Do Housing Prices Account for School Accountability?

Working Paper

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Abstract

Since the passing of the No Child Left Behind Act of 2001, each state is required to publicly report school quality measures and student test performance. Many states, including North Carolina, were already reporting their own quality measure and since 2002 have included an additional quality measure to meet the newer federal requirements. There has been extensive research documenting the relationship between housing prices and test scores at local public schools. Given the research, one may presume additional information about school quality to also influence the housing market. This paper examines whether state reported school quality measures influence household sorting decisions, using a regression discontinuity approach and comprehensive data on real estate transactions over the period 2003-2007. The results suggest that even when taking into account student performance on test scores and other variables the market's response to the release of information related to school quality provided by the state's recognition system is significant.

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1 Introduction

The notion that local public goods, particularly public schools, influence the housing market extends back to Tiebout's influential 1956 paper on residential sorting. Tiebout describes how varying baskets of local goods/services and differing personal valuations of these baskets causes individuals to "vote with their feet" and find the jurisdiction which maximizes their personal utility. As such, it is argued that housing markets represent a well established and potentially informative form of school choice.[1] It is the competition between local communities which generates "market discipline" that induces school districts to move in the direction towards efficiency. Similarly, advocates of school choice programs, including vouchers and charter schools, argue that inefficiencies within the educational system can be solved by increasing parental choice and providing compensation to schools with high demand. The incentives built into school choice programs would likely stimulate competition between schools and lead to increased productivity.[2]

A fundamental assumption of the Tiebout model, and other arguments in favor of increased school choice, is that consumers have adequate knowledge regarding the quality of local public services. Hanushek (1981) points out that the success of these choice programs crucially depends on the information parents use to form their valuation of school quality. In general, markets rely on the assumption that individuals are able to make informed decisions. It is not easy for most consumers to obtain reliable information that accurately reflects the quality of local schools, Hess (2010). Without reputable information school districts will not achieve an efficient educational system, as predicted by Tiebout's model.

Throughout the 1990s many states began implementing intricate schemes for evaluating school performance using student test scores. These states often provided the public with comprehensive, highly accessible, "one-stop shops" for public school information many times in the form of an online

[1] Examples include, Tiebout (1956), Brennan and Buchanan (1980), Oates (1985).

[2] Hoxby (1999) models the impact of competition in a model where there are rents in the market for schools, and argues that a Tiebout-like mechanism may increase school productivity. Chubb and Moe (1990) states, the public school system is currently a monopoly organized to meet the demands and goals of democratic institutions and a highly developed education bureaucracy. To improve education, the system should be reorganized and a competitive education marketplace created.

report for the school. Additionally, in 2001 education and school accountability rose to the forefront of the nation's political agenda and the federal No Child Left Behind Act of 2001 spearheaded this focus. George W. Bush's education reform was designed to assess schools based on improvements in students' performance on statewide standardized math and reading examinations. The Act also requires states to publicly report information regarding each schools' progress toward statewide proficiency goals often in the form of "school report cards". In these report cards, many states provide summary information which groups and then ranks schools according to some measure of school quality.

Previous economic studies have examined the impact of test scores on residential mobility and local housing markets.[3] Test score information forms the crux for determining school quality largely due to its growing availability and increased publication. Since the government and media continue to place attention on school accountability measures, it stands to reason that this additional information may also provide a basis for school choice. The extent to which school accountability measures inform parental valuation of school quality has potentially large effects on household location decisions. Knowing and understanding how these school accountability measures motivate homebuyers should have direct implications for the way in which policymakers formulate these measures.

In the North Carolina school accountability system, the distinction between the three most prestigious recognitions rests exclusively on test performance and there is minimal fluctuation in school recognitions over time. It is the basic criteria of the North Carolina system that enables me to improve upon the existing literature by employing a regression technique that allows me to avoid potential identification problems in the previous study and offer more compelling results.

In this paper I investigate whether state provided information related to school quality, in the form of various recognitions, influences house prices. I explore the relationship between the housing market and these recognitions, on top of other publicly available school characteristics such as attendance information, test scores, and school demographics. I seek to determine if houses located

[3]Recent examples include, Black (1999), Bogart and Cromwell (1997), Bogart and Cromwell (2000), Weimer and Wolkoff (2001), and Kane, Staiger, and Samms (2003).

within close proximity of two schools that otherwise have alike characteristics are consistently valued differently if their corresponding schools receive different recognitions.

The analysis uses data from the North Carolina housing market provided by Dataquick and HMDA (the Home Mortgage Disclosure Act) in conjunction with school level data. I employ a regression discontinuity design to estimate the long-term relationship between house prices and school rankings. To overcome the problems caused by omitted variables, I take advantage of the state's recognition criteria. I compare the sales prices between homes located in the proximity of schools that just miss and those that just make the cutoff for a particular level of recognition. Since recognitions are given to schools discontinuously based on average student test scores, I exploit the resulting discontinuity in recognitions to identify the effect of highly recognized schools on local housing prices. The resulting regression discontinuity estimates will not suffer from omitted variables bias if the unobserved school characteristics vary continuously across the recognition cutoffs. In order to address concerns that better schools are located in better neighborhoods, I also control for neighborhood-year interactions which will all me to control for similarities across properties within a specific subdivision during a given time period.

Using this regression discontinuity method coupled with rich data set, I find that the housing market does respond to the category recognitions. In fact, the average premium of achieving one higher level of recognition is valued by the housing market at roughly 3-4 percent. This premium exists even after controlling for other measures of school quality along with neighborhood and house characteristics. These results suggest that school accountability systems which synopsize easily publicized test score information into concise recognitions do have a significant and lasting effect on housing prices.

As an extension of the baseline effects, I investigate how myopic consumers are in this environment. More specifically, I investigate whether the price differentials reflect the willingness to pay for access to better schools today as well as in the future or rather just for the current period. I begin by determining whether there is still an impact of older report once newer information is

released. I find that any lagged information is not reflected in housing prices. Additionally, I do not find evidence indicating building up a reputation as receiving a particular recognition matters. Altogether this suggests that a school's recognition in the current period plays a pivotal role in the public's perception of school quality.

A series of theoretical[4] and empirical[5] papers examine the relationship between information regarding school quality and housing prices. Many of these studies estimate the marginal willingness to pay for a standard deviation increase in average test score and find that housing prices are indeed influenced by neighborhood school quality. Drawing from this research, it is reasonable to expect the increased attention on school accountability and school quality measures provided by school report cards to also be reflected in housing prices.

One study in particular, Figlio and Lucas (2004), investigates whether the housing market responds to the information provided by state-administered recognitions. The paper examines the Florida housing market,[6] they find that information provided in school report cards did have an impact on housing prices.[7] Figlio and Lucas use repeat sales data and determined that the housing market initially exhibited a strong response to the assignment of school letter grades. However, due to fluctuations in the school grades over time, they find these effects almost fade completely after 3 years. Although their findings indicate a large initial response to these school quality measures, none of the point estimates presented are significant at conventional levels. In and of themselves, these results do not fully assuage questions concerning the effects school accountability measures have on housing prices and residential location decisions.

My findings suggest that households are referring to these school accountability measures as

[4]Several theoretical papers developed equilibrium models to analyze the effects of education policies on household sorting. They show changes in school quality yields income and residential sorting in equilibrium; examples include Benabou (1993), Fernandez and Rogerson (1996), and Nechyba (1999,2000).

[5]Black (1999), along with many other studies including, Bogart and Cromwell (1997), Weimer and Wolkoff (2001), and Bayer, Ferreira, and McMillan (2003).

[6]In Florida schools are given grades of A-F based in large part on school performance and slightly more complicated requirements for various subgroups of the student body.

[7]In contrast, Kane et. al. (2003) found no evidence that indicated housing prices respond to school rankings. They use earlier data from the housing market in Mecklenburg County, North Carolina between 1997 and 2001. They propose that either school quality was known to buyers for some time even without the information provided by school report card or that homebuyers were uninterested in differences in school quality measures.

a signal of school quality. Following the Tiebout model, these accountability measures could lead to significant changes in household sorting decisions. As such, it becomes increasingly important for policymakers to ensure that useful information on school quality is driving the ranking criteria. It is not clear that simple test scores accurately reflect relevant characteristics of the school, such as superior instruction or the composition of the student body. It is essential that states seek to ensure that these highly publicized recognitions provide the best information possible. Incomplete information could very well lead to inefficient sorting of households across locations.

The remainder of the paper is organized as follows. After providing some details about the North Carolina school accountability systems (the ABCs) in section two, I describe the data and develop the empirical strategy based on a regression discontinuity approach in sections three and four, respectively. I then present a descriptive analysis of the data to give preliminary evidence of the effect of the school recognitions. Section five continues with the baseline regression discontinuity estimates and some extensions. In the final two sections, I explore the sensitivity of the estimates to several robustness and falsification tests and conclude.

2 The North Carolina School Accountability System

2.1 The ABCs

In the fall of 1997, North Carolina implemented the School-Based Management and Accountability Program, the ABCs (Accountability, Basis Skills with high educational standards, and Control at the local level), for schools with grades K-8. The program includes growth and performance composites based on student performance on yearly End of Grade reading and mathematics exams. The model uses changes in yearly test scores as the major component when measuring the annual success of a school. A school's expected growth for each year and grade is computed as the state average increase in test scores for that grade, adjusted upwards for the initial proficiency of students in that grade and towards the mean for possible mean reversion.

Once the growth standards are calculated each school is placed into a category. A school is categorized as meeting its "expected growth" if the average gains of its students are at least as great as the school's expected growth. If the gains of a school's student body exceed the expected gains by more than 10 percent it receives a "high growth" rating. Teachers in these schools receive a financial bonus of $1500. If a school does not meet its growth standards it falls under one of three categories, "no recognition", "priority", or "low performing", for schools with at least 60 percent of the students with scores at grade level or above, between 60 and 50 percent, and schools with less than 50 percent of students performing at grade level, respectively. For the schools that meet growth expectations, the state also recognizes schools in which high proportions of students meet grade-level standards. Schools of "excellence" are those in which at least 90 percent of students are at grade level, schools of "distinction" have 80.0 to 89.9 percent at grade level and schools of "progress" have 60.0 to 79.9 percent of students at grade level.[8] Figure 1 depicts the ABCs recognition categories. The figure illustrates that the top three recognitions, 'excellence', 'distinct', and 'progress' are are sole based on percentage requirements for students' scoring at or above grade level. This study focuses on homes located in the neighborhoods of these top performing schools.

2.2 Report Cards

Each summer report cards for Public Education are made available on the Department of Public Instruction website.[9] The online reports provide a single source of data about student achievement and attendance, class size, school safety, teacher quality, school technology and other information from the states public and charter schools. Since the 1997-98 academic year, the state's electronic re-

[8]Beginning in 2003, in addition to the already existing category recognitions, every school in the state is required to report whether they succeeded in making adequate yearly progress (AYP). Thus since 2003 the state of North Carolina has reported two different school accountability measures; one primarily based on yearly academic performance and assesses schools on a pass/fail basis, the other incorporates year-to-year growth measures and further ranks schools into six categories based on annual student performance. This study focuses on the second accountability measure which ranks the schools from Excellent to Low Performing. In 2004 the state board of education approved adding a recognition category for Schools of Excellence that meet AYP. These school are recognized as "Honor" Schools of Excellence. The ABCs growth and performance requirements for the "School of Excellence" and "Honor School of Excellence" are the same. Therefore, to make comparisons easier across years, I group these schools under the single recognition "School of Excellence".

[9]For the years relevant to this study, the State Board of Education released school accountability reports on September 10, 2003; August 5, 2004; August 4, 2005; October 5, 2006.

School Status Labels and Recognitions

Performance Level	*Academic Growth*	
Based on Percent of Students' Scores at or above Achievement Level III	Schools Making Expected Growth or High Growth	Schools Making Less than Expected Growth
90% to 100%	Schools of Excellence	No Recognition
80% to 89%	Schools of Distinction	
60% to 79%	Schools of Progress	
50% to 59%	Priority Schools	
Less than 50%	Priority Schools	Low Performing
Additional Recognitions		
25 Most Improved K-8 Schools	10 Most Improved High Schools	

Figure 1: ABCs Awards and Recognition Categories

port cards[10] also include each school's ABCs status along with the percentage of student performing at grade level. In addition, local newspapers and many district websites also report school awards and recognitions. Although the state was already publishing information on school quality the No Child Left Behind Act of 2001 (NCLB) required states to publish even more detailed information regarding school quality. This measure of school quality brought considerable media attention to the state's school accountability system. Beginning in the 2002-03 academic year a new kind of school quality indicator was published for the first time. The state required a school's AYP[11] status to also be determined and published in the annual school report card along with ABCs status. The report cards offer a clear signal about school quality by ranking each school within the ABCs system.

[10] Figure A.1 of the appendix displays a sample from the electronic report card for one elementary school in the data.

[11] AYP, adequate yearly progress measures the yearly progress for each of ten NCLB defined student groups toward the NCLB goal of all students being at or above grade level in reading and math by the end of the 2013-14 school year. Each school is recognized as 'made adequate progress' or 'failed to make adequate progress'.

3 Data

3.1 Housing

The housing data come from two sources. The first is from Dataquick, a national provider of real estate information, and provides information on every housing unit sold in the core counties of North Carolina. The names of buyers and sellers are given, along with transaction price, street address, square footage, year built, lot size, number of rooms, number of bathrooms, number of units in building, and many other housing characteristics. Overall, the housing characteristics are considerably more detailed than those provided in Census micro data. This information is augmented by data from a second source, the Home Mortgage Disclosure Act (HMDA). Incorporating the HMDA provides access to more detailed information about home buyers. I began with data on housing transactions in several counties throughout North Carolina. Of these, I have detailed-enough data for 13 counties to identify the specific subdivisions of each parcel. I include only parcels sold at arm's length between 2003 and 2007. Further, transactions were dropped if the housing characteristics were missing or if a given house fell into the top or bottom 1% of any attributes' distribution.[12]

To carry out this strategy I match each house to the nearest elementary school in its district. Ideally each house would be matched to the school for its particular assignment zone. However, many districts underwent frequent reassignment throughout the relevant time period and few districts maintained intricate school zoning data, making it difficult if not impossible to construct school boundary data for this period. Figure 2 presents an example of a county in the sample; the lines represent the school attendance boundaries, the dots are the location of each elementary school within the county, and the circle surrounding each dot encompasses the area within a half mile of the school. By limiting the sample to homes that are within half a mile of an elementary school I can be reasonably certain that I have matched each house with the correct local school. Moreover, buyers that purchase homes located within half a mile of a school likely believe their home will be assigned to

[12]The table of data summary statistics is presented in Table A.1 of the appendix section.

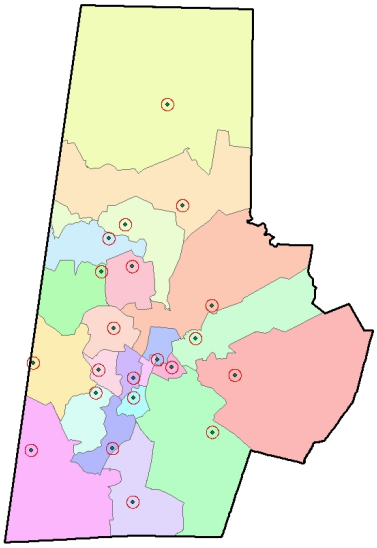

Figure 2: Example of Data Collection for One County: Durham

that particular school regardless of future changes in school attendance zones.

Information regarding school quality is assigned to each real estate transaction beginning the month following the public release of these data. The focus of this analysis is to compare the capitalization ABCs recognitions into housing prices. Therefore, this study covers report cards released for school years 2002-03 through 2005-06; the first three school years following the passing to of NCLB which mandated state accountability systems. The school report card data is matched to the housing transaction data from the month following the release of the test score data to the month before the release of the next report. School reports cards are generally released in August or September. Therefore, for example, I matched the September 2003 school quality information to the housing transactions from October 2003 through August 2004.

3.2 School

The school data are available through an extensive micro-level data set provided by the North Carolina Department of Public Instruction (NCDPI) through the North Carolina Education Research

Table 1: Comparing ABC Status Labels Across School Years

	School Year			
	2002-03	2003-04	2004-05	2005-06
School of Excellence	0.309	0.393	0.323	0.035
School of Distinction	0.488	0.374	0.306	0.163
School of Progress	0.194	0.078	0.081	0.308
No Recognition	0.006	0.155	0.285	0.349
Priority School	0.003	0.008	0.005	0.134
Low Performing	0.000	0.000	0.000	0.002

Data Center at Duke University. Working with the NCDPI, the Data Center has acquired various files related to districts, schools, students, and teachers. NCDPI annually collects data on its 117 districts, 2,300 schools, 1.3 million students, and 100,000 teachers.

Table 1 compares various attributes of schools that receive different categories of recognition in 2004. In the group of elementary schools, associated with the Dataquick housing transactions data, 30.9 percent of the sales occurred in the proximity of school that were labeled as "School of Excellence" in 2004, 48.8 percent were in the proximity of school that were labeled as "School of Distinction" in 2004, 19.4 percent were in the proximity of school that were labeled as "School of Progress", and .009 percent were in the proximity of school that were labeled as "No Recognition", "Low-Performing" or "Priority Schools". There is a striking change to the distribution of ABCs recognition in the 2005-06 school year. This year corresponds with substantial changes the ABCs assessment criteria: (1) new editions of the mathematics End-of Grade assessments were implemented along with higher standards for grades 3-8. (2) new ABCs growth formulas for all grades were instituted (3) writing results were included in the performance composite using a confidence interval. As a result of these changes many schools, even those that had maintain the same recognition for several years, failed to meet the new growth standards and received the title of "No Recognition". For many of these schools the overall student achievement or ability did not decrease at all and the fall in recognition is merely a reflection of the more rigorous requirements.

Table 2 highlights the differences in student performance on the End of Grade examinations.

Table 2: Comparing Proficiency by ABC Status

	2002-03 Performance Composite
School of Excellence	93.6
School of Distinction	85.9
School of Progress	73.9
No Recognition	66.9
Priority School	57.6

Students enrolled at a "School of Excellence" outperform, on average, those enrolled at a "School of Distinction" by 7.7 percentage points, about one standard deviation. While the difference in performance by students at a "School of Distinction" versus a "School of Progress" is relatively larger, approximately one and a half standard deviations. Overall proficiency levels, the percentage of students performing at grade level, are much higher for schools with higher levels of recognition. In 2003, the percent proficient ranges from 57.6 percent at Low Performing/Priority schools to 93.6 percent at schools receiving the Excellence recognition. This is not surprising because the central component used in determining the categorical recognitions is the school's proficiency score.

Since the volatility of categorical recognitions received by a particular school may influence the extent to which buyers view these recognitions as a reliable signal of school quality it is useful to examine the changes in the recognitions over time. Table 3 highlights the category changes of the schools relevant to this study. There are notable year-to-year changes in the school category recognitions. 19.4 percent of the schools received the recognition "School of Progress" in 2003. Of these 34.3 remained a "School of Progress", 26.3 dropped to "No Recognition", 38.1 percent became a "School of Distinction", and 1.3 percent reached the level of Excellence by the following year. One can make the same comparison for schools that began as a "School of Excellence" in 2003. The majority of these schools maintained their recognition, only 14 percent failed to make "recognition" in 2004. The third and fourth sections of Table 3 examine the differences in changes in the following two years 2004-05 and 2005-06. The table reflects the fact that the fluctuations were minimal from 2003-2005. Many schools maintained the same level of recognition until 2006 when the restructuring

Table 3: Comparing Schools with Excellence through Progress Rating in 2003

	ABCs School Rating in 2003		
	Excellence	Distinction	Progress
Median House Price in 2003 (yr 2000$)	147068	121538	87638
Met AYP Standards in 2003	0.862	0.621	0.411
School of Excellence in 2004	0.851	0.268	0.013
School of Distinction in 2004	0.073	0.563	0.381
School of Progress in 2004	0.000	0.015	0.343
No Recognition in 2004	0.072	0.154	0.263
Priority School in 2004	0.000	0.000	0.000
Low Performing in 2004	0.000	0.000	0.000
School of Excellence in 2005	0.746	0.192	0.000
School of Distinction in 2005	0.124	0.456	0.255
School of Progress in 2005	0.000	0.034	0.298
No Recognition in 2005	0.131	0.318	0.426
Priority School in 2005	0.000	0.000	0.012
Low Performing in 2005	0.000	0.000	0.000
School of Excellence in 2006	0.101	0.000	0.000
School of Distinction in 2006	0.402	0.085	0.004
School of Progress in 2006	0.194	0.404	0.255
No Recognition	0.301	0.441	0.204
Priority School in 2006	0.003	0.066	0.485
Low Performing School in 2006	0.000	0.003	0.051
Number of Different Ratings in 2003-2006			
One	0.101	0.012	0.039
Two	0.697	0.574	0.295
Three	0.183	0.385	0.564
Four	0.019	0.291	0.103

of the state's rating system caused some schools to drop a level in recognition.

The bottom part of Table 3 presents the number of different grades received across three years by the school's recognition in 2003. Of the schools recognized as "School of Excellence" in 2003, 10.1 percent maintained the recognition, 69.7 percent received two different recognitions between the 2003 and 2006 school years, and 1.9 percent received a different recognition each year. As for the schools that were recognized as a "School of Distinction", 57.4 percent received two different recognitions and 38.5 percent received three between 2003 and 2006. Finally, of those receiving the recognition "School of Progress" in 2004, 10.3 percent had a different recognition each year from 2003

to 2006.[13]

The top portion of the table also gives median sales price statistics by school recognition. Homes located in the proximity of schools receiving higher levels of recognition average higher sales prices. Houses in the proximity of a "School of Excellence" in 2003 averaged 21 percent higher sales prices than houses in the proximity of a "School of Distinction" in 2003, and houses in the proximity of a "School of Distinction" averaged 38 percent higher sales prices than houses in the proximity of a "School of Progress".

Lastly, Table 4 makes a light comparison between the state's two different accountability systems, ABCs and AYP, for the schools relevant to this study. At the top there are two categories of school performance standards as outlined by NCLB/AYP. Among schools that met the ABCs growth standards only 44 percent made adequate yearly progress. From this table it is evident there is a clear disparity between the standards that the state is using and those required under the federal reform regarding school accountability.

4 Empirical Strategy

The approach here employs the use of hedonic price regressions in combination with discontinuity design. I initially use a standard hedonic model to ascertain how the housing market responds to the new information found in the ABCs report. I then take advantage of the discontinuities created by the criteria used in formulating the ABCs measure to further investigate how school quality information influences the housing market.

Studies investigating the link between school quality and housing prices face two major challenges. First, it is difficult to distinguish between the impact of school quality and factors such as neighborhood amenities. In general, students with more educated and wealthier parents perform

[13] As discussed earlier, several changes to the ABCs assessment criteria led to major shifts in school recognitions. Before the changes were implemented there was far less volatility among the school distinctions; 69 percent of schools maintained the same recognition during the three years prior to the 2005 changes. Over this time period, the ABCs measure is a far more stable indication of school quality relative to the AYP measure.

Table 4: Comparing School AYP and ABC Status

ABC Status	AYP Status: Did Not Meet Performance Standards	AYP Status: Met Performance Standards
School Year 2002-03		
Did Not Meet Expected Growth	0.004	0.000
Met Expected Growth	0.380	0.616
School Year 2003-04		
Did Not Meet Expected Growth	0.050	0.093
Met Expected Growth	0.097	0.760
School Year 2004-05		
Did Not Meet Expected Growth	0.135	0.152
Met Expected Growth	0.162	0.552
School Year 2005-06		
Did Not Meet Expected Growth	0.280	0.177
Met Expected Growth	0.191	0.352

better in school. In turn, schools with better performing students tend to be located in more upscale neighborhoods. Therefore, if neighborhood characteristics are not controlled for estimates will exhibit some upward bias.[14] In order to control for these neighborhood effects I make use of the available data and include subdivision fixed effects.[15] Secondly, since schooling is only one component in the basket of public services affixed to one's residential location, it is also challenging to disentangle the relationship between school quality and the quality of other public services. Thus, to control for the provision of public services other than education I include municipality fixed effects.

The identification strategy suggested here is analogous to the fixed effects approach implemented by Figlio and Lucas (2004). The hedonic regression is a revealed preference method of estimating the value of attributes of products that lack specific market transaction data. Following Rosen

[14]Black (1999) Kane, Staiger, and Samms (2003) and Bayer, Ferreira, and McMillan (2007) show boundary fixed effects substantially reduces the coefficient on school quality in hedonic price regressions. Bayer, Ferreira, and McMillan (2007) also find that subsequent inclusion of precise neighborhood control variables reduces the estimate further, by as much as approximately 50%.

[15]A subdivision is defined as a distinct neighborhood typically developed at about the same time with similar houses, in terms of style, square footage, and lot size.

(1974), the basic model assumes that house prices reflect the market value of housing attributes, neighborhood characteristics, and characteristics of local public schools. The empirical specification to be estimated by ordinary least squares takes the following form,

$$\ln price_{insmcy} = \alpha_c + \phi_m + \delta_{ny} + \eta' X_{sy} + \gamma' Z_i + \psi ABC_{sy} + \beta' AYP_{sy} + \epsilon_{icsmny} \tag{1}$$

where $\ln price_{insmcy}$ is the natural log of the sales price of house i in neighborhood n assigned to school s in month m in year y. The two variables of interest in this basic equation, ABC_{sy} and AYP_{sy}, are dummy variables indicating whether the school received a particular recognition. To escape issues with the timing between the release of school report cards with the time between listing and closing in the housing market I remove transactions that take place during the month following the release of the report cards each year. School characteristics are included in the vector X_{sy}. The vector includes the percent of Black/Hispanic/Native American students, the percent of students receiving subsidized lunch, the percent of student who attend school daily, and the percent of students who score at or above grade level on the end of year exams along with its square. The last two variables are components included in the school grades. Housing characteristic are reflected in the vector Z_i, these include age of the home and its square, the number of bathrooms, the number of bedrooms, the number of stories, and the square footage of the home.[16]

The model also controls for other fixed effects. The neighborhood year fixed effects δ_{ny} capture characteristics about homes within a subdivision that change over time. The municipality fixed effects α_c embodies differences across counties. Many housing transactions take place in each school area at differing points in time. In this case it is possible that a common random effect occurs in a school area during a given time period. Therefore, to correct for this, standard errors account for clustering at the school-time level.

[16]Summary statistics for the housing and school characteristics are presented in the appendix.

4.1 Regression Discontinuity Design

Here I describe the regression discontinuity model used to estimate the effect of the ABCs recognitions on housing prices. A full review of the regression discontinuity method can be found in Imbens and Lemieux (2008), this section just focuses on the econometric specification used to estimate the parameters of interest. Following Imbens and Lemieux (2008), I use a nonparametric approach.[17] The regression design exploits a discontinuity in the rule that determines a schools ABCs status, where schools in which the percentage of students performing at grade level exceeds a predetermined threshold receive a higher level of recognition. Although schools near the threshold have comparable performance, their ABCs status will be different, this provides the basis for a regression discontinuity interpretation of the effect of school quality information on housing prices.

First consider the 90 percent threshold, c_{90}. Schools making expected growth that also have at least 90 percent of its students perform at grade level are labeled as a "School of Excellence". Let y_i be the transaction price for house i, and let d_i be an indicator equal to 1 if the house is assigned to a school that is labeled as a "School of Excellence". Moreover, let $y_i(1)$ be the outcome (transaction price) if house i were a "School of Excellence" and $y_i(0)$ be the outcome if it were not a "School of Excellence". Then the observed outcome is $y_i = d_i y_i(1) + (1 - d_i) y_i(0)$. Since, in addition to the proficiency requirement, schools must also meet growth standards to be labeled as a "School of Excellence" the probability of receiving this recognition as a function of the school's proficiency, $\mathbb{E}[d_i|x] = \Pr[d_i = 1|x]$ where x equals the percentage students performing at grade level, is not a 0-1 step function. However, it is a function that is discontinuous in x at the cutoff;

$$\lim_{x \to c_{90}} \Pr(d_i = 1|X = x) \neq \lim_{x \leftarrow c_{90}} \Pr(d_i = 1|X = x) \tag{2}$$

This case represents cause for a fuzzy regression discontinuity design. Imbens and Lemieux (2008)

[17] I fit local linear regression functions to the observations within a distance, given by the choice of bandwidth, on the set of observations on either side of the discontinuity point. Local nonparametric methods are appealing in this framework because they produce consistent estimation of regression functions and retain desirable bias properties when estimating regressions at the boundary. For a general discussion of local linear regressions see Fan and Gijbels (1996).

show that, under some continuity assumptions and a local monotonicity assumption, the ratio of the jump in the regression of the outcome on the covariate, x, to the jump in the regression of the treatment indicator on the covariate can be interpreted as an average causal effect of the treatment. More specifically the fuzzy regression discontinuity estimator is,

$$\hat{\tau}_{FRD} = \frac{\hat{\alpha}_{yr} - \hat{\alpha}_{yl}}{\hat{\alpha}_{dr} - \hat{\alpha}_{dl}} \tag{3}$$

where

$$\hat{\alpha}_{yr} - \hat{\alpha}_{yl} = \lim_{x \leftarrow c_{90}} \mathbb{E}(\tilde{y}|X = x) - \lim_{x \rightarrow c_{90}} \mathbb{E}(\tilde{y}|X = x) \tag{4}$$

and

$$\hat{\alpha}_{dr} - \hat{\alpha}_{dl} = \lim_{x \leftarrow c_{90}} \mathbb{E}(d|X = x) - \lim_{x \rightarrow c_{90}} \mathbb{E}(d|X = x) \tag{5}$$

where $\hat{\alpha}_{yr}, \hat{\alpha}_{yl}, \hat{\alpha}_{dr}$, and $\hat{\alpha}_{dl}$ are computed as,

$$(\hat{\alpha}_{\tilde{y}r}(x), \hat{\beta}_{\tilde{y}r}(x)) = \underset{\alpha_{\tilde{y}r}, \beta_{\tilde{y}r}}{\operatorname{argmin}} \sum 1_{X_i > x} \cdot (\tilde{y}_i - \alpha_{\tilde{y}r} - \beta_{\tilde{y}r}(X_i - x))^2 \cdot K\left(\frac{X_i - x}{h}\right) \tag{6}$$

$$(\hat{\alpha}_{\tilde{y}l}(x), \hat{\beta}_{\tilde{y}l}(x)) = \underset{\alpha_{\tilde{y}l}, \beta_{\tilde{y}l}}{\operatorname{argmin}} \sum 1_{X_i < x} \cdot (\tilde{y}_i - \alpha_{\tilde{y}l} - \beta_{\tilde{y}l}(X_i - x))^2 \cdot K\left(\frac{X_i - x}{h}\right) \tag{7}$$

$$(\hat{\alpha}_{dr}(x), \hat{\beta}_{dr}(x)) = \underset{\alpha_{dr}, \beta_{dr}}{\operatorname{argmin}} \sum 1_{X_i > x} \cdot (d_i - \alpha_{dr} - \beta_{dr}(X_i - x))^2 \cdot K\left(\frac{X_i - x}{h}\right) \tag{8}$$

and

$$(\hat{\alpha}_{dl}(x), \hat{\beta}_{dl}(x)) = \underset{\alpha_{dl}, \beta_{dl}}{\operatorname{argmin}} \sum 1_{X_i < x} \cdot (d_i - \alpha_{dl} - \beta_{dl}(X_i - x))^2 \cdot K\left(\frac{X_i - x}{h}\right) \tag{9}$$

where 1_{con} is an indicator function taking the value of 1 if the condition con is satisfied, and K is a kernel function that weights the elements of the sum according to a bandwidth h.

The estimator represents the local average treatment effect for the subgroup of houses for which the assigned ABCs status changes discontinuously at the c_{90} threshold. These are the homes who's school recognition is that of "distinction" (or "no recognition" if they were also unable to

met the growth standard) if their proficiency level fell just below c_{90}, but would be a "School of Excellence" if their proficiency level exceeded c_{90}.

To control for other characteristics that also influence transaction price I employ the use of baseline covariates. To do so, I 'residualize' the dependent variable and then conduct a regression discontinuity analysis on the residuals. The specification used in the first steps is almost identical to equation (1) however I eliminate the school characteristics. It takes the form,

$$\ln price_{inmcy} = \alpha_c + \phi_m + \delta_{ny} + \gamma' Z_i + \epsilon_{icmny} \tag{10}$$

I then compute the residuals, $\tilde{y}$, by subtracting y from a prediction of y and in the second step the regression discontinuity estimator becomes,

$$\hat{\tau}_{FRD} = \frac{\lim_{x \to c} \mathbb{E}(\tilde{y}|p = c_{90}) - \lim_{x \leftarrow c} \mathbb{E}(\tilde{y}|p = c_{90})}{\lim_{x \to c} \mathbb{E}(d|p = c_{90}) - \lim_{x \leftarrow c} \mathbb{E}(d|p = c_{90})} = \frac{\hat{\alpha}_{\tilde{y}r} - \hat{\alpha}_{\tilde{y}l}}{\hat{\alpha}_{dr} - \hat{\alpha}_{dl}} \tag{11}$$

This allows me to net out the share of the variation in house prices predicted by the pre-determined characteristics, leaving the categorical recognitions to explain the remaining residual variation in housing prices. A similar estimator is computed for the threshold that occurs at 80 percent for schools of "distinction". For this portion of the analysis I focus on these two categories of recognition.

4.1.1 Regression Discontinuity Validation

Regression discontinuity is a viable identification strategy under the assumption that schools with proficiency scores just below and above each cutoff have comparable potential outcomes. In other words, it is assumed that factors that determine student performance change smoothly across the discontinuity. I cannot test whether the unobserved factors vary across the cutoffs however, I can test whether the two groups of schools just on either side of the cutoff, on average, have similar observed characteristics. First, I investigate whether the observable characteristics of schools, such as percent black, percent free-reduced lunch, percent daily attendance, pupil teacher ratio, and school

Table 5: Comparison of Schools on Either Side of each Threshold. School Years 2003-2006.

School Characteristics	ABCs Threshold			
	Excellence		Distinction	
	Above 90	Below 90	Above 80	Below 80
Percent White	70.25	66.59	47.23	43.59
Percent Black	20.54	23.05	38.79	40.41
Percent Hispanic	6.51	7.10	10.30	11.15
Percent Free/Reduced Lunch	44.64	47.62	59.55	64.26
Percent Daily Attendance	95.63	95.67	95.58	95.48
Pupil Teach Ratio	15.16	15.24	14.53	14.35
Teacher Turnover Rate	16.90	18.48	21.75	23.57
Percent High Quality Teachers	91.51	91.20	89.33	91.94
Percent Internet Classrooms	97.51	97.73	96.16	98.02
Books Per Student	22.23	22.36	23.11	23.27
Title 1 Eligible	64.65	70.04	82.03	80.15
School Size	531	521	487	480

size are similarly distributed on either side of the thresholds.

Table 5 compares the means of characteristics for schools that fall just below and above the "School of Excellence" and "School of Distinction" thresholds. The distribution of characteristics on the higher side of and the lower side are fairly similar and in each cacse I fail to reject the null hypothesis that the means are equal to one another.[18] Furthermore the statistics show no obvious pattern that may explain why schools just above the thresholds are more attractive than those just below the threshold. Figure 3 also provides a simple check of this assumption, it shows the relationship between the performance composite and some school level characteristics - percent black, percentage of student who attend school daily, percent receiving free or reduced lunch, and the likelihood of meeting the state's growth standards. The data points have been collapsed into bins based on the performance composites with bands of width 1. The curve fitted to each data series is a cubic in the performance composite along with an indicator variables for whether the performance composite is above 90 and whether the performance composite falls between 60 and 80.

The patterns in Figure 3 illustrate that schools with lower proportions of black students or

[18]This table compares schools with students performing within one percentage point just above and just below each threshold. A similar test was performed comparing schools performing within two percentage points. While differences in means were slightly larger, they were only statistically different in one case; percent white at the 90 threshold.

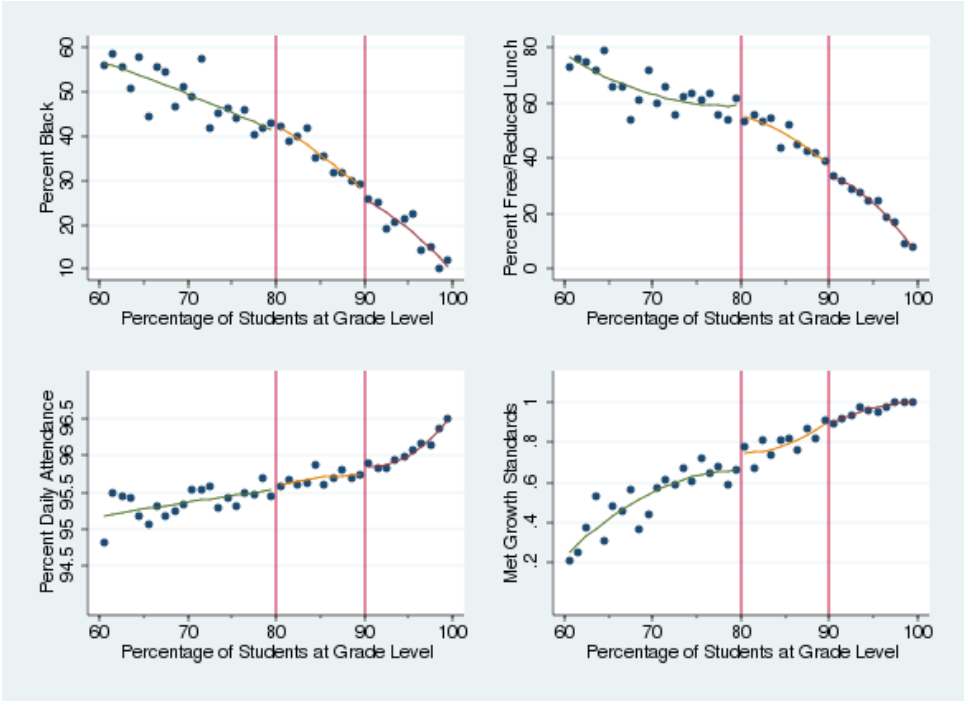

Figure 3: Covariates and Regression Discontinuity Estimation

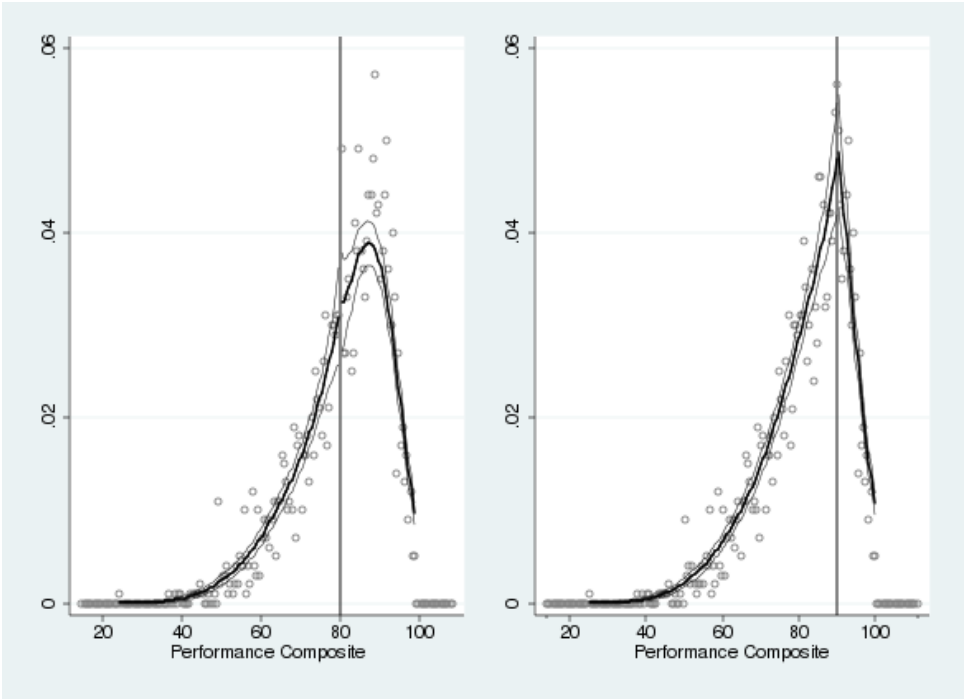

Figure 4: Density Smoothness Test of Underlying School Observations

students receiving free/reduced lunch tend to have higher levels of proficiency. From the figure, there are no obvious differences between schools just below and just above each cutoff. In each case I test the hypothesis of no difference between schools with performance composites on either side of each cutoff. The p-values for this hypothesis all range from 0.94, in the case of met growth standards at the 90 percent cutoff, to 0.23 in the case of percent receiving free/reduced lunch also at the 90 percent cutoff. Therefore, at all conventional levels of significance, I fail to reject the hypothesis and conclude there are no apparent differences between schools on either side of each cutoff.

Lastly, I support the validity of the regression discontinuity approach by checking whether schools have the ability to sort themselves around the cutoffs. If schools can influence there position relative to the cutoff the assumption that unobserved characteristics vary continuously around each cutoff may not hold. Deliberate sorting around the cutoffs would likely be accompanied by a discontinuous jump in the density of the underlying school observations at the cutoffs. I implement the test for density smoothness proposed by McCrary (2008). I do not find any evidence of sorting at the cutoff points. Figure 4 shows the estimated densities around the 80 and 90 cutoffs. It does not indicate any pattern in which the number of schools just at or after the cutoffs is much larger than the number of schools before the cutoffs.

5 Results

The results are presented in three sections. In the first, I estimate the relationship between alternative measures of test performance and house values using a basic hedonic specification including several fixed effects without the category recognitions. I find a significant and positive relationship between test performance and housing values. These results are consistent with those found in the literature (Kane et. al., 2003 and Black 1999), the results are robust across several different specifications. The first section also presents the results when I estimate equation (1), investigating the influence of the ABCs reports on housing prices. I find that there is a response to the information

provided by the ABCs recognitions. I further explore whether housing prices respond to the categorical recognitions provided by the ABCs reports using the regression discontinuity design outlined in the empirical section. Although the estimates are smaller than those found using the hedonic approach, I find evidence that suggests the ABCs recognitions significantly influence housing prices. In the second section, I explore whether the housing market's response to new information fades as one proceeds through the academic year. I find no evidence that the effects diminish over time. Finally in the third section, I investigate the strength of the market's response to new information in the form of the current year's report cards. I find evidence that year-to-year differences in school recognitions do have an impact on housing prices.

5.1 School Recognitions and Housing Prices

5.1.1 Hedonic Analysis

Column 1 of Table 6 (and column 1 of Table A.2) presents the coefficients on elementary school performance composite, other school characteristics, and housing characteristics. The dependent variable is the natural log of sales prices. There are also several dummies included; month-year dummies account for seasonality and overall trends in the housing market throughout North Carolina and municipality dummies control for differences between municipalities such as tax rates. The specifications only include houses located within 0.5 miles of an elementary school. The magnitude of the coefficient on the performance composite indicates that a 10 percent (about one student-level standard deviation) increase in the percent proficient is associated with a 7 percent difference in housing prices. It is likely that this specification gives an overestimate of the impact because it does not account for neighborhood differences in housing prices that are not captured by housing characteristic.

Fixed effects for each of the subdivisions are included in column 2. The results are consistent with earlier work done on housing prices. The coefficient on the performance composite is reduced

Table 6: House Price Regression: Dependent Variable is Natural Log of House Prices

	Specification[a]				
	(1)	(2)	(3)	(4)	(5)
Sample:	2003-06 < 0.5 miles	2003-06 < 0.5 miles	2003-06 < 0.3 miles	2003-06 < 0.7 miles	2003-06 < 0.5 miles
Performance Composite/10[b]	0.072	0.036	0.059	0.044	0.028
	(0.026)	(0.018)	(0.026)	(0.009)	(0.011)
School of Excellence			0.069	0.039	0.046
			(0.040)	(0.016)	(0.019)
School of Progress			-0.167	-0.134	-0.137
			(0.037)	(0.015)	(0.017)
No Recognition			-0.151	-0.088	-0.098
			(0.033)	(0.013)	(0.015)
Priority School			-0.272	-0.152	-0.156
			(0.075)	(0.028)	(0.033)
Low Performing			-0.253	-0.202	-0.238
			(0.150)	(0.060)	(0.067)
Met AYP			-0.008	-0.004	-0.006
			(0.024)	(0.009)	(0.011)
Subdivision Fixed Effects	No	Yes	Yes	Yes	Yes
Observations	32047	31857	11496	57018	31809
R^2	0.474	0.812	0.824	0.819	0.822

Notes: The specification includes all arm's length transactions of homes located within the proximity of an elementary school. Each regression also includes month of year dummies and municipality. Huber-White standard errors were calculated allowing for clustering at the school level.

a. Specifications also include housing and school characteristics such as number of bedrooms, number of bathrooms, age of house and its square, internal square footage, distance to elementary school, performance composite squared, percentage of minority students, percentage of students eligible for free/reduced lunch, percentage of students attending school daily. See appendix 1 for these estimates.

b. The performance composites are measured at the elementary school level and represent the percent of students performing at grade level averaged over three years.

to about half of that in column 1 after controlling for the variation between neighborhoods. Square footage of the house, as well as bedrooms and bathrooms, are positively correlated with higher house prices. The age of the house is nonlinear and negatively related to house prices. As for school characteristics, they too enter the equation as expected.

I estimate equation (1) for the sample of houses located within 0.5 miles of an elementary school, these results are reported in column 3 of Table 6. Columns 4 and 5 show the estimates as the sample is varied by reducing and expanding the distance to the nearest elementary school. In both

cases the coefficients do not change significantly.[19] The columns include indicators for each of the ABCs category recognitions and AYP status, these are allowed to vary by year for each school. The omitted category includes schools that received "School of Distinction" - those schools that met the growth standard and had a proficiency score between 80 and 90 percent. The sample is limited to 2003-2006, the initial years following the increased media attention surrounding school accountability resulting from the No Child Left Behind Act of 2001.

Even with the inclusion of the performance composite the coefficients on the categorical recognitions are individually statistically significant from zero. The results indicate that the estimated effect of receiving the recognition "School of Excellence" is associated with an 4.7 percent increase in housing prices, relative to schools with the recognition "School of Distinction". Being recognized as a "School of Progress", in turn, is estimated to be associated with a 12.8 percent decrease in housing prices relative to school of "Distinction", these result are significant at the 1 percent level. These findings show that after accounting for the factors that are captured in the school accountability system, the school recognition system does indeed impact the housing market.

5.1.2 Regression Discontinuity Analysis

The results in Table 6 provide compelling evidence, suggesting that the information provided by the ABCs recognition does indeed impact housing prices. However, these estimates may be biased if there are significant differences in the average school and student characteristics between the groups of schools bounded by each cutoff. More credible estimates can be obtained by employing the regression discontinuity design outlined in the previous section and comparing the housing prices of homes associated with schools close to each cutoff.

Panel 1 of Figure 5 shows the relationship between the performance composite and the likelihood of being recognized as a "School of Excellence", similarly the likelihood of being recognized as a "School of Distinction" is illustrated in panel 2 of Figure 5. Each point in the graphs is an average

[19] Because there is no substantive difference in the results between the 0.5 mile, 0.3 mile, and 0.7 mile sample, I use the 0.5 mile sample in future regressions.

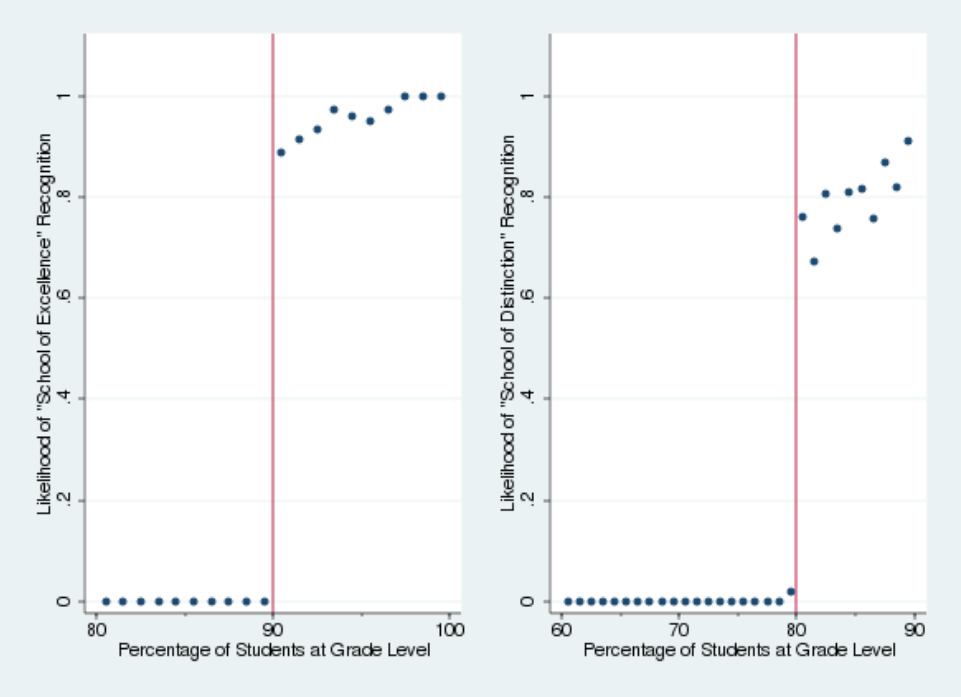

Figure 5: The Categorical Recognition Discontinuity

across 1-point, non-overlapping, intervals of the performance composite. Although it is not sharp, the figures clearly shoe discontinuities at the 90 and 80 percent cutoffs.

Figure 5 provides a graphical representation of the basic results from the analysis. The horizontal axis displays the percentage of students performing at grade level (or the performance composite). The vertical axis measures the residuals from equation (4). The data points are averaged across 2-point, non-overlapping, intervals of the performance composite. The curve fitted to each data series is a quadratic in the performance composite along with an indicator variables for whether the performance composite is above 90 and whether the performance composite falls between 60 and 80.[20] The figure suggests that homes in the neighborhood of schools that barley receive a higher recognition are associated with higher sales price than those homes in the neighborhood of schools that barely missed receiving the higher recognition. At both the 80 and 90 percent thresholds, corresponding to the thresholds for the "School of Distinction" and "School of Excellence" recognitions, there are clear

[20]These ranges correspond to the proficiency criteria for receiving recognitions of "School of Excellence" and "School of Progress", respectively.

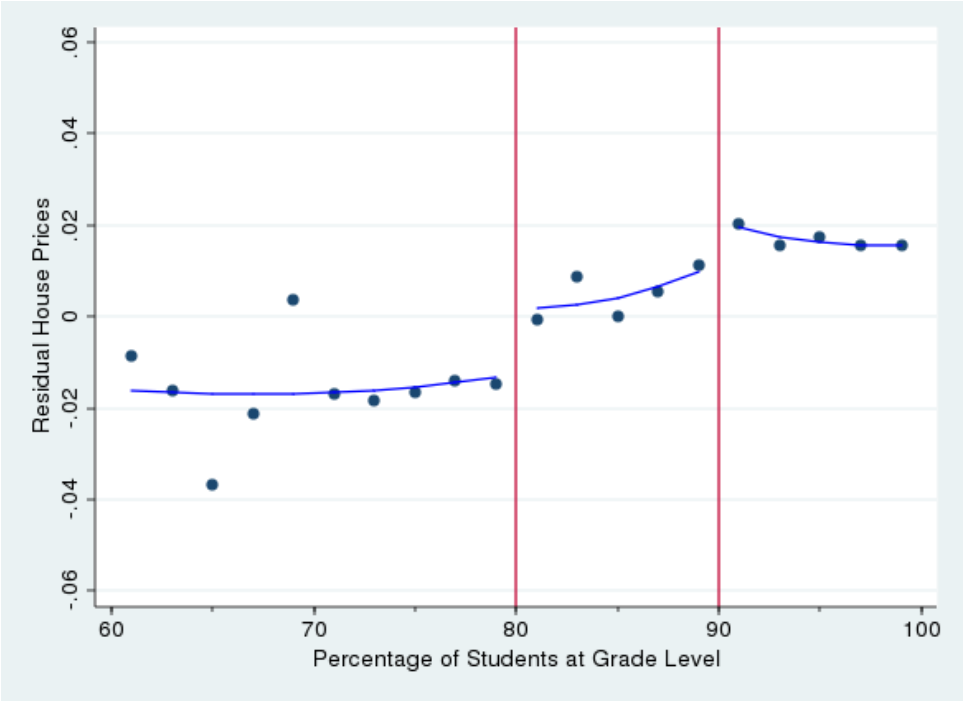

Figure 6: Outcome Variable and Regression Discontinuity Estimation

and significant discontinuities.

Column 1 of Table 7 presents the baseline regression discontinuity results with the use of the optimal bandwidth.[21] The findings indicate that homes within the neighborhood of a school recognized as a "School of Distinction" are associated with 4.5 percent higher housing prices over homes within the neighborhood of a "School of Progress" and homes within the neighborhood of a school recognized as a "School of Excellence" are associated with 3.6 percent higher sale prices. It is also important to recall that in this study all homes located within a 0.5 mile radius of a public elementary school are assigned to that particular school. As a result there is some error in the assignment process, so these results are likely a conservative indication of the true effects. These findings are robust with respect to the choice of bandwidth, the results from two alternate bandwidth selections

[21] The optimal bandwidth given by Imbens and Kalyanaraman (2009) is $h_{opt} = \text{argmin}_h MSE(h)$ where MSE is an approximation to the mean squared error. The optimal bandwidth is then, $h_{opt} = C_K \left(\frac{\frac{\sigma_r^2(c)}{f_r(c)} + \frac{\sigma_l^2(c)}{f_l(c)}}{(m_r^{(2)}(c) - m_l^{(2)}(c))^2} \right)^{1/5} \cdot N^{-1/5}$ where C_K is a constant, $\sigma^2(x)$ is the conditional variance function of Y_i, $f(\cdot)$ is the marginal distribution of the forcing variable X_i, and $m(x) = \mathbb{E}[Y_i | X_i = x]$.

Table 7: ABCs Impact on House Prices

	RD Local Wald Estimates		
Bandwidth:	Optimal[a]	Alternate 1	Alternate 2
School of Excellence	0.036	0.034	0.039
	(0.014)	(0.015)	(0.017)
First stage	0.812	0.806	0.833
	(0.022)	(0.023)	(0.032)
Bandwidth	1.48	1.08	1.88
Observations	7525	5707	9263
School of Distinction	0.045	0.038	0.065
	(0.023)	(0.023)	(0.029)
First stage	0.846	0.857	0.827
	(0.020)	(0.014)	(0.023)
Bandwidth	1.71	1.31	2.11
Observations	5247	3792	6013

Notes: The specification includes all arm's length transactions of homes located within 0.5 miles of an elementary school. Heteroskedasticity consistent standard errors are in parentheses.
a. Optimal bandwidth proposed by Imbens and Kalyanaraman (2009).

are given in columns 2 and 3 of Table 7.

Recall from Table 3, substantial changes the ABCs assessment criteria in 2005 caused many schools, even those that had maintain the same recognition for several years, were 'downgraded' in terms of the recognition they received. For example, only 3.5 percent of the schools in the sample were a "School of Excellence" during the 2005-06 school year. Whereas in each year prior to roughly 30 percent of the school in the sample received the same recognition. For many of these schools the lower recognition was a result of the more rigorous requirements and not a reflection of lower student achievement or ability. The changes to the ABCs criteria may raise concerns that, by including 2005-06 in the sample, the baseline regression estimates may be picking up extremely high willingness to pay for the schools in the far tail for the distribution. To help verify whether or not this is the case I restrict the sample by excluding the 2005-06 year and perform the same analysis. If I were to find contradicting results in this specification, it would raise concerns that higher premiums for the most elite schools led to the results presented above. However, I observe that this is not the case. In this

specification, I find similar results as those presented in Table 7. The estimated effect of a "School of Excellence" recognition is positive (0.038, with a standard error of 0.021) and the estimated effect of a "School of Excellence" recognition is also positive (0.039, with a standard error of 0.024). While the results are slightly less precise they are still significant and the magnitudes are similar to the baseline results.

5.2 Seasonal Trends

It is plausible that the impact to the school recognitions is concentrated in the months following the release of the school reports. This could be due to the increased publicity schools receive when the new report card information is released to the public. If homebuyers are only responding to this additional information when media attention is high one would expect the regression discontinuity effects to decline as the year progresses. I compare regression discontinuity estimates across three samples; homes sold between one to four months after school report cards are publicized, homes sold between five to eight months after report cards are publicized, and homes sold between nine months after the information becomes public to the month preceding the next release of information.

I do not find evidence suggesting the housing market's response is greater just after media reports are released. In fact the results, reported in Table 8, show that the homebuyer's response to the information provided in the state's reports is strongest during the months leading up to next report card release. The estimated effect of receiving an "excellence" recognition is associated with a 4.4 percent increase in sales prices, relative to a "distinction" recognition during the months following a report. But this goes up to a 9.4 percent increase in sales price during the months preceding the next report. Similarly, the estimated effect of receiving an "distinction" recognition is associated with a 3.6 percent increase in sales prices, relative to a "progress" recognition during the months following a report. This grows to a 6.7 percent increase in sales price during the months preceding the next report.

In general the months prior to the release of a report are June, July, and August - the summer

Table 8: Seasonal ABCs Impact on the Housing Market

	Specification		
	(1)	(2)	(3)
Sample:	1-4 months after report	5-8 months after report	9 or more months after report
School of Excellence	0.044	0.023	0.094
	(0.026)	(0.017)	(0.036)
Observations	1887	2024	1732
School of Distinction	0.036	0.047	0.067
	(0.039)	(0.028)	(0.029)
Observations	1596	2118	1512

Notes: The specification includes all arm's length transactions of homes located within 0.5 miles of an elementary school. Heteroskedasticity consistent standard errors are in parentheses.

months. It is worth noting that many parents choose to let their children finish out the school year before a move, because moving during summer break to allows them to start fresh in the new location for the beginning of school year. Education experts agree that it's better to move during the summer.[22] Books on moving warn parents of the disruptive and possible negative consequences for children, Janik (1988) and McCollum (1990). The sociology literature also shows a disproportionate number of parents of schoolage children who plan a move that requires their children to change schools do so during the summer to avoid disrupting their children's school lives; Tucker, Long, and Marx (1995). It is reasonable to expect that the movers most concerned with school quality are homebuyers with schoolage children. Larger premiums for school recognitions during the summer period reflect the higher willingness to pay of a different makeup of homebuyers in these months.

5.3 Reputation

It is a straightforward prediction that under complete information, the school recognitions should have no impact conditional on the performance composite. Recall, the published report cards

[22]Jodi Goldberg, the executive director of GreatSchools Milwaukee, cautions against switching schools mid-year, citing studies that suggest it's much worse for children's education to move during a school year even if their current school is merely mediocre, GreatSchools Staff (2010).

include a school's performance composite and ABCs recognition. Since the difference between the top three recognitions is simply based on whether a school meets some threshold of performance, the recognitions themselves do not provide any additional information. Results from the previous section show there is an evident response to the ABCs recognitions, which suggests that there are costs to acquiring the more complete information. The cost is considerable enough that the market responds to the somewhat noisy indicators of school performance. Still, the question remains: just how myopic are consumers in this environment, are the price differentials reflecting willingness to pay for a lifetime of access to a better school or just for a single year? I begin to investigate this issue by first tracing out the effects over time to determine if the regression discontinuity effects completely fade during the years following the release of a report. Secondly, I develop a direct measure of the reputation of the local school using a school's previous ABCs recognitions and test whether the market continues to respond to changes in recognition once a school has a built-up a given reputation.

I begin by asking whether or not one can still see some impact over a year later, after a new set of information has arrived. I test whether one-year lagged ABCs recognitions impact current housing prices. The results are presented in Table 9, they do not imply that the lagged information has any influence on buyer decisions whatsoever. There is no premium in the current market for homes within the neighborhood of schools that were recognized as "distinction" or "excellence" in the previous year relative to a "School of Progress" or "School of Distinction" in the previous year, respectively. The results suggest consumers are shortsighted in this setting. The price differentials from the baseline estimates, given again in column 1 of Table 9, may reflect willingness to pay just for access to a better school for the upcoming year.

In Table 11, I investigate the impact of ABCs reputation on housing prices. In column 1, I consider schools that have built up a reputation for being a "School of Excellence" for two years in a row, 2003 and 2004. I then test whether there is a premium for being recognized as a "School of Excellence" relative to a "School of Distinction" in 2005. Not only is this a comparison between

Table 9: Lagged ABCs Impact on the Housing Market

	Specification	
	(1)	(2)
	Baseline	1 year Lag
School of Excellence	0.036	0.016
	(0.014)	(0.025)
Observations	7525	4311
School of Distinction	0.045	-0.011
	(0.023)	(0.038)
Observations	5247	3827

Notes: The specification includes all arm's length transactions of homes located within 0.5 miles of an elementary school. Heteroskedasticity consistent standard errors are in parentheses.

schools that are essentially no different from one another in 2005, because they have either just made or just missed the 90 percent cutoff, but these schools also received the same recognition for the past two years. This means they are virtually indistinguishable from one another in terms of performance, other than the fact that some schools were downgraded and just missed out on making "School of Excellence" for the third year in a row. If reputation does matter, there should not be a significant discontinuity at the 90 percent cutoff between schools that made "excellence" three years in a row and schools that were downgraded in the third year. I find that, despite the fact of these schools being so similar, maintaining a reputation as a "School of Excellence" is associated with a 6.9 percent increase in sales price, relative to schools that were downgraded to a "School of Distinction". This suggests that once a school is downgraded, any built-up reputation does not matter.

I repeat this analysis in column two, this time considering schools that have built up a reputation for being a "School of Excellence" for three years in a row, 2003-2005. I find similar results, maintaining a reputation as a "School of Excellence" is associated with a 7.5 percent increase in sales price, relative to schools that were downgraded to a "School of Distinction". In the bottom row I continue to investigate whether there is an effect of being downgraded, but here I examine schools that have built up a reputation as a "School of Distinction". Column 3 presents the results for schools that maintained the level of "distinction" for two years in a row, again I find that reputation in this case

Table 10: Impact of ABCs Reputation on the Housing Market

	Specification			
	(1)	(2)	(3)	(4)
Sample:	School of Excellence 2003-2004	School of Excellence 2003-2005	School of Distinction 2003-2004	School of Distinction 2003-2005
School of Excellence	0.069	0.075	0.076	
	(0.026)	(0.044)	(0.092)	
Observations	733	452	196	
School of Distinction			0.054	0.039
			(0.022)	(0.044)
Observations			925	89

Notes: The specification includes all arm's length transactions of homes located within 0.5 miles of an elementary school. Heteroskedasticity consistent standard errors are in parentheses.

does not matter. I observe that the estimated effect of receipt of a recognition as "School of Distinction" for the third year is associated with a 5.4 percent increase in sales prices, relative to schools that were downgraded to a "School of Progress". Similar results are found in column 4, where I analyze schools that maintained the level of "distinction" for three years in a row. While the regression discontinuity estimate based on this sample is less precise, as can be expected given the smaller sample on which it is based, it is qualitatively similar to the basline estimate.

Lastly, I consider the effect of being upgraded. The top row of column 3 is the sample of schools that were a "School of Distinction" during 2003 and 2004. Here I estimate the impact of just making a "School of Excellence" in 2005 compared to receiving a recognition as "School of Distinction" for the third year in a row. This result is also less precise, but an estimated 7.6 percent increase in sales price is analogous to the previous estimated impact of receiving a recognition as "School of Excellence" in the current period. Altogether these results suggest that, primarily, the current periods ABCs information is what is capitalized into housing prices.

One may assume that home buyers form impressions of schools over long periods. In many areas, certain schools or school districts have reputations for being better than others. Community members base their judgments about the school quality not just on performance outcomes but on

information gathered over time from individuals in their social networks, including parents and realtors. These results show, the housing market seems to focus on current information on school quality and downplays reputation information. This is not what we would expect if homebuyers have prior beliefs about school quality. Perhaps this is a reflection of the growing North Carolina community. Over the last decade North Carolina has been among the top ten fastest growing states by population in the United States and, other than Florida, is the fastest growing state east of the Mississippi River. Outsiders are likely have limited to no prior information regarding the local schools in North Carolina. It is not surprising then to find that reputation effects are small in this market. Without local network connections, it is conceivable that newcomers turn to the prevailing accountability reports as the primary source for information regarding the quality of neighborhood schools.

6 Sensitivity Analysis

As an further validation check, to test for the comparability of schools on either side of each cutoff, I control of these differences in observed characteristics in the estimation. Not only will this account for the prospect of differences in average school characteristics but also it will also control for their importance in explaining overall school achievement. For that reason, linear controls for school characteristics were included in the hedonic equation (4), which was then estimated for the two discontinuity thresholds corresponding to the 90 and 80 percent cutoffs.[23] The estimates obtained from this analysis and the corresponding t-values for a test of equality between them and the estimates given in column 1 of Table 7, indicate that there is no significant difference between the two sets of estimates.

I also run a series of falsification tests in Table 10 to present additional evidence on the robustness of my findings. Since there are no discontinuities in recognitions for performance composite scores of 70, 77, 83, 87, or 95, regression discontinuity estimates for these alternate samples should

[23]The school characteristics included were percent black, percent free-reduced lunch, percent daily attendance, along with indicators for whether or not the school met growth and adequate yearly progress.

Table 11: Falsification Tests: comparing market response at non-ABCs cutoffs

	Alternative Thresholds					
Performance Composite:	95	87	85	83	77	70
RD Local Wald Estimate	-0.004	-0.014	0.006	0.011	0.003	-0.009
	(0.015)	(0.012)	(0.018)	(0.017)	(0.022)	(0.043)
Observations	5560	5181	5460	5521	3593	2346

Notes: The specification includes all arm's length transactions of homes located within 0.5 miles of an elementary school. Heteroskedasticity consistent standard errors are in parentheses.

not show significant house price effects. The results, provided in Table 10, show that none of the coefficients is statistically significant. Furthermore, the estimates are much smaller in magnitude than the baseline results. These results give evidence of the internal validity of the regression discontinuity approach and suggest that the previous findings were not a product of the model specification or some overall upward trend in house prices.

7 Conclusion

This paper investigates the link between school accountability measures and the housing market. The results suggest that even when taking into account student performance on test scores and other variables the market's response to the release of information related to school quality provided by the state's categorical recognition system is significant. Many states throughout the county were already publishing some information on school quality, but the No Child Left Behind Act of 2001 required most states to publish even more detailed information than they had previously reported. Therefore, these findings may have implications for markets across the nation.

Earlier work by Figlio and Lucas failed to find any lasting impact of a school recognition system in the state of Florida. In contrast, I do find evidence suggesting that the state's preexisting categorical recognition system, the ABCs of education, constantly influences the housing market. The ABCs ranks schools in a manner that condenses readily available information. It may be the case that the market values the more consistent and apparently reliable information provided by

the ABCs. Perhaps the heightened media attention surrounding school quality brought on by the No Child Left Behind Act of 2001 also led homebuyers to place greater value on the state's school quality measure. The evidence implies that classifications which help rank schools and summarize statistics in a way that is easily perceived by individuals is valued by homebuyers. Hence, relatively arbitrary classifications, such as the ABCs school ranking system, my very well have lasting distributional implications.

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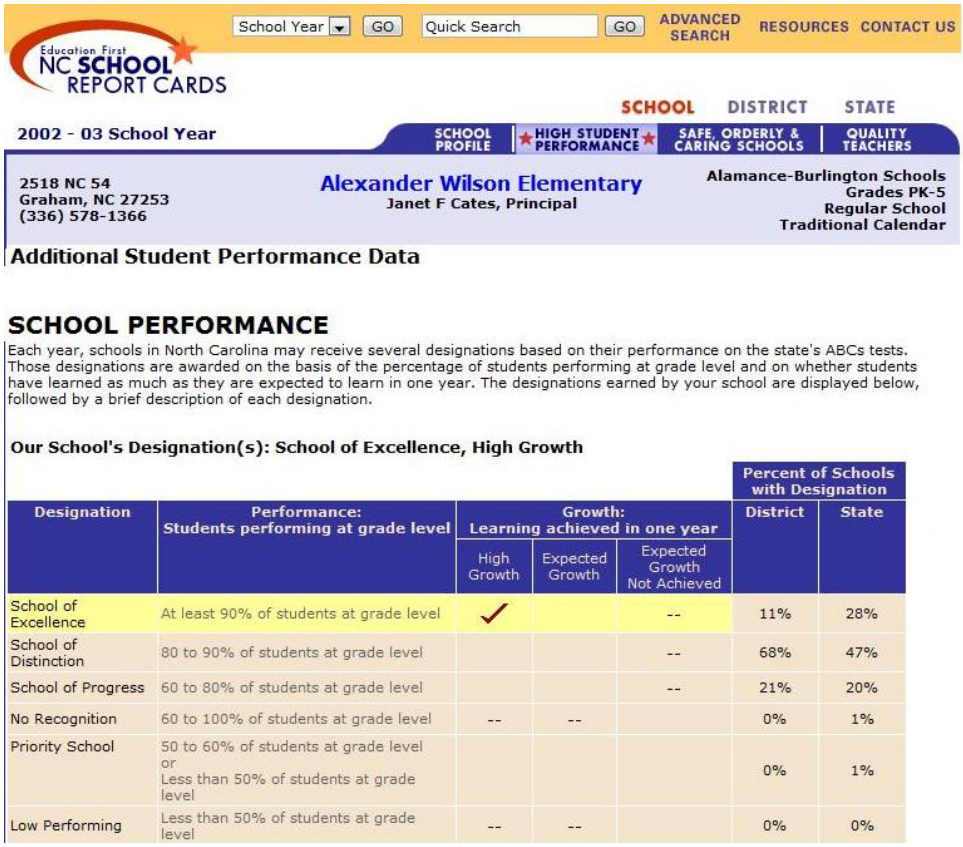
A Appendix



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Additional Student Performance Data

SCHOOL PERFORMANCE

Each year, schools in North Carolina may receive several designations based on their performance on the state's ABCs tests. Those designations are awarded on the basis of the percentage of students performing at grade level and on whether students have learned as much as they are expected to learn in one year. The designations earned by your school are displayed below, followed by a brief description of each designation.

Our School's Designation(s): School of Excellence, High Growth

Designation	Performance: Students performing at grade level	Growth: Learning achieved in one year			Percent of Schools with Designation	
		High Growth	Expected Growth	Expected Growth Not Achieved	District	State
School of Excellence	At least 90% of students at grade level	✓		--	11%	28%
School of Distinction	80 to 90% of students at grade level			--	68%	47%
School of Progress	60 to 80% of students at grade level			--	21%	20%
No Recognition	60 to 100% of students at grade level	--	--		0%	1%
Priority School	50 to 60% of students at grade level or Less than 50% of students at grade level				0%	1%
Low Performing	Less than 50% of students at grade level	--	--		0%	0%

Figure A.1: Sample from the Online Report Card for One School

Table A.1: School and Housing Summary Statistics. Years 2003-2006.

Variable	Definition	Median	Mean	Std.Dev.
Performance Composite	The percent of students perform- ing at grade level or higher on the End of Grade Tests	88.76	86.99	9.93
Percent Daily Attendance	The average percent of students who attend school daily	95.70	95.64	0.96
Percent Black	The percent of students enrolled in school of Black, not Hispanic descent	32.65	37.67	23.01
Percent Hisp/NA	The percent of students enrolled in school of Hispanic or Native American descent	10.16	12.78	10.61
Free/Reduced Lunch	The percent of students eligible to participate in the Free Lunch Program under the National School Lunch Act	41.76	47.17	26.42
ln Price	Natural log of the house transaction price	11.74	11.83	0.77
Age	Age of the House	22	29	24.3
Bathrooms	Number of Bathrooms	2	2.21	0.87
Bedrooms	Number of Bedrooms	6	6.1	1.7
Square Footage	Internal Square Feet, in thousands	1.55	1.80	0.79
Stories	Number of Stories	1	1.403	0.53

Table A.2: Other Coefficients from Basic Hedonic Regression in Table 3[a]

	Specification	
	1	2
Sample:	2003-06 < 0.5 miles	2003-06 < 0.5 miles
Performance Composite/10 Squared[b]	-0.0004	-0.0002
	(0.0001)	(0.0002)
Percent Black	-0.0003	-0.001
	(0.002)	(0.002)
Free/Reduced Lunch	-0.003	-0.003
	(0.001)	(0.002)
Percent Daily Attendance	0.035	0.010
	(0.033)	(0.023)
Age	-0.002	-0.004
	(0.001)	(0.002)
Age House Squared	0.001	0.002
	(0.002)	(0.002)
Bedrooms	0.027	0.015
	(0.024)	(0.011)
Bathrooms	0.157	0.078
	(0.023)	(0.015)
Square Footage (1000s)	0.444	0.351
	(0.023)	(0.020)
Distance to School (miles)	-0.012	-0.023
	(0.065)	(0.075)
Observations	32047	31857
R^2	0.474	0.812

Notes: The specification includes all arm's length transactions of homes located within 0.5 miles of an elementary school. Each regression also includes month of year and municipality dummies. Huber-White standard errors were calculated allowing for clustering at the school level.

a. Dependent Variable is Natural Log of House Price

b. The performance composites are measured at the elementary school level and represent the percent of students performing at grade level averaged over three years.