for access to a high-quality school, home values may stagnate, leaving districts with less money than predicted for education and other services. This thesis examines how this choice policy has impacted housing sales in hopes of offering some insights...
on these questions. I also provide some suggestions for future work in the areas of data collection and research on rental units and segregation.

**Literature Review**

There is a rich body of scholarship that guides the approach of this thesis. This section discusses the contributions of previous scholars regarding hedonic price modeling, parent choice, and school choice and competition. Combined, these areas of scholarship outline the ecosystem which forms the relationship between school quality and housing prices under the My School DC universal lottery system. Hedonic modeling first implemented by Oates (1969) provides the quantitative method for measuring how the universal lottery impacts the relationship between school quality and housing prices. Understanding the factors behind parents’ school preferences helps undergird the control and explanatory variables needed to explain the capitalization of school quality under a school choice regime. Finally, this chapter will describe scholarship on school competition. This literature is important to this thesis as it explains how parents might react to competition for limited seats in overenrolled, high quality schools.

**Hedonic Price Modeling**

Hedonic price modeling is an established practice for modeling the effect of certain characteristics on home prices. Researchers have applied this strategy to study how housing prices are affected by anything from public parks to tax rates to transportation (Oates, 1969; Troy & Grove, 2008; Charlot, Paty & Visalli, 2013; Hawkins & Habib, 2018). Model specification is challenging, as there are many unobservable characteristics that impact housing prices, and thus the coefficients on covariates tend to be biased. In general, most studies find that the expenditure on public programs increases property values, and recoups at least the cost through tax revenue.

Hedonic price modeling is widely used to model the impact of school characteristics on housing prices. Since Oates’ (1969) formative paper on the subject, accepted practices for
correct model specification have changed dramatically, and scholars have attempted to identify the impact of school quality using different variables and time and space scales.

In one of the first studies on private tax capitalization, Oates found that property values have a positive association with expenditures on public benefits, and negative association with the property tax rate. This aligns with the modern tax structure of wealthy communities: wealthy individuals tend to gather in low tax areas, and the concentrated property wealth is sufficient to provide excellent public goods even though they are being taxed at a low rate. Meanwhile, low-income communities must tax at a much higher rate to receive the same revenue (Urban Institute, 2017). Oates’ peers and contemporary scholars critiqued his methods for several reasons (Downes & Zabel, 2002). Firstly, modern scholars have improved upon the measures of neighborhood quality that Oates chose (Black, 1999). Secondly, he used median house price for an area, rather than disaggregated home prices, reducing the power of the estimate. Finally, his measure of public good quality, expenditures per elementary school pupil, is an imprecise measure of school quality. Additionally, it is highly correlated with income, leading to a biased estimate of the impact of both income and spending.

In her study of Boston, Black (1999) improves upon Oates’ control for neighborhood characteristics. By using neighboring houses that are zoned for different attendance boundaries, Black was able to see the impact of different test scores on houses with identical neighborhood characteristics. Black acknowledges the potential impact of the Massachusetts’ intra-district school choice program, which began in the 1991-1992 school year. Because the program was fairly small, and students could only transfer for certain pedagogical and diversity justifications, Black believed this program would not greatly bias her results. If school choice did impact her programs, then it is possible Black underestimated the effect of school quality on housing prices.
This thesis aims to build on Black’s boundary method while contributing estimates that explicitly account for a robust school choice program.

Building on Black and others, Downes and Zabel (2002) made two important contributions. Firstly, they emphasize that school-level, rather than district-level data, is most accurate for predicting schools’ impact on housing prices. This supports the idea that hedonic studies can be done within rather than between municipalities and districts, comparing the impact of individual schools rather than differences between districts. Second, they found that parents were more likely to make housing decisions based on school outputs like test scores rather than inputs such as per-pupil spending. Downes and Zabel’s findings reinforce that school-level outputs are appropriate for hedonic analysis, since we are working within one district, the District of Columbia.

**Measuring Parent Preferences**

One of the common debates in this literature concerns how to measure school quality. Some studies used “objective” outputs like test scores and graduation rates (Black, 1999; Brasington,1999). Others (like Oates) use inputs, such as per pupil funding or teachers’ level of education (Brasington,1999). This thesis considers which factors D.C. parents identify as central to their school choice.

Including parents’ self-reported preferences is important for model specification. In order to make conclusions regarding how school choice impacts schooling and housing decisions, it is important to include variables that accurately capture parent preferences. If the model uses measures of quality that are unknown to parents, then we cannot be sure if is capturing willingness to pay for schools.

While capturing parents’ private decision-making process may be difficult, D.C. has relatively good survey data on the matter. A 2018 survey study conducted for the Office of the
District of Columbia Auditor (2018) shows parents generally say that the quality of the educators and the rigor of the curriculum are the most important qualities they consider when choosing a school. This presents a challenge for model specification, as the experience level of teachers and the rigor of the classroom environment are hard variables to capture. Traditional assessment measures, such as class sizes and test scores, ranked less highly, but were still important factors for 73% of all parents (ODCA, 2018).

The racial background of a parent impacts their school preferences (Whitehurst, 2017; Yoon & Lubienski, 2017). As school choice policy seeks to curb racial segregation, increase competition among schools, and increase equity, policymakers must understand how these policies may affect different demographics. For example, black students are much more likely to participate in choice programs when transportation is offered, whereas other racial groups do not have such a dramatic increase in participation (Whitehurst, 2017). Whether due to prejudice, habit, or desire for belonging, parents tend to enroll their child in schools where the child is the same race as the majority of students ⁴(Kleitz et al., 2000; Schneider & Buckley, 2002; Smrekar & Honey, 2015). In New York City, black families’ first choice schools have worse learning outcomes and are more racially isolated than those of other racial groups (Whitehurst & Whitfield, 2013). This seems to be the case in D.C. as well, with black parents giving less importance to the racial diversity of a school than parents of all other racial backgrounds (ODCA, 2018).

In addition, we have some indication of which schools parents prefer from the waitlists. Waitlists may indicate a parent’s preference when they cannot afford to buy-in to a successful

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⁴ This trend is less strong for Latinx families, who enroll their children in majority white schools with more frequency than black families. Perhaps due to less residential racial isolation, Asians are unlikely to find a school where they are the majority, and they tend to enroll in majority white schools (NCES, 2017).
catchment area. However, waitlists pose some complications as a measure of parent preference. Parents may choose the school due to heightened coverage in local media or social networks, rather than school quality. Additionally, because the waitlist does not represent a commitment to a certain school, it is difficult to assign an intensity of preference to this action.

**School Choice and Competition**

Directed by this extensive body of literature, one could estimate the price of a house in D.C. given its property, neighborhood, and school qualities. However, the relationship between schooling and housing in D.C. is complicated by universal school choice. Unlike Black’s dismissal of the impact of school choice in 1990’s Boston, D.C.’s school choice policy is much more pervasive.

Though school choice and its relationship to learning and later-life outcomes, racial segregation, and parent satisfaction are widely studied, the relationship between school choice and housing is less thoroughly examined in an American context. In their study of school choice in Oslo County, Machin and Salvanes (2016) find that school choice reduces the impact of school quality on housing prices by about 50%. They attribute this directly to reduced competition for housing in the catchment areas of preferred schools. They also found a diminished relationship between the probability of moving, and the quality of the school, suggesting that in a system with choice, parents were less likely to move for access to a school. While this has interesting implications for D.C. policymakers, similar modeling should be replicated with D.C. data due to the heterogeneity of the parents. Furthermore, D.C.’s choice policy is limited to the city and residence in a desirable catchment area supersedes the lottery (unlike in Oslo).

Besides allowing parents mobility, school choice also create a new kind of competition, as seats are now opened to all children, rather than just those in living in the catchment area. In
their examination of London and the South East of England, Gibbons and Machin (2006) find that this competition tends to increase housing prices for houses near popular (over-enrolled) schools. They creatively use distance to school and school capacity as measures of parental preference and school competition in the complicated English system of school assignment. This approach would be useful to replicate in the context of D.C., where school choice has created immense enrollment pressure on certain schools. It is meaningful to investigate if choice exacerbates the same school quality house premium, as parents are willing to pay for a guaranteed spot.

Like Gibbons and Machin (2006), researchers studying the American context have applied clever measures of school competition to make up for the lack of data collection on school choice polices. In their analysis of New York choice schools Schwartz, Voicu & Horn (2014) compare housing units within 3,000 feet of a choice school (usually a magnet or charter school in the NYC context) with those beyond this buffer because they hypothesize parents are willing to pay more to be close to a high quality schooling option, even if that option is not guaranteed given the random nature of lottery acceptance. They also create an indicator for choice school openings and closings, allowing them to see how the capitalization of school quality changes when the choice policy is “implemented” locally. The authors find “the opening of a choice school reduces the capitalization of test scores from zoned schools into housing values by approximately one third,” suggesting that with the addition of a choice option, parents may feel less pressure to buy into an expensive catchment area (Schwartz, Voicu & Horn, 2014, p.4).

Bibler and Billings (2019) address slightly different questions; they are focused on the mobility of lottery winners versus losers in overenrolled catchment areas in the Charlotte-
Mecklenburg schools. Though many families in their study exited the public-school systems or moved to other districts, many moved within the district to higher-quality school catchment areas and accepted the related higher average home values. They state their findings have the most relevance for students assigned to schools of average school quality, with a high preference for school quality, and thus an incentive to enter the lottery or move in order to obtain access to a better school.

These studies of Oslo, London & Southern England, New York City, and Charlotte-Mecklenburg schools highlight the range of unique methods of measuring school competition. Specifically, they highlight how researchers can work with limited variables to reflect the competition created by the unique choice policies of their community. D.C. has a robust data system associated with My School DC, which includes the three variables used to capture school competition in this analysis. They reflect the degree to which students are attending the school they are assigned to, and demand for limited spots. The author cannot find previous studies that apply these variables for hedonic analysis. Thus, there is little scholarship to directly support the relevance of these variables. However, like the other early studies discussed here, these variables have significant effects in the models, and they align with conceptual models of the city’s specific choice policies.

**Conceptual Method**

As the review of literature suggests, it has been consistently difficult to estimate how schools impact housing prices. Prices are combination of countless factors, latent and observed. As observed by Oates (1969), using school quality alone will overestimate the effect of school quality on housing prices. Differences in resources and parent education are correlated both with school quality and housing prices. Median income of the neighborhood is another important confounder, as it is correlated with both school quality and housing prices. However, at the upper
bounds of this variable, many parents may send their child to private school, and thus the quality of the neighborhood school may not impact their real-estate decisions. Similarly, if transportation and walkability are high, then parents may feel less pressure to buy a home “attached” to a good school, because they can easily access other satisfactory options through the lottery. Whether the neighborhood is kid-friendly may also impact both prices and school competition.

Since there are dozens of possible neighborhood factors that impact housing prices, there is a risk of over-specifying the model. As first described by Black (1999), modeling boundary effects controls for neighborhood characteristics while allowing for discrete “jumps” in school quality and competition. Houses that are close to each other on either side of a school catchment boundary may be identical in terms of neighborhood characteristics, while school characteristics may change significantly as one crosses the border.

School quality, assessed through the proxy of median test scores, passing rates, or proficiency rates, is a common feature of hedonic models in the education policy space. This continues to be an important variable for this analysis. To this factor, I will add indicators of school competitiveness. If a neighborhood school is highly competitive, it follows that parents will be willing to pay a premium for guaranteed admittance. Though parent choices are likely associated with strong test scores, they are inevitably formed by many other factors too, including parent perceptions, social networks, school branding, and media attention. Because measure of competitiveness quantify demand for certain types of schooling, these variables may be very helpful in capturing some of the latent preferences discussed below.

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5 In the My School DC system, you are guaranteed a spot in your in-boundary school (My School DC, n.d.).
Private or latent preferences are very hard to observe, but nonetheless effect both home and school selection. For example, a parent’s profession might affect their need for ample street parking, and also after-school care for their children. Furthermore, a person’s education, race, and social networks may impact why they prefer a certain school or neighborhood. Unfortunately, these are all unobservable characteristics, though elements may be partially controlled for by the inclusion of boundary indicators, as affirmed by Black (1999).

The general model is as follows:
\[
\ln(houseprice) = \alpha + \beta_{academicproficiency} + \gamma_{boundary} + \gamma_{schoolcompetition} + \rho_{housequality} + \\
\tau_{Post} + \phi_{specialityschool} + \mu
\]

Where the change in house price is attributed to a vector of neighborhood qualities, including the neighborhood where it is, and school characteristics, including which catchment boundary it is in, and the competitiveness of the neighborhood school.

I predict school quality will have a smaller effect on house prices than previous estimates, due to the universal lottery system. High demand neighborhood schools, defined as schools with large waitlist and high in-boundary and boundary participation rates, will have a positive effect on housing prices.

**Data and Methods**

This analysis combines several data sets to match each house with its neighborhood characteristics, and its assigned elementary school. The unit of observation is the house. In order to capture the change associated from the universal lottery policy, the data captures these factors for the years 2010 to 2017.

Housing data comes from the D.C. record of home sales, the Integrated Tax System Public Extract-Property Sales (Open Data DC, 2019a). The variable *last sale price* will be used
for housing value. All prices are converted to 2009 dollars to account for inflation. Non-residential and vacant properties were removed from the sample. The variable land area controls for lot size. An indicator unit was created for all properties recorded with a unit number, to control for condos, or owner-occupied apartments. Latitude and longitude of each property are used to assign each house to its elementary catchment area. Outliers above or below three standard deviations from the mean house price are dropped from the sample.

Catchment boundary shapefiles originate from School Attendance Zones (Elementary) and School Attendance Zones (Elementary-Old) (Open Data DC, 2019c; Open Data DC, 2019b). DCPS conducted a dramatic re-districting effort, culminating in the 2014-2015 school year. Houses sold before 2015 are assigned to their pre-2014 boundaries using the School Attendance Zones (Elementary-Old) shapefile, and all houses sold after that time were assigned to their neighborhood school using the School Attendance Zones (Elementary) dataset.

Using the Integrated Tax System Public Extract Property Sales data, DCPS catchment boundaries, and GIS software, I assigned each house to its catchment boundary and identifies the second closest boundary. In previous studies, authors limited their sample to houses within 0.3 miles of a boundary, in order to compare school effects on housing, for houses with practically identical neighborhood characteristics (Black, 1999). However, in D.C. only a few houses (~4.7 percent) are more than 0.3 miles from a boundary, and therefore all houses can be retained. None are more than .9 miles from a boundary. Dropping the houses further than .3 miles from a boundary would result in more attrition from a few large catchment areas, making the results less applicable to those boundary areas.\(^6\)

\(^6\) DCPS does not provide transportation to schools. As a result, parents in these larger catchment areas may already drive their children to school or have alternative arrangements for transportation (DCPS, 2017a).
School quality is proxied through a measure of academic achievement. The measure of academic proficiency changed during the study time period, from the DPCS Comprehensive Assessment System (CAS) test to the Partnership for Assessment of Readiness for College and Career (PARCC) test. Before school year 2014-2015, ELA and Math proficiency is measured as the percent of third graders at each house’s neighborhood elementary school scoring proficient or above on the ELA or Math section of the CAS test (DCPS, 2010-2014). Starting in school year 2014-2015, the measure is the same, only substituting the PARCC test (DCPS, 2015-2018). For this analysis, I use third grade measures of proficiency, as this may approximate the time when young parents would be buying a house with school quality in mind. Furthermore, by third grade, much of a child’s academic success can be attributed to their school environment, and teacher perception and reading ability appear to matter more than family context (Reynolds & Bezruyczko, 1993).

Measure of competition come from the dataset: Waitlist data and seats made available in the lottery by school year 2014-2018 (My School DC, 2014-2018). In this dataset, the size of the waitlist indicates the number of students who were not initially matched with a school, but instead were placed on a list with the possibility of gaining a seat if a matched student refused their offer. Measures of enrollment at assigned neighborhood schools are captured by in-boundary rate and boundary participation rate (My School DC, 2014-2018). In-boundary rate is defined as the number of students attending the school who live in-boundary, divided by the total number of enrolled students(My School DC, 2014-2018). Boundary participation captures the ratio of students who live in the boundary and attend the school divided by the total number of students assigned to that neighborhood school (My School DC, 2014-2018). Because these variables were only generated at the time of the implementation of the lottery, these variables do
not exist before 2014. To remedy this, all pre-2014 waitlists are set to zero. In-boundary and Boundary participation rates are set to 1, assuming all students attend their assigned school. This is not necessarily accurate; in the pre-treatment period, students could enter a lottery for a seat in a charter school and others attended private school. However, given the lack of pre-lottery figures, this is was the least arguable imputation method. Given these assumptions, it is likely this analysis underestimates the impact of the lottery system, given that I cannot account for the more limited choice policies before My School DC.

This thesis uses OLS and regression discontinuity design to estimate this hedonic pricing model and its relationship to the universal school lottery. To control for varying neighborhood characteristics, I apply Black’s (1999) method of boundary indicators.

**Descriptive Statistics**

The housing prices are taken from Open Data D.C.’s Integrated Tax System Public Extract Property Sales. The sample is restricted to residential properties sold between 2010 and 2018. There are 41,502 observations, identified for the sample in the manner described in the previous section. I use sale price rather than tax appraisal value because appraisals often fail to account for intangibles like school quality. To account for inflation, I standardize the data using the Consumer Price Index to 2009 USD. The mean is $661,399 USD with a standard deviation of $1,584,067.

School quality indicators come from DC Comprehensive Assessment System (CAS) for the years 2009-2014 and Partnership for Assessment of Readiness for College and Careers (PARCC) standardized tests for the years 2015-2019. I use third grade math and ELA proficiency rates. The mean math proficiency is 37.1%, with a standard deviation of 23.1%. The average proficiency rate for ELA was 33.7%, with a standard deviation of 21.7%.
The waitlist in the lottery period had a mean of 187 students with a standard deviation of 275 students. The in-boundary rate had a mean of 54.3%, with a standard deviation of 16.8%. Boundary participation rate had a mean of 41.9% and a standard deviation of 25.7%.

**Table 1**

*Descriptive Statistics of Dependent and Independent Variables*

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Housing Characteristics</strong></td>
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<td></td>
</tr>
<tr>
<td>Residential Home Prices ($)</td>
<td>661399</td>
<td>1584067</td>
</tr>
<tr>
<td>Land Area of Property (sq ft)</td>
<td>2114.38</td>
<td>3954.84</td>
</tr>
<tr>
<td><strong>School Quality</strong></td>
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<td></td>
</tr>
<tr>
<td>3rd Grade Reading Proficiency</td>
<td>0.34</td>
<td>0.23</td>
</tr>
<tr>
<td>3rd Grade Math Proficiency</td>
<td>0.37</td>
<td>0.22</td>
</tr>
<tr>
<td><strong>School Competition 2014-2017</strong></td>
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<td></td>
</tr>
<tr>
<td>Waitlist</td>
<td>188</td>
<td>275.8</td>
</tr>
<tr>
<td>In Boundary Rate</td>
<td>0.54</td>
<td>0.17</td>
</tr>
<tr>
<td>Boundary Participation Rate</td>
<td>0.42</td>
<td>0.26</td>
</tr>
</tbody>
</table>

See the supplemental tables in the Appendix for descriptive statistics by Ward, high and low academic proficiency catchment areas, and specialty schools (Montessori and Dual Language).

**Results**

**School Quality**

The effects of school competition and school quality vary widely based on school type, location, and school competitiveness factors. For all elementary schools, an increase in Math proficiency has a significant positive impact on housing prices, though small in an economic sense. ELA proficiency has a negative coefficient, but it is small both in terms of significance
and economic consequence. These are slightly different than previous estimations of capitalization of school quality. Black (1999), Oates (1969), and Downes & Zabel (2002) all find consistent evidence that test scores are positively associated with housing prices. Hedonic studies all using relatively similar methods generally show that a one standard deviation increase in test scores is correlated with a three to five percent increase in housing prices (Schwartz, Voicu & Horn, 2014).

Table 2

*Difference in Capitalization Under Neighborhood Assignment and My School DC 2010-2013 & 2014-2017*

<table>
<thead>
<tr>
<th></th>
<th>Pre-Lottery</th>
<th>Lottery</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academic Proficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010-2017</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELA Proficiency</td>
<td>0.00</td>
<td>0.10**</td>
<td>0.10</td>
</tr>
<tr>
<td>(0.06)</td>
<td>(0.05)</td>
<td>(0.05)</td>
<td></td>
</tr>
<tr>
<td>Math Proficiency</td>
<td>0.17 *</td>
<td>0.05</td>
<td>-0.47</td>
</tr>
<tr>
<td>(0.07)</td>
<td>(0.05)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School Type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and School</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competition Variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014-2017</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dual Language School</td>
<td>NA</td>
<td>-0.04</td>
<td>NA</td>
</tr>
<tr>
<td>(0.02)</td>
<td>(0.04)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Montessori School</td>
<td>NA</td>
<td>-0.1**</td>
<td>NA</td>
</tr>
<tr>
<td>(0.03)</td>
<td>(0.03)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-Boundary Rate</td>
<td>NA</td>
<td>-0.05</td>
<td>NA</td>
</tr>
<tr>
<td>(0.04)</td>
<td>(0.04)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boundary Participation</td>
<td>NA</td>
<td>-.01</td>
<td>NA</td>
</tr>
<tr>
<td>Rate</td>
<td></td>
<td>(0.06)</td>
<td></td>
</tr>
<tr>
<td>Waitlist</td>
<td>NA</td>
<td>0.00</td>
<td>NA</td>
</tr>
<tr>
<td>(0.00)</td>
<td>(0.00)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample Size</td>
<td>12,833</td>
<td>24,530</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Dependent variable of all regressions is the natural log of house prices (adjusted for inflation). Land area of lot and indicator if the residence is a unit are used as house characteristic controls in both
regressions. Fixed effects of Year are present to control for real estate fluctuations that affect all schools equally within a year. School boundary indicators are present in both equations, to provide a control for various neighborhood characteristics while allowing for a discrete jump in test scores across boundaries. Ward fixed effects are also included.

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

In contrast, these results suggest a weaker relationship between school quality and housing prices. This study finds that under the My School DC regime, academic proficiency has a smaller effect both in terms of coefficient size and significance. In the pre-lottery era, a five percentage point increase in ELA proficiency increased housing prices by about 0.002 percent, while the same increase in Math proficiency raised housing prices by 0.84 percent. In standard deviation terms, a one standard deviation increase in ELA proficiency would only increase housing prices by .01 percent and by 3.67 percent increase for an equivalent increase in Math proficiency.

Comparatively, under the My School DC lottery program, a five percentage point increase in Math proficiency is associated with a only .23 percent increase in housing value. Furthermore, the coefficient is no longer statistically significant. When comparing these results to the body of literature and my pre-lottery results, these numbers suggests that under the My School DC universal lottery scheme, houses are less dependent on Math education quality.

Notably, the effect of ELA proficiency on housing prices increases in the lottery period. In other words, an increase in ELA proficiency is capitalized to a greater degree in the lottery period. However, these estimates are still smaller than previous estimates that do not account for school quality.
### Table 3

**Analysis of Discontinuity Sample Using Regression Discontinuity Design**

<table>
<thead>
<tr>
<th></th>
<th>Full Sample</th>
<th>Condos/Rental Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Intervention Indicator</td>
<td>0.06</td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
<td>(0.08)</td>
</tr>
<tr>
<td>ELA Proficiency</td>
<td>0.07</td>
<td>0.14</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td>(0.10)</td>
</tr>
<tr>
<td>Post x ELA</td>
<td>0.03</td>
<td>0.34**</td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td>(0.12)</td>
</tr>
<tr>
<td>Math Proficiency</td>
<td>0.26***</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td>(0.12)</td>
</tr>
<tr>
<td>Post x Math</td>
<td>-0.51***</td>
<td>-0.66***</td>
</tr>
<tr>
<td></td>
<td>(0.08)</td>
<td>(0.17)</td>
</tr>
<tr>
<td>Dual Language School</td>
<td>-0.05**</td>
<td>-0.22</td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
<td>(0.02)</td>
</tr>
<tr>
<td>Montessori School</td>
<td>0.02</td>
<td>-0.35</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.10)</td>
</tr>
<tr>
<td>In-Boundary Rate</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
<td>(0.08)</td>
</tr>
<tr>
<td>Boundary Participation Rate</td>
<td>0.00</td>
<td>-0.17</td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
<td>(0.09)</td>
</tr>
<tr>
<td>Waitlist</td>
<td>0.00**</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Sample Size</td>
<td>26,138</td>
<td>9,096</td>
</tr>
</tbody>
</table>

**Note.** Dependent variable of all regressions is the natural log of house prices (adjusted for inflation). This analysis using Regression Discontinuity Design uses a discontinuity sample of 36 months before and after the implementation of My School DC, using January 1st, 2014 as an approximate implementation date.

All regressions include month from intervention, it’s squared and cubed transformation, and its interaction with POST. They include the same neighborhood, ward, and house controls as in Table 2.

Standard errors are robust.

*p < .05. **p < .01. ***p < .001
This thesis also makes use of Regression Discontinuity Design to calculate a Local Average Treatment Effect (LATE) in the absence of randomization or even a traditional control group. In the estimates provided in Table 2, there are possible unobservables or omitted variables that change between the pre and lottery period, biasing the impact of academic proficiency given the lottery. RDD addresses this issue, though the results are LATE; they only apply to the narrow discontinuity sample and only if assume that in the pre-lottery period all families complied with neighborhood assignment (a strong assumption). Given that we have reason to believe that perfect compliance was unlikely, these results likely underestimate the impact of the lottery on the relationship between academic proficiency and house prices.

The results of the RDD also indicate that the effect of academic proficiency is either smaller or insignificant under My School DC. The coefficient on the interaction Post x ELA is insignificant, consistent with the fact that over the full study period in the RDD analysis, the effect of ELA proficiency on housing prices is consistently insignificant.

The coefficient on Post x Math is negative, indicating that the effect is smaller in the lottery period. This effect is statistically significant. In other words, an additional percent of Math proficiency has a smaller effect on housing prices in the lottery regime. This is what we would expect if we believe that the lottery is removing some housing demand around high-quality schools. However, these coefficients are economically small, suggesting that the lottery has not strongly reduced the demand for houses assigned to high quality schools.

**School Competition**

The results from the school competitiveness measures offer novel insights regarding the hedonic relationship between school quality and housing prices under a universal lottery system. The author cannot find previous applications of hedonic analysis using in-boundary rates, boundary participation rates, or waitlist data. Therefore, these results fill in a meaningful gap in
the hedonic literature and provide more context regarding how a universal lottery system potentially shapes a city’s housing market.

Measures of school competitiveness have varied impact on housing prices. The in-boundary rate has a small and statistically insignificant positive relationship with housing prices. A 1 percentage point increase in the in-boundary rate increases housing prices by .02 percentage points, about $117 on the average house. Boundary participation is significant, but negative. A 1 percentage point increase in boundary participation rate decreases housing prices by .004 percentage points. On the average house, this is a decrease in value of about $26. Both coefficients are small in terms of economic consequence, and statistically insignificant, suggesting these characteristics do not strongly influence housing prices (or proxy for another variable that does).

However, the difference in signs suggests a possible mechanism by which school coemption is impacting the relationship between academics and housing prices. As the number of in-boundary students increases, housing prices increase, suggesting that schools in expensive housing markets retain more in-boundary students. This may be because parents are willing to buy a house in an expensive catchment area in order for a guaranteed spot. However, as the number of in-boundary students as a percentage of students assigned to that boundary increases, housing prices decrease. One explanation for this is that in a wealthy community, a substantial portion of students attend private school, and so while the in-boundary participation rate might suggest high local demand for a school (in-boundary students make up a large percentage of total enrollment), that same school might have a low boundary participation rate because a large percentage of in-boundary students are attending private school.
Previous scholars have noted that prices change in response to school data that is easily assessible and understandable (for example test scores) and so perhaps the in-boundary and boundary participation rate data is rarely applied by parents when making housing decisions (Brasington & Hauri 2009). Waitlists are potentially a more salient data point for parents, reinforced by the fact that the coefficient is positive and significant. This significance confirms that under a universal lottery system, the lottery does impact the relationship between schools and housing prices. Because this study constitutes an early application of this data, the significance also suggests that a waitlist variable is a salient variable that is a relevant measure of school competition for hedonic and other analyses.

When looking at rental units only, many of the same trends still hold. Math proficiency in the lottery period has an even smaller impact on housing prices when compared to the full sample. Interestingly, in this sample the impact of ELA proficiency in the lottery period is larger and more significant, suggesting that this type of academic quality is important to condo/rental unit owners/buyers.

Perhaps surprisingly, houses zoned for dual language are on average .05 percent less expensive than other elementary schools. These effects are economically small, but statistically significant. Alternatively, houses in Montessori catchment areas are about .02 percent more expensive than average, though this effect is statistically insignificant. On average, Montessori schools have lower in-boundary and boundary participation rates compared with DCPS schools in general, suggesting that parents are willing to arrange transportation to Montessori schools, but demand has not increased housing prices in the catchment areas. Results for Dual Language and Montessori schools should be interpreted with caution, as explained in the discussion.
Summary
Compared with a traditional neighborhood school assignment policy, housing prices under the D.C. universal lottery system are affected by both school quality and school competition. As a result, the capitalization of school quality is generally smaller under a universal lottery regime. This is potentially due to the mobility offered by the universal lottery system, which allows parents to attempt admission at higher-quality schools without paying a premium to live in a high-quality catchment area. In other words, houses in high-quality catchment areas are less valuable after the implementation of the universal lottery system because families have other routes to access high-quality schools besides purchase of a property within a high-quality catchment area.

However, though this is true in general, this trend varies widely between different neighborhoods, and types of schools. For example, in Ward 3, the relationship between housing values and both ELA and Math are both smaller in the lottery period, though insignificant. Additionally, in contrast to the full sample, boundary participation is negative, suggesting that parents were buying expensive homes and still choosing an out-of-boundary option. This means that a universal lottery system does not reduce the price premium in all neighborhoods.

Given this variation, it is likely that the universal lottery does not affect all homes in the same way. Some of this is due to the fact that certain boundaries experience only small differences in academic proficiency, and therefore these differences only have very small impacts on housing prices. This feature of the results suggests that the findings, particularly around school competition, should not be generalized to the whole of D.C. or to other contexts.

Limitations of Analysis
Though this research makes important contributions to the body of literature on the capitalization of school quality under a universal lottery system, there are several limitations that
both guide the proper policy application of these results and also point to future iterations of this research design.

All of the limitations are related to data. Firstly, most other hedonic analyses use house characteristics to compare houses of similar quality, specifically houses with the same number of bedrooms and bathrooms (Black 1999). D.C. does not have this data publicly available. The control variable land area may control for some variation in price due to house quality, but it is likely not sufficient. This is likely not a problem if the composition of housing is similar between each boundary, but that is not a reasonable assumption.

In a similar vein, this analysis would benefit from the inclusion of rental data as well. My condo/rental unit variable captures the sale price of rental units or condos, not the monthly rent. In D.C. in 2018, 57.7% of residents were renters (Census Bureau, 2018). This analysis does not capture the behavior and preferences of these renters that make up the majority of the population. While the results do reveal important info on how the universal lottery is changing parents housing and schooling choices, it cannot be extrapolated. In other words, the results should be thought of as only applying to homeownering parents and not all parents of public-school students.

Finally, it is likely that private school attendance is a force missing from the econometric analysis. According to 2014-2015 DCPS data, the share of student enrolled in private school between 2009 and 2013 ranges from 8.4% in Ward 7 to 82.3% in Ward 2 (DCPS, 2016). This means that in some places, about 80% percent of families (or 40% if each family has two children) are not factoring the public schools into their housing decisions. In the absence of this data, this thesis does not delve into how private school enrollment might impact this relationship.
Policy Implications

Mobility and Housing Affordability

From the in boundary and boundary participation rates in general, we can see that the lottery has a profound impact on student’s choice of schools. Looking specifically at the lottery sample (2014-2017) used in this study, on average, D.C. elementary students attending their assigned neighborhood school made up 54% of the total elementary enrollment. A related measure, boundary participation rate, indicates that in the average elementary school, only 42% of the students assigned to that boundary actually attended that school. These simple descriptive statistics highlight that in this lottery regime, parents are using the lottery to access different school markets without having to move.

The results of this analysis reflect the policy narrative that overall, the capitalization of school quality went down, as families used other routes (the lottery) which reduced demand for houses in high quality neighborhoods. Black, who estimated that a 5 percent increase in scores was correlated with a 2.5 percent increase in housing value (Black 1999). In their discussion of recent school-quality hedonic literature Schwartz, Voicu & Horn (2014) find two studies that find a one standard deviation increase in test scores increases housing prices by 3 to 5 percent (Machin, 2011; Nguyen-Hoang & Yinger, 2011).

Comparatively, under the My School DC lottery program, a five percentage point increase in Math proficiency is associated with a only .23 percent increase in housing value. This smaller coefficient indicates that the effect of academic proficiency on housing prices has decreased. Thus, the capitalization of Math proficiency is smaller under the lottery than during neighborhood assignment, and also when compared to the effect size identified in studies of other school districts. As discussed in the results section, the interactions between the post indicator and academic proficiency in the RDD analysis reinforce this.
These smaller effect sizes suggest that parents are less willing to buy into a high-quality school under the My School D.C. lottery system. This may have dramatic impacts on school segregation, as school assignment moved beyond residential assignments that tend to produce schools segregated by wealth and race. Another related but distinct result is the possibility that students who previously attended low-quality schools attend high-quality schools because of the lottery. Choice advocates argue that this “reshuffling” of students will increase overall academic achievement and reduce the achievement gap. Whether this bears out in the D.C. context is beyond the scope of this thesis and likely requires more years of data. The conclusion section of this paper discusses possible future research design in this area.

However, this analysis also provides some evidence that the city-wide competition for seats also puts some pressure on housing markets in over-enrolled catchment districts. A one seat increase in total waitlist increases the housing price by .007 percent, or the equivalent of about $48 for the average house. Though this is economically insignificant figure, the statistical significance of this competition metric justifies its future inclusion in future analyses.

This is consistent with Bibler and Billings’ (2019) findings in the Charlotte-Mecklenburg schools: building off their findings in the sense that the lottery forces lottery losers (or risk adverse parents) to seek a place in high-quality schools through neighborhood assignment when the lottery does not provide them with their desired outcome. If Bibler and Billings’ findings play out in the D.C. context, then we expect that unsuccessful lottery applicants may move to catchment areas with high waitlists in order to secure a spot. This is different from parents paying a premium for school quality; instead, the demand for the school is being capitalized into the house price. The difference is important because school quality does not have a perfect linear
relationship with waitlists, perhaps reflecting that parents base their schooling decision around more than just academic quality.

It is also possible that reverse causation is at play here. In this sample, catchment areas with above average academic proficiencies also have higher housing values and waitlists. The legacy of unequal public education, segregated by wealth, may persist in the sense that wealthy schools continue to show impressive academic achievement, and the lottery system has only increased the competition to attend these institutions. While it is certainly true that the lottery system has opened out-of-boundary spots in wealthy schools, the significance of the waitlist variable also signifies the continued preference for schools in these wealthy areas, rather than the openings of new attractive options across the city.  

Education research is increasingly interested in cost-benefit or cost-effectiveness analysis. A method of economic analysis originally used for development and environmental sensitivity, this type of policy analysis is being used to look at how the cost of education interventions, including spillover effects and general equilibrium outcomes compare with the outcomes. If housing values are affected, this policy may be impacting property tax revenue, and this may be an important factor when evaluating the true costs of the policy. It is beyond the scope of this paper to calculate how total property values would have grown in the absence of a universal lottery system.

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7 As discussed later in the recommendations for future research, charter schools have radically transformed the school choice landscape in D.C., but due to data limitations they could not be included in this analysis. A study of charter schools might reveal different pressures on housing, since not all charter schools include a proximity preference in their lottery procedures (My School DC, n.d.).
Effect of Magnet Schools

D.C. has added Montessori and dual-language programs throughout the city’s schools in an apparent effort to replace poor performing schools with high quality options that fit a range of parent preferences. In the 2017-2022 Strategic Plan document, district administrators pledged to “ensure excellent schools” by “[growing] schools based on need and promote diversity and innovation, including multilingual or magnet programs” (DCPS, n.d., p.4). Additionally, competing for students with the increasingly innovative charter market, DCPS opened more specialty schools. With the universal lottery, some educators are concerned that magnet schools tend to attract and enroll primarily wealthy families, who have the interest and efficacy to engage in the lottery process (Langhorne, 2019). Does this hedonic analysis suggest this trend?

In order for these schools to serve under-supported populations, students must actually attend these schools, either by living in their attendance zones or winning a seat in a lottery. In D.C., all public non-charter Montessori schools are in Wards 5&7; they are at least physically located in neighborhoods with low median-incomes, and low academic proficiency rates (Open Data DC, 2019b). The results of this thesis show that in the overall sample, Montessori schools are associated with slightly higher housing values. This is perhaps in conflict with two other features of the data: the mean academic proficiency and boundary participation indicators are much lower for Montessori schools compared to the overall average. This does not support the idea that wealthy families are paying a premium for academic proficiency as school quality is not ideal. Further, the measures of boundary participation are low, suggesting that many parents who buy into this assignment area end up choosing an out of boundary school for their child. This coefficient may also reflect that there is some unobservable related to Montessori schools for which parents have a strong preference. Furthermore, this may be a reverse causality problem:
Montessori schools may be opened in primarily wealthy areas for a range of reasons, perhaps strong parental preference and political efficacy.

The results seem to say something different regarding Dual-Language schools. Dual-language schools are located in every ward besides Ward 8, and therefore the refined sample of dual-language schools is more similar to the sample as a whole. In the sample as a whole, dual-language schools are also associated with lower home values. In other words, switching from a non-dual-language public school to a dual-language school means you are moving to an area where housing prices are on average $50,300 lower. However, unlike Montessori, the mean waitlist of a dual-enrollment school is higher than the total average, suggesting a high demand for these schools, but the high demand is perhaps not translating into high pressure on the housing market in those areas.

**Conclusion**

This research constitutes a novel attempt to quantify how school choice policies impact the valuation of school quality. Significantly this research finds smaller capitalization of academic quality than most other hedonic analyses. The insights provided by the significant effect sizes on competition indicators highlight the importance of including choice policies in hedonic analysis. This provides evidence that school choice is changing how school quality is capitalized into housing values. Specifically, it suggests that overall, the parents and families are less willing to pay a premium for school quality under a universal choice regime. Furthermore, it includes measure of waitlist size as a variable in OLS and RDD regressions, providing a measure of competition that would likely be relevant to future analyses. However, the effects of the My School DC lottery identified in this thesis vary by ward, type of school, and even by school assignment boundary. Therefore, it would be wrong to generalize these findings to D.C. as a
whole or apply them to other school systems. Instead, further examination should be undertaken to better understand this relationship.

**Further Research**

Future research on the outcomes of D.C.’s universal lottery system should examine how the relationship between school quality and housing prices, altered by the universal lottery system, also affects the racial segregation of schools. As families no longer need to pay a price premium for quality education, it largely follows that black families will have increased access to high quality schools. However, affordable housing was probably not the only barrier to high-quality housing, but it should be examined as part of a robust analysis of the racial impacts of this universal lottery system.

Robust qualitative research is also essential for understanding the mechanisms behind these results. Conducted in 2018 for the Office of the District of Columbia Auditor, “Shopping for Public Schools in the District of Columbia” provides good insight regarding parents’ experiences with DCPS and the lottery system (ODCA, 2018). However, richer information could be collected, including information on parents’ income level, access to car, and level of education. Similar research could also report results at the level of the school. While this may appear tedious, it will support future researchers in identifying how parental choices are affecting different types of schools.

Finally, the richness of DCPS data can be harnessed to identify mobility trends. Previously, DCPS has released the schools and their associated number of students attended by student assigned to each particular boundary. This data (though not currently formatted for this type of analysis) could supplement this type of analysis by identifying mobility patterns of students. Furthermore, more complete data on charter schools should be incorporated, since this element of the public education system has dominated choice in D.C. Previous research has
incorporated charters by looking at houses within a certain distance of charter buildings, but given the mobility of D.C. students, this method is likely unsatisfactory, and different methods will need to be devised.

Similar hedonic analysis should be conducted in other cities and districts with robust choice policies. As mentioned, these results tell a rich story about choice in D.C., but they vary so much across the city that it is hard to get a clear conclusion regarding how these changes are impacting parent choices, student outcomes, and school or neighborhood segregation. A greater body of evidence from a wide range of geographic areas is therefore necessary. Indeed, as the debate over school choice rages on, it is increasingly important to support this debate with research specific to the policies and conditions of each district (and perhaps each catchment area) because the nuanced effect of the specific choice policy matter greatly.
### Table A1

**Characteristics of Catchment Areas by Academic Proficiency**

<table>
<thead>
<tr>
<th></th>
<th>Above Average ELA Proficiency</th>
<th>Below Average ELA Proficiency</th>
<th>Above Average Math Proficiency</th>
<th>Below Average Math Proficiency</th>
<th>Above Average Proficiency in Math &amp; ELA</th>
<th>Below Average Proficiency in Math &amp; ELA</th>
</tr>
</thead>
<tbody>
<tr>
<td>House Price</td>
<td>724244 (983695)</td>
<td>606408.6 (1962614)</td>
<td>746803.4 (1107680)</td>
<td>572732.9 (1955829)</td>
<td>745208.3 (986306.8)</td>
<td>566399.2 (2079611)</td>
</tr>
<tr>
<td>Waitlist</td>
<td>428.34 (343.28)</td>
<td>68.05 (109.54)</td>
<td>329.07 (327.84)</td>
<td>48.79 (77.76)</td>
<td>434.47 (343.24)</td>
<td>47.83 (75.82)</td>
</tr>
<tr>
<td>In-Boundary Rate</td>
<td>0.61 (.21)</td>
<td>0.51 (0.13)</td>
<td>0.55 (0.20)</td>
<td>0.53 (0.13)</td>
<td>0.61 (0.21)</td>
<td>0.53 (0.13)</td>
</tr>
<tr>
<td>Boundary Participation Rate</td>
<td>0.72 (0.22)</td>
<td>0.27 (0.10)</td>
<td>0.59 (0.26)</td>
<td>0.25 (0.09)</td>
<td>0.73 (0.21)</td>
<td>0.25 (0.09)</td>
</tr>
<tr>
<td>Sample Size</td>
<td>19,368</td>
<td>22,134</td>
<td>21,140</td>
<td>20,362</td>
<td>16,376</td>
<td>17,370</td>
</tr>
</tbody>
</table>

### Table A2

**Home and School Characteristics by Ward**

<table>
<thead>
<tr>
<th>Ward</th>
<th>Ward 2</th>
<th>Ward 3</th>
<th>Ward 4</th>
<th>Ward 5</th>
<th>Ward 6</th>
<th>Ward 7</th>
<th>Ward 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>House Price</td>
<td>703879 (131940)</td>
<td>1088770 (341842)</td>
<td>863323 (105339)</td>
<td>593506 (695148)</td>
<td>447904 (418645)</td>
<td>580077 (849314)</td>
<td>301656 (780953)</td>
</tr>
<tr>
<td>ELA Proficiency</td>
<td>0.30 (0.16)</td>
<td>0.45 (0.25)</td>
<td>0.64 (0.11)</td>
<td>0.30 (0.19)</td>
<td>0.18 (0.14)</td>
<td>0.30 (0.19)</td>
<td>0.16 (0.11)</td>
</tr>
<tr>
<td>Math Proficiency</td>
<td>0.38 (0.16)</td>
<td>0.47 (0.22)</td>
<td>0.61 (0.18)</td>
<td>0.37 (0.17)</td>
<td>0.22 (0.12)</td>
<td>0.32 (0.19)</td>
<td>0.19 (0.11)</td>
</tr>
<tr>
<td>Waitlist</td>
<td>131.24 (164.01)</td>
<td>318.57 (317.46)</td>
<td>514.13 (328.11)</td>
<td>118.29 (199.07)</td>
<td>21.56 (25.23)</td>
<td>170.42 (251.13)</td>
<td>19.41 (37.77)</td>
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<tr>
<td>In-Boundary Rate</td>
<td>0.45 (0.11)</td>
<td>0.47 (0.14)</td>
<td>0.73 (0.17)</td>
<td>0.61 (0.13)</td>
<td>0.58 (0.09)</td>
<td>0.44 (0.17)</td>
<td>0.55 (0.10)</td>
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<td>Boundary Participation Rate</td>
<td>0.37 (0.17)</td>
<td>0.54 (0.20)</td>
<td>0.86 (0.10)</td>
<td>0.35 (0.21)</td>
<td>0.16 (0.05)</td>
<td>0.37 (0.15)</td>
<td>0.25 (0.05)</td>
</tr>
<tr>
<td>Sample Size</td>
<td>5,797</td>
<td>5,633</td>
<td>5,745</td>
<td>4,802</td>
<td>4,534</td>
<td>5,671</td>
<td>3,590</td>
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</table>
Table A3

*Housing and School Characteristics for Montessori and Dual Language Schools*

<table>
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<tr>
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<th>Montessori Schools</th>
<th>Dual Language Schools</th>
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<tbody>
<tr>
<td>Housing Price</td>
<td>368529.5 (258749)</td>
<td>611101.4 (598014.4)</td>
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<td>ELA Proficiency</td>
<td>0.14 (0.10)</td>
<td>0.33 (0.18)</td>
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<tr>
<td>Math Proficiency</td>
<td>0.19 (0.07)</td>
<td>0.46 (0.17)</td>
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<tr>
<td>Waitlist</td>
<td>22.93 (24.05)</td>
<td>170.03 (225.53)</td>
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<td>In-Boundary Rate</td>
<td>0.55 (0.03)</td>
<td>0.40 (0.11)</td>
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<tr>
<td>Boundary Participation Rate</td>
<td>0.19 (.06)</td>
<td>0.45 (0.19)</td>
</tr>
<tr>
<td>Sample Size</td>
<td>934</td>
<td>3,035</td>
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</tbody>
</table>
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