Essays on the Impact of School Accountability

by

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Dissertation submitted in partial fulfillment of the requirements for the degree of
Doctor of Philosophy in the Department of Economics
in the Graduate School of Duke University
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ABSTRACT

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Abstract

Comprised of three related chapters, this dissertation evaluates the effects of the North Carolina School Accountability System on agents in different markets using, in most part, school data provided by the North Carolina Education Research Data Center. North Carolina introduced its primary school improvement program, the ABCs of NC, in 1997. The model includes growth and performance composites and recognized/rewarded schools for performing well. In response to the No Child Left Behind Act of 2001, the state introduced a second accountability program, AYP, to run in conjunction with the ABC system. The AYP program focuses on closing the achievement gap and its primary goal is for all public school children to perform at grade level in reading and mathematics by the end of the 2013-14 school year. Failure to show improvement toward this goal leads to sanctions and increased accountability pressures at the school level. This dissertation seeks to determine the impact of the school accountability program on two groups of individuals - teachers and homebuyers.

Chapter 1 examines the influence of school accountability on teacher mobility. I estimate the effect of accountability incentives - teacher bonuses under the ABCs, and accountability pressures - threats and sanctions under AYP, on teacher mobility between schools. I investigate how the state's two accountability systems affect the distribution of teachers to schools, and in particular the willingness of quality teachers to teach in schools where student achievement is low. I provide

empirical evidence on the differential effects the two accountability systems have on the ability of low-performing schools to employ quality teachers. It may be that bonus given under the state's ABC system can help to offset high turnover rates in schools that face increased accountability pressure under the AYP system. Or conversely, if schools that face increased accountability pressure are not able to perform well enough to receive bonuses it may lead to even higher turnover rates. These higher turnover rates will undoubtedly place personal burdens on students, administrators, and parents; ultimately undermining the primary goals of performance gains under school accountability.

In Chapter 2, I examine the affect the labeling of schools under the ABC system has on the housing market. 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 chapter 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.

Chapter 3 provides a narrative on the extent to which public perceptions of the quality of local schools correspond to actual service quality. The chapter also discusses ways in which the relationship between actual and perceived school

quality may vary across different groups of people, specifically parents of school-age children, homeowners, and minority or low-income households. The results in chapter 2 suggest that public accountability systems may have a causal effect on citizen perceptions of service quality. However, due to data limitations, very few economics studies have analyzed the relationship between school accountability and public perceptions. With the use of a perceptions survey of North Carolina residents, I propose a study investigating public perceptions of the quality of public schools and the degree to which they freely available information about the level of school quality and student performance at the schools.

In memory of Cierra Cheyenne Boone

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1

Does School Accountability Influence Teacher Mobility?

1.1 Introduction

Since 1997 North Carolina began assigning schools various category recognitions reflecting school quality. The assignment of these recognitions was based on a combination of a value added measure to determine a school's academic growth and "status" scores measuring the fraction of a school's students who achieve some level of proficiency to determine a school's annual performance. The system also gives salary bonuses to teachers at schools that met or exceeded annual growth requirements. The state's accountability system was later revamped to meet the requirements of Bush's No Child Left Behind Act of 2001. Beginning in 2002, 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. Thus since 2002 the state of North Carolina has reported two different school accountability measures; one primarily based on yearly academic performance and the other incorporates year-to-year growth measures. Each program

uses a different means of inducing increases in achievement. AYP[1], sanctions schools that are performing poorly and do not meet the minimum threshold for percentage of students performing at grade level. The other program, the ABCs[2] of North Carolina, recognizes schools for making annual improvements despite high/low overall-performance levels.

In a given year, anywhere from twenty to sixty percent of schools are operating well according to one accountability measure and poorly according to the other. This means that many schools are being rewarded and punished at the same time, or conversely, neither reward or punished. In this paper I examine teachers' response to positive and negative reinforcement imposed under the two school accountability systems. One might predict that positive reinforcement efforts should override punitive measures and help to decrease teacher turnover at low performing schools. On the other hand, one may expect downward negative pressure to dwarf attempts to acknowledge positive growth and therefore cause teacher turnover despite the recognition. I investigate whether a school's accountability status differential effects teacher turnover.

Prior studies document the adverse effects of accountability pressures on teacher turnover. Clotfelter, Ladd, and Vigdor (2004) analyze the affect of North Carolina's school accountability system on the ability of schools serving low-performing students to attract and retain high quality teachers. They find that the introduction of the accountability program has had an adverse effect on teacher retention rates. They are unable to conclude however, that accountability has led to the decline in the average teacher qualifications of the teachers in these schools. Feng, Figlio, and Sass (2010) investigates the affect of an accountability shock in Florida on teachers' mobility decisions. They find that teachers are more likely to leave

[1] Adequate Yearly Progress

[2] Accountability, Basic Standards, Control at the Local Level

schools facing increased accountability pressure and that schools facing increased accountability pressure experience an increase in the quality of teachers who leave or stay.

Altogether, teachers appear notably responsive to negative accountability reinforcements. It is less apparent how coexisting positive accountability reinforcements effect teacher turnover and attrition. The goal of accountability pressure is to make the necessary changes, which may include the loss of some personnel, to increase achievement of a student body. And sanctions have been shown to be effective tools to induce teacher movement. However, turnover can lead to teacher shortages in key subjects and devastate efforts to keep good teachers. High levels of teacher turnover and attrition might impact a school's culture or climate and, subsequently, its students. Schools with the highest turnover tend to serve the lowest performing students, creating a cycle that continues to hurt the school. Teachers leave because of a poor school environment and poor performance; in turn, both the environment and performance suffer when turnover is a high. High teacher turnover also places an overwhelming burden on taxpayers by using resources that could have alternatively been put towards tutors, books, and other resources. If schools that fail to meet AYP and therefore face increased contractibility pressure are recognized if they are successful at illustrating sufficient growth in achievement, the recognition may slow teacher turnover to some degree. This paper is meant to shead some light on how teachers behave in the presence of two independent, and at times contradictory, accountability systems.

1.2 Related literature

Several recent papers have studied the factors that influence teacher mobility and attrition. This literature points to two primary influences on teacher turnover:

monetary and non-monetary aspects of teaching.

1.2.1 Salary Incentives

There is an extensive body of literature providing evidence that financial incentives, teacher salaries as well as salaries for outside options at non-teaching positions, influence the ability of schools to attract and retain teachers.

Several studies show higher salaries are associated with reduced attrition. In a study of teachers at Michigan public schools, Murnane and Olsen (1989) show that a $1000 increase (1967 dollars) in salary is associated with an increase of more than four years in the median teaching spell duration for Michigan public school teachers. The authors, Murnane and Olsen (1989b), also find similar effects for Colorado school teacher. Stinebrickner (1998) finds that a higher wage increases teaching spells. The author finds that an individual with wages that are one standard deviation above the mean is nine percent more likely to stay in teaching than an individual with the mean wage during a five-year span. [3]

In addition, better outside salary options have been shown to lead to increased attrition among teachers. Stinebrickner (1998) finds that teachers with bachelor's degrees in science were more likely to quit. When comparing average salaries of teacher in neighboring districts, Imazeki (2005) observes higher transfer rates among women teaching math and special education.[4]

1.2.2 Non- salary Incentives

A teacher's preferences also depend on the non-financial conditions of a job. Most important are the benefits and costs incurred when teaching. In general studies

[3] Also see Podgursky, Monroe, and Watson (2004); Reed, Rueben, and Barbour (2006); Krieg (2006); and Clotfelter, Ladd, and Vigdor (2010).

[4] Also see Murnane and Olsen (1990); Brewer (1996); Gritz and Theobald (1996); Lankford, Loeb, and Wyckoff (2002); and Podgursky et al. (2004), and Feng (2009)

have found that teachers have preferences for schools with large proportions of high achieving, non-minority, and affluent students. Smith and Ingersoll (2004), Shen (1997) and Murnane et al.(1991) find that teachers from schools with a high proportion of minority students or a large fraction of students who are eligible for free and reduced-price lunch are more likely to leave. Hanushek et al. (2004) find that Texas public school teachers who changed schools, in large part, ended up in a school with smaller proportions of minority students.

In addition to the characteristics of the student body, the administrative environment within a school also influences teacher attrition. Increased pressures resulting from low accountability scores may lead to policy changes, thereby making teaching less attractive at these schools. Feng et el. (2010) find that teachers are more likely to leave schools facing increased accountability pressure.

To summarize, many recent papers have analyzed the determinants of teacher mobility. However, evidence related to on the impact of coexisting positive incentives and negative pressures under school accountability and teachers' decisions in the labor market is far less common.

1.3 The North Carolina School Accountability System

1.3.1 ABCs

In the fall of 1997, North Carolina implemented the School-Based Management and Accountability Program, the ABCs (Accountability, Basic 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 growth composite is a model of accountability that measures progress by tracking achievement scores of the same students from one year to the next with the

intent of determining whether or not students have made progress. In general, 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.[5]

Prior to 2006, for elementary and middle schools and each grade-subject (i.e., grade 3 math and reading), a student's expected score was based on an equation of the form,

$$S_t - S_{t-1} = a + bX_1 + cX_2 \tag{1.1}$$

where S_t is the test score in either math or reading in year t and S_{t-1} the test score in the same subject in year $t-1$, X_1 is a proxy for the student's proficiency and is measured as the sum of the student's math and reading scores for the previous year minus the state average, and X_2 is designed to account for mean reversion and is measured as the student's prior year score in the subject of interest minus the state average in that subject. The tests are scored on a developmental scale and the parameter a can be interpreted as the statewide average gain in score for students in the specified grade and for the specified subject. The parameters a, b, and c were estimated using 1994 test scores for each grade. Because the b and c coefficients were quite similar across grades for each subject area, the state uses a single pair of b and c coefficients for each subject area to determine the expected growth rates.

In 2004, the accountability system was evaluated and found to have several flaws. One of which was the inability of the state's growth formula to adapt to changes in the underlying standardized tests. It was also apparent that the formula inadequately dealt with mean reversion and that it rewarded schools even when large test score gains were concentrated among a small proportion of stu-

[5] For a more complete discussion of North Carolina's teacher bonus system see Vigdor (2009)

dents. As a result, in 2006 the department of public instruction implemented a new formulas for determining whether schools were eligible for bonus payments.

ABC currently uses a standardized scale, similar to z-scores, to measure relative student performance. Student scores are standardized and a student's performance is considered as a point on the c-scale (change scale) relative to standard performance for that grade level in a standard setting year. A student's developmental scale score is converted to a c-scale score. In the first year of a test edition implementation (called the standard setting year), approximately half of the students in the state will score above 0 and half below. After the standard setting year, a student scoring above 0 on the c-scale is performing better than the average student in the standard setting year. The difference between a c-scale and normative scales is that there is no reason why all students in the state cannot score above 0 in any year after the standard setting year. On the c-scale, if a student performs equally as well in two consecutive years, the academic change (AC) would be 0; for example, this would mean that the student, relative to the grade level average in the standard setting year, is performing equally as well in grade 5 as previously in grade 4. If a school assists students to achieve as well in the current year as in the previous year it receives a change of 0 on the c-scale. If a school does not perform as well in the current year, then its AC is negative, and if a school performs better, its AC is positive.

When a student's scores are placed on the c-scale the individual student is expected to perform at least as well on the end-of-grade (EOG) assessment for the current year as she or he did, on average, during the previous two years. The current accountability model views "growth" as academic change. Academic change is expressed as the difference between a student's actual c-scale score for

the current year and the student's average of two previous assessments[6] with a correction for regression toward the mean. A positive academic change indicates a gain in academic achievement, while a negative academic change indicates a loss in academic achievement from the previous two years. The simplified formula given by the following,

$$AC = CS_{c-scale} - 0.92ATPA_{c-scale} \tag{1.2}$$

where CS is a student's current score and $ATPA$ is the average of two previous assessment scores. [7]

Once the growth standards are calculated each school is then 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. 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. In 2004 the state board of education approved adding a recognition category for Schools of Excellence that meet adequate yearly progress

[6] If there is only one previous year's EOG test data available, the expectation for change is based on one previous assessment.

[7] A slight modification is made to the formula for determining academic change in grade 3 and for any instance when only one previous year's EOG score is available. The formula is: $AC = CS_{c-scale} - 0.82PA_{c-scale}$, where PA is a student's previous score.

(as outlined in the following section). 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" remained the same.

1.3.2 AYP

After the federal No Child Left Behind Act of 2001 (NCLB) North Carolina began an implementing an additional accountability system called Adequate Yearly Progress (AYP). AYP 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. The AYP measure aims to provide a better indication of each school's success at closing achievement gaps across subgroups of the student body. A school makes AYP only if it meets two requirements. First, each of the ten student groups, with at least 40 students, in the tested grades must meet proficiency targets and each group must have at least 95 percent of its students taking tests in reading and math. Secondly, the school as a whole must show progress in attendance/graduation rates.

The student groups are: 1) the School as a Whole (all students); 2) White; 3) Black; 4)Hispanic; 5) Native American; 6) Asian; 7) Multiracial; 8) Economically Disadvantaged students (students eligible for free or reduced-price lunch); 9) Limited English Proficient students; and 10) Students With Disabilities. Each student group must have at least 40 students across the tested grades to be included in AYP calculations at the school level. Most schools have several, but not all, 10 groups. A student must attend a school 140 days by the first day of spring testing to be included in AYP calculations at the school level. However, students who are part of groups smaller than 40 or who attend a school fewer than 140 days contribute to AYP calculations at the district level. Many students are represented in more than one group in AYP calculations.

Participation and proficiency in reading and math end-of-grade (EOG) assessments for grades 3-8 determine if elementary and middle schools make AYP. Proficiency target goals define the percentage of students expected to meet or exceed the state's proficient level (grade level) in reading/language arts and math each year. Target goals are the same for each of the ten student groups. Target goals increase until 2014, which is when the expectation of NCLB is 100 percent proficiency. Each student group at the school, district, or state level must meet or exceed the proficiency target goals to make AYP.

Progress in the attendance rate in elementary and middle schools are "Other Academic Indicators" in North Carolina. For elementary and middle schools, progress is defined as a 0.1 percentage point increase or more or any fluctuation at or above the 90 percent threshold. There are special conditions that may apply when either of the grade spans has fewer than 40 students.

If a school does not make AYP, it begins a process that can lead to "School Improvement" status. The first year that a school misses AYP, it is put on alert status but faces no consequences. Instead, the school is advised develop or review its school improvement plan. Interventions begin at the end of the second consecutive year a school does not make AYP in the same subject, reading or math. Title I[8] schools enter Title I School Improvement and must offer its students transfer options. After three years of not making AYP in the same subject, a Title I school must offer special tutoring services, known as supplemental educational services (SES), to economically disadvantaged students while continuing to offer transfer options to all students. For districts participating in a federal SES pilot program, the options are reversed. Schools in these districts offer SES after not making AYP

[8] Title I provides funding for high poverty schools to help students who are behind academically or at risk of falling behind. Schools must have at least 35 percent or more of their students eligible for free or reduced-price lunch to be eligible for Title I funding. About half of North Carolinas public schools are Title I schools.

in the same subject for two years in a row and offer transfer options in the next year if they continue to not make AYP. Consequences increase in severity as long as the school does not make AYP.

In summary, the goal of both accountability programs is to increase performance. ABC's focus is on changes in the level of performance of the student body, while AYP is concerned with the level of performance of the student body as a whole as well as various groups within the student body.

1.3.3 Descriptive Statistics

Table 1.1 gives a comparison between the state's two different accountability systems, ABCs and AYP, for the schools elementary and middle school between the 2002-03 and 2007-08 school years. At the top there are two categories of school performance standards as outlined by NCLB/AYP. In a particular year, anywhere from 20 to 60 percent of the schools are performing well according according to ABC standards and poorly according to AYP standards, or vice-versa. Teachers in these schools received bonuses in recognition of the year-to-year progress made by the students, however they face increased administrative pressures due to the overall low performance by students; or the reverse holds. 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.

In Table 1.2 compares school ABC and AYP status by the percentage of students scoring at grade level. In general, schools with greater proportions of students performing at grade level fare better on both the ABC and AYP. However a large share of schools, roughly 46 percent, with fewer than 60 percent of its students performing at grade level meet the state's growth standards in a given year even though about 89 percent of those schools fail to make adequate yearly progress. Therefore, despite generally unappealing working as a result of large

Table 1.1: Comparing School AYP and ABC Status by Year

ABC Status	AYP Status: Did Not Meet Performance Standards	AYP Status: Met Performance Standards
School Year 2002-03		
Did Not Meet Expected Growth	0.038	0.007
Met Expected Growth	0.440	0.516
School Year 2003-04		
Did Not Meet Expected Growth	0.145	0.097
Met Expected Growth	0.101	0.604
School Year 2004-05		
Did Not Meet Expected Growth	0.214	0.146
Met Expected Growth	0.168	0.472
School Year 2005-06		
Did Not Meet Expected Growth	0.326	0.142
Met Expected Growth	0.227	0.306
School Year 2006-07		
Did Not Meet Expected Growth	0.245	0.049
Met Expected Growth	0.314	0.393
School Year 2007-08		
Did Not Meet Expected Growth	0.076	0.005
Met Expected Growth	0.600	0.319

proportions of low achieving, minority, and low-income students within these schools, the positive recognition and monetary bonuses may result in lower turnover rates than what would have otherwise occurred at these low-performing schools in the absence of a bonus program.

Table 1.2: Comparing School AYP and ABC Status by Performance Level

ABC Status	AYP Status: Did Not Meet Performance Standards	AYP Status: Met Performance Standards
90% to 100% of Students at Grade Level		
Did Not Meet Expected Growth	0.033	0.063
Met Expected Growth	0.124	0.780
80% to 89% of Students at Grade Level		
Did Not Meet Expected Growth	0.088	0.109
Met Expected Growth	0.238	0.565
70% to 79% of Students at Grade Level		
Did Not Meet Expected Growth	0.165	0.128
Met Expected Growth	0.323	0.384
60% to 69% of Students at Grade Level		
Did Not Meet Expected Growth	0.288	0.109
Met Expected Growth	0.378	0.225
50% to 59% of Students at Grade Level		
Did Not Meet Expected Growth	0.424	0.048
Met Expected Growth	0.430	0.099
less than 50% of Students at Grade Level		
Did Not Meet Expected Growth	0.433	0.006
Met Expected Growth	0.524	0.038

1.4 Model and Methodology

As in Cameron and Trivedi (2005), a teacher's decision to quit or stay is often modeled using a utility-maximizing framework, where a teacher chooses between quitting teaching and staying in teaching according to whichever decision pro-

vides higher utility. Hanushek et al. (2004) characterize the problem a teacher faces in the following manner: A teacher will select a group of schools based on her individual preferences and the characteristics of the job, taking into consideration both monetary aspects (salary) and non-monetary components (working conditions). A teacher will compare the options that are available and select the school which yields the highest present value of expected utility. I model this decision in a similar way but also take into account whether external accountability pressure also influences teachers to change jobs. [9]

The utility a teacher gets from working at a particular school is a function of the teacher's individual preferences, salary, working conditions, and external accountability pressure. A teacher maximizes his or her utility by selecting the option that provides the highest utility among four possible choices: stay at the current school, move to a public school within the same school district, move to a public school in a different North Carolina school district, or leave the North Carolina public school system.

More specifically, the decision facing a teacher in a given year,

$$U = f(X_{indt}, C_{indt}, W_{indt}, A_{ndt}) \tag{1.3}$$

$$\max PV(U_C, U_S, U_N, U_L) \tag{1.4}$$

where X_{indt} is a vector of determinants that influence a particular job's attractiveness for an individual teacher; including demographic characteristics of teachers, such as race, gender and age along with interactions between age and gender are included to account for birthing. C_{indt} represents the conditions of the working environment for teacher i in school n and district d at time t. This includes teacher-specific school characteristics, such as the demographic composition of the students, the poverty level of students, and student performance on exams. I

[9] Feng et al. 2010

also include similar factors measured at the district levels. W_{indt}, represents the base salaries earned for individual i in school n and district d at time t.

I am particularly concerned with identifying the effects of a particular aspect of the working environment, school accountability influences. Therefore, I also include a vector of accountability indicators A_{indt}. This includes the AYP or ABC status of the individual teacher's school in a given year.

Since most decisions to leave take place at the end of the school year, the exit decision occurs annually. In which case I employ a discrete-time multinomial logit hazard model. The discrete-time hazard function can be interpreted as the probability of transitioning at time t given survival up to time t,

$$h_{indt}(t) = Pr(T_{indt} = t | T_{indt} \geq t) \tag{1.5}$$

This hazard function models the probability that one of the four events happened to teacher the during period, conditional on the event not occurring until that time,

$$h_{indt}(t) = Pr(T_{indt} = t | T_{indt} \geq t, X_{indt}, C_{indt}, W_{indt}, A_{indt}) \tag{1.6}$$

The multinomial logit hazard gives the probability of choosing each possible option as a function of teacher, school, and district characteristics. The probability of exiting a school is the sum of the transition probabilities of the three exit options - move to a public school within the same district (S), move to a public school in a new district (N), or leave the North Carolina public school system (L):

$Logit(h_{indt}(S)) =$

$$\log\left(\frac{h_{indt}(S)}{(1 - h_{indt}(S))}\right) = \alpha_{St} + \beta_{S1}X_{indt} + \beta_{S2}C_{indt} + \beta_{S3}W_{indt} + \beta_{S4}A_{indt} \tag{1.7}$$

$Logit(h_{indt}(N)) =$

$$\log\left(\frac{h_{indt}(N)}{(1 - h_{indt}(N))}\right) = \alpha_{Nt} + \beta_{N1}X_{indt} + \beta_{N2}C_{indt} + \beta_{N3}W_{indt} + \beta_{N4}A_{indt} \tag{1.8}$$

$$Logit(h_{indt}(L)) =$$

$$\log\left(\frac{h_{indt}(L)}{(1-h_{indt}(L))}\right) = \alpha_{Lt} + \beta_{L1}X_{indt} + \beta_{L2}C_{indt} + \beta_{L3}W_{indt} + \beta_{L4}A_{indt} \quad (1.9)$$

The independent variables of interest in the model are indicators related to a school's AYP and ABC in a given year. Control variables in the baseline model include the salary, experience, race and gender of teacher, the proportion of minorities in an school, as well as the proportions of a school's students who are eligible for free and reduced lunch.

When estimating the model I begin with data on all elementary and middle school teachers from the 2002-03 to 2008-09 school years in North Carolina. 2002-03 was the first school year in which both accountability systems, ABC and AYP, began running concurrently statewide. Only teachers who start teaching spells during the 2002-03 to 2008-09 period are included in the study. Otherwise, including teachers who taught during the 2002-03 but began their spell prior to that year would lead to left-censoring issues. [10]

1.5 Data

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 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.

[10] There are several cases in which teaching spells had not ended by the last year of the data. Therefore, I use the 2008-09 data to identify teachers who ended a teaching spell in 2007-08. Thus, the final sample includes all elementary and middle school teachers employed in the state of North Carolina who began a spell between the 2002-03 and 2007-08 school years.

Classroom and Teacher Characteristics: The data set contains information regarding the demographic characteristics of teachers as well as forms of monetary compensation received by teachers.[11] As a measure of teacher compensation, I use the annual base salary without bonuses. Other teacher specific characteristics include race, gender, a set of indicator variables for a teachers age and also the age interacted with gender. The age-female interaction is included to account for exit due to birthing decisions. Lastly, I control for teacher quality in two different ways, holding an advanced degree and having advanced degree attended a very competitive undergraduate college/university.[12]

School Characteristics:The general school conditions may also influence teacher decisions. To control for the school environment I include school level proficiency scores as a measure of academic achievement of the student body, the proportion of students who are black, the proportion who are some other minority, the fraction of students in the school who are eligible for free/reduced-price lunch, total school enrollment, and whether it is a middle school.

Several studies have shown that teacher exhibit preferences for teaching students of their own race. [13] Therefore, I include interactions between teacher race and racial composition of the student body at a given school.

District Characteristics:There are undoubtedly differences in the working con-

[11] Additional descriptive statistics can be found in Table A.1 of Appendix A.

[12] The undergraduate competitiveness categories were derived from information from Barron's College Admissions Selector for 1988, based on information for first-year students in each university in 1986-87. The very competitive category includes universities rated as most competitive, highly competitive or very competitive. The competitive category are those schools rated as competitive. less competitive are those rated as less competitive or non competitive; and the unranked category includes special programs such as art schools, international universities or universities for which the rating is unknown. Barron's uses criteria such as curriculum, class rank, grades, SAT scores, ACT score, and acceptance rates. This classification is similar to that used in Clotfelter, Ladd, and Vigdor (2010)

[13] Hanushek et al. (2004), Imazeki (2004) and Boyd et al. (2005) each find that minority teachers favor schools with higher shares of minority student enrollment.

ditions across school districts. To capture these differences I incorporate district-level variables for student achievement on the end of grade exams, percent black, percent other minority, fraction of students eligible for free or reduced lunch, and district enrollment.

1.6 Results

1.6.1 Descriptive Results

Table 1.3 presents a descriptive summary of teacher job exit by a school's accountability status for each of the exit categories: exit a school but move to a school within the same district, exit a district and move to a school in another district within North Carolina, exit the North Carolina teacher labor market, and exit by any of the three routes. In general, exit rates are significantly higher for schools that have failed to meet AYP standards relative to schools that meet those standards, regardless of whether of not the school meets ABC standards. This suggests that, despite monetary and incentives and other positive recognition teacher associated with making ABC, turnover will be higher in schools that face interventions. Most of this movement is due to teachers teachers leaving a particular school rather than changing school districts or leaving the labor market. What is less clear from these descriptive results however is, conditional on failing AYP, whether teacher turnover is lower in the presence of monetary rewards for academic growth in site of poor overall-performance.

Table 1.3: Exit Rates by ABC and AYP Status

	Any Exit	Exit Teaching	Exit District	Exit School
Met AYP and ABC Standards	44.41	17.27	2.55	22.56
Met AYP, Failed ABC Standards	36.15	20.15	2.94	13.06
Failed AYP, Met ABC Standards	51.42	19.30	2.83	25.30
Failed Both Standards	52.11	21.88	3.30	27.02

1.6.2 Estimates of School Accountability and Teacher Mobility

Full results for all teachers are given in Table 1.4.[14] The parameters are reported as the odds ratio, where ratios below one indicate that a determinant makes exiting through a given route less likely and above one more likely. As suspected, female teachers are less likely to leaving the teaching profession relative to males. Also, female teachers between the ages of 25-29 are more likely to exit the teaching labor market than male teachers and teachers of other ages in any given year. Although black teachers are more likely than white teachers to leave their current school, they are less likely to leave the district.

The results also show that teachers who graduated from very competitive undergraduate schools have significantly higher exit rates, which is chiefly due to teachers exiting the profession altogether. These teachers are likely to have better outside options due to their competitive degrees; therefore, it is not surprising to find that the such high exit rates. Conversely, teachers with advanced degrees are less likely than teachers without an advanced degree to leave their school. This is not surprising, many teachers who obtain an advanced degree are dedicated to

[14] The dependent variable for the logit model is the probability that a teacher will leave a school between year t and t+1. Standard errors were clustered at the school-year level. ***denotes statistical significance of the underlying hazard coefficient at the 1% level, **denotes statistical significance of the underlying hazard coefficient at the 5% level, *denotes statistical significance of the underlying hazard coefficient at the 10% level.

Table 1.4: Teacher Exit, by Route, for All Teachers (Multinomial Logit Hazard Regression - Odds Ratio)

Variable	Any Exit	Exit Route: Exit Teaching	Exit Route: Exit District	Exit Route: Exit School
Met AYP	0.726***	0.848***	0.841***	0.618***
Met ABC	0.932***	0.902***	0.950	0.995**
Female	0.910*	0.838***	1.39**	0.951
Black	1.029*	1.02	0.797**	1.043**
Other Minority	0.890*	1.03	0.589***	0.790***
Salary	1.000**	0.999***	0.989***	1.000***
Age 25-29	0.741*	0.64**	1.040	0.859*
Age 30-34	0.594*	0.54*	1.046	0.607*
Age 35-39	0.510*	0.52*	0.983	0.456*
Age 40-44	0.387	0.52**	0.663	0.344*
Age 45-49	0.489	0.550*	0.753	0.245**
Age 50 and over	1.089	0.904	1.221	0.719*
Age 25-29 * Female	1.15**	1.345***	0.990	1.008
Age 30-34 * Female	0.980	1.157	0.067**	0.868
Age 35-39 * Female	0.981	1.034	0.625*	0.946
Age 40-44 * Female	1.11	1.145	0.741	1.07
Age 45-49 * Female	1.05	0.977	0.765	1.11
Age 50 and over * Female	0.889	0.964	0.345	0.959
Very Competitive Undergrad	1.073***	1.187***	0.839**	1.01
Graduated NC College	0.843***	0.775***	1.027	0.864***
Advanced Degree Holder	0.774***	1.007	1.050	0.480**
Middle School	1.03*	1.226***	1.35***	0.846**
Free/Red Lunch - School(%)	1.001***	1.005***	1.007***	1.003***
Black(%) - School	0.998	1.003***	1.007***	0.993*
Black(teacher) * Black(%) - School	1.000	0.998	0.987***	1.001*
Other Minority(%) - School	1.000	0.998*	0.998	1.003***
Total Students - School	1.000	0.999***	0.999	1.001***
Percent at Grade Level - School	0.933***	0.967	0.986***	0.888***
Black(%) - District	0.980	0.995	0.997	0.958
Other Minority(%) - District	0.997	0.981	0.998	0.962
Total Students - District	1.000*	0.999	0.999	1.002
Percent at Grade Level - District	0.992**	0.9646	0.984	0.853
Number of teacher-year observations	74,615	74,615	74,615	74,615

the teaching profession and obtain a higher degree in order to earn a higher salary. Finally, the results indicate that graduating from a college within North Carolina decreases the likelihood for a teacher to exit his/her school and the profession. Similar patterns have been found in earlier work.[15]

The top panel of Table 1.5 displays the odds ratio by school accountability status for all teachers. In each case the ratios are relative to schools that failed to meet AYP standards but met the state's ABC standards. These are schools that face sanctions because they do not make AYP requirements but they are recognized for obtaining annual growth in achievement levels. So, while teachers at these schools may be subject to interventions, they are also receiving monetary bonuses. The hope is that these bonuses and positive recognition can lead to lower teacher turnover rates relative to schools that fail to meet AYP and also show no growth. If the positive incentives are not enough, then a school's ABC status would have no effect on exit decisions, conditional on the school failing AYP. I find that, relative to schools that failed to meet AYP standards but met the state's ABC standards, teachers at schools that fail to meet both accountability standards are more likely to exit schools and exit the profession. This indicates that the state's ABC program provides teachers with enough incentives to reduce turnover in schools that are facing accountability pressures.

While the previous results may not be surprising, what is less clear is whether teachers are more likely to prefer a school with rewards in the presence of negative sanctions or no rewards and the absence of any sanctions. What is stronger, the attraction of money or the repulsion of threats? Consistent with evidence cited earlier, there is reason to believe that the answer to this question could go either way. While there are several studies that highlight the pecuniary reasons behind the labor market decisions of teachers, there are yet several others that emphasize

[15] Clotfelter, Ladd, and Vigdor (2010)

Table 1.5: Effects of AYP and ABC Status on Teacher Exits (Odds Ratio)

	Any Exit	Exit Route: Exit Teaching	Exit District	Exit School
All Teachers				
Met AYP and ABC Standards	0.774***	0.879***	0.894*	0.684***
Met AYP, Failed ABC Standards	0.653***	0.880**	0.794**	0.462***
Failed Both Standards	1.109*	1.118*	1.095	1.097*
Experienced Teachers				
Met AYP and ABC Standards	0.779***	0.883***	0.893	0.692***
Met AYP, Failed ABC Standards	0.638***	0.858***	0.837*	0.462***
Failed Both Standards	1.110*	1.115**	1.108	1.111*
New Teachers				
Met AYP and ABC Standards	0.949	0.86	0.902	0.880
Met AYP, Failed ABC Standards	0.793*	0.996	0.821	0.692*
Failed Both Standards	1.021	1.074	1.170	0.992

The dependent variable for the logit model is the probability that a teacher will leave a school between year t and t+1. Standard errors were clustered at the school-year level. ***denotes statistical significance of the underlying hazard coefficient at the 1% level, **denotes statistical significance of the underlying hazard coefficient at the 5% level, *denotes statistical significance of the underlying hazard coefficient at the 10% level. The models also includes all additional LHS variables found in the baseline model.

the non-pecuniary reasons as well. I find that along all exits routes teachers are less likely to exit schools that make AYP and fail ABC, relative to schools that fail AYP and make ABC. These findings show that, above monetary rewards, teachers prefer an environment with few accountability pressures.

This situation may in fact be ideal. The results indicate that exit rates are lower at schools that meet AYP but fail to meet ABC, relative to schools that failed to meet AYP standards but met ABC. This suggests that the positive incentives under ABC are large enough to reduce teacher turnover at failing schools but not significant enough to drive all their decisions.

There is significant evidence that new teachers are considerably less effective

than more experienced teachers. Given these findings, one might expect teachers without prior experience to respond more significantly to differences in school accountability ratings since experienced teachers may feel they have the sufficient tools to overcome poor ratings in the future. In the bottom two panels of Table 1.5, I separately analyze two groups of teachers, those who had at least one year of teaching experience prior to 2002-03 and those that were new to the profession in 2002-03 or some other time during the panel. Across all exit routes, I find that experienced teachers are less likely to leave schools that make AYP, relative to schools that make ABC but fail to make AYP, and are more likely to change districts or exit the profession when their school fails to make AYP and ABC. In contrast, the exit decisions of teachers without previous teaching experience are driven by actions at the school level. This suggests that the decision of new teachers to leave teaching or a particular district is not related to the school's accountability status.

1.6.3 Estimates of School Accountability, Teacher Quality, and Teacher Mobility

The results indicate that North Carolina's two independent accountability systems reduce teacher turnover at schools that are failing but manage to show incremental progress toward proficiency goals. In this section I use the degree of selectivity of the undergraduate school the teacher attended as a measure of teacher quality to examine how the accountability systems affect the average characteristic of teachers in a school. The use of this measure as a signal of teacher quality is based on the assumption that teachers from more competitive undergrads are, on average, more likely to have higher academic ability than those from less competitive undergrads and as a result, are likely to be more effective teachers than others.

Several studies have shown that there are meaningful within school differ-

ences in the level of teacher quality.[16] If high quality teachers exit schools with increased accountability pressure despite the bonuses this would mitigate the benefits of rewarding teacher bonuses at these schools and potentially undermine the purpose of the accountability sanctions. On the other hand, if less qualified teachers tend to be unresponsive to bonus rewards at failing schools and continue to have higher exit rates in the presence of bonuses, this could strengthen the positive aspects of both accountability systems.

Table 1.6 shows the effects of the AYP and ABC accountability systems of the exit rates for the three different groups of teachers. The exit patterns for teachers with a very competitive undergraduate degree are similar to those with a competitive undergraduate degree. Both groups of teachers are less likely to exit schools that fail AYP and make ABC, relative to schools that fail AYP and ABC. However, teachers with less competitive undergraduate degrees do not have significantly different exit rates in schools that fail AYP and ABC relative to schools that fail AYP and make ABC. This does not indicate that teachers with less competitive degrees are less likely, relative to teacher's with more competitive undergrade degrees, to exit schools fail AYP and make ABC but it does demonstrate that lower quality teachers, relative to higher quality teachers, illustrate different exit patterns under the various accountability scenarios.

To get a clearer picture of how the exit rates may differ across schools of different performance levels we turn to Tables 1.7 and 1.8. Table 1.7 reports the average levels in the distribution of teachers from very competitive, competitive and less competitive undergraduate schools, for schools that failed to meet AYP but met ABC and schools that failed to meet both AYP and ABC for the previous school year. The first column in Table 1.7 includes all schools the following 3 columns compare the levels for schools with less than 60 percent, 60-79 percent,

[16] Aaronson, Barrow, and Sender (2007); Rivkin, Hanushek, and Kain (2004)

Table 1.6: Effects of AYP and ABC Status and Teacher Qualifications on Teacher Exits (Odds Ratio)

		Exit Route		
	Any Exit	Exit Teaching	Exit District	Exit School
Very Competitive Undergraduate School				
Met AYP and ABC Standards	0.779***	0.877*	0.877	0.715***
Met AYP, Failed ABC Standards	0.663***	0.852	0.794	0.475***
Failed Both Standards	1.146*	1.134*	1.456**	1.112*
Competitive Undergraduate School				
Met AYP and ABC Standards	0.793***	0.893**	0.904	0.702***
Met AYP, Failed ABC Standards	0.657***	0.887*	0.844	0.464***
Failed Both Standards	1.112*	1.131**	1.163	1.097*
Less Competitive Undergraduate School				
Met AYP and ABC Standards	0.776***	0.897**	0.881	0.670***
Met AYP, Failed ABC Standards	0.650***	0.897*	0.767**	0.452***
Failed Both Standards	1.086	1.112*	0.972*	1.080

The dependent variable for the logit model is the probability that a teacher will leave a school between year t and t+1. Standard errors were clustered at the school-year level. ***denotes statistical significance of the underlying hazard coefficient at the 1% level, **denotes statistical significance of the underlying hazard coefficient at the 5% level, *denotes statistical significance of the underlying hazard coefficient at the 10% level. The models also includes all additional LHS variables found in the baseline model.

and more then 79 percent of students performing at grade level, respectively. Table 1.8 shows the trends in the distribution of teachers from very competitive, competitive and less competitive undergraduate schools, for schools that failed to meet AYP but met ABC and schools that failed to meet both AYP and ABC for the previous school year.

As expected, Table 1.7 illustrates that the proportions of teachers with very competitive undergraduate degrees are highest in schools with the greater percentage of students performing at grade level. Also, the proportion of teachers from very competitive undergrads is significantly larger in schools that fail to

Table 1.7: Proportions of Teachers by Teacher Quality and School Performance

	All Schools	Schools with Less than 60% Proficient	Schools with 60-79% Proficient	Schools with More than 79% Proficient
Very Competitive Undergraduate School				
Failed AYP, Met ABC Standards	0.140	0.128	0.136	0.148
Failed Both Standards	0.124	0.115	0.127	0.137
Difference	0.016	0.013	0.009	0.012
(standard error)	(0.003)	(0.007)	(0.004)	(0.007)
Competitive Undergraduate School				
Failed AYP, Met ABC Standards	0.510	0.416	0.509	0.537
Failed Both Standards	0.472	0.434	0.489	0.505
Difference	0.038	-0.018	0.020	0.032
(standard error)	(0.005)	(0.010)	(0.007)	(0.010)
Less Competitive Undergraduate School				
Failed AYP, Met ABC Standards	0.344	0.449	0.348	0.308
Failed Both Standards	0.398	0.445	0.379	0.352
Difference	-0.055	0.004	-0.031	-0.044
(standard error)	(0.004)	(0.010)	(0.006)	(0.010)

meet AYP but met ABC, relative to schools that fail to meet AYP and ABC, this holds for each range of proficiency scores. In general this holds for teachers from competitive undergrads as well, while the proportion of teacher from less competitive undergraduate institutions is the opposite - schools that fail to meet AYP both ABC relative to schools that fail meet AYP but met ABC. This suggests that the reason these schools are able to meet ABC despite failing AYP may be, in part, due to the high quality teachers in these schools. Each difference in Table 1.7 is significant at conventional levels except for one. At the lowest performing schools, there is no difference between the proportion of teachers from less competitive undergraduate institutions at schools that fail to meet AYP both ABC relative to schools that fail meet AYP but met ABC.

Table 1.8: Change in Proportions of Teachers by Teacher Quality and School Performance

	All Schools	Schools with Less than 60% Proficient	60-79% Proficient	More than 79% Proficient
Very Undergraduate School				
Failed AYP, Met ABC Standards	0.0011	-0.010	0.006	-0.000
Failed Both Standards	-0.0006	0.001	0.003	-0.001
Difference	0.0017	-0.011	0.003	0.001
(standard error)	(0.0044)	(0.012)	(0.006)	(0.008)
Competitive Undergraduate School				
Failed AYP, Met ABC Standards	0.005	-0.006	-0.009	0.013
Failed Both Standards	0.003	-0.001	-0.004	0.021
Difference	0.002	-0.005	-0.005	-0.009
(standard error)	(0.007)	(0.019)	(0.010)	(0.013)
Less Competitive Undergraduate School				
Failed AYP, Met ABC Standards	-0.005	0.016	0.004	-0.012
Failed Both Standards	-0.002	-0.001	0.001	-0.013
Difference	-0.003	0.017	0.003	0.001
(standard error)	(0.007)	(0.020)	(0.009)	(0.013)

Table 1.8 investigates whether the ABC system affects the trends in the proportions of teachers, in schools with different levels of proficiency. The entries in the table are the change in the proportion of teachers from one year to the next given the accountability results from the previous year; ie. after realizing the accountability results teachers make exit decisions and the difference in proportions before and after those decisions is given here. A negative number indicates a decline in the proportion over the period and a positive number an increase in the proportion. For example, the share of teachers from very competitive undergraduate schools at the lowest performing schools decreased by 0.01 in schools that failed AYP but met ABC. Similarly, the share of teachers from very competitive under-

graduate schools at the lowest performing schools increased by 0.001 in schools that failed AYP and ABC. The negative 0.001 difference between these two, indicates that the lowest performing schools that met ABC lost a greater share of teachers from a very competitive undergraduate school, however this difference appears to have occurred at random. The results provide no evidence that being recognized for showing growth, ie. meeting ABC, lowers the turnover of high quality teachers at schools that fail to make AYP. None of the differences in the table of significant. There does not appear to be a differential effect on year-to-year transitions for teachers of different quality, across all schools or in schools with varying ranges of performance.

1.7 Conclusion

This paper provides evidence of the effects of two independent, concurrent, and many times conflicting accountability systems on teacher mobility. Previous studies have analyzed the influence of state accountability systems but none examine a situation quite like that in North Carolina.

I find that schools that face increased accountability pressure are more likely to lose their teachers relative to schools that face increased accountability pressure and are awarded teacher bonuses for growth. Additionally the results show that, even without the allure of bonuses, schools that do not face accountability pressure have significantly lower turnover rates than schools with teacher bonuses and increased pressure. This suggests that non-monetary aspects of the work environment have greater influence over teacher labor market depictions than monetary employment considerations. At a minimum, current monetary incentives are not large enough to outweigh the negative accountability pressures. There is little evidence that accountability systems the have an impact on the distribu-

tion of teacher quality in high or low performing schools. Altogether, schools with increased accountability pressure have higher teacher turnover rates than schools that do not face pressure, regardless of whether or not the teachers receive bonuses.

These results have potential public policy implications. Failing schools that face increased accountability pressure have to deal with interventions, such as new instructional policies and techniques designed to increase student achievement. Several studies document how these schools also have the increased challenge of replacing more teachers. If states began to adopt policies that recognize incremental achievements toward an overall goal, it could have positive effects of the working conditions. This would perhaps lead to less teachers exiting a school and perhaps induce teachers to work even harder. The findings in this paper suggests that positive recognitions help schools retain teachers which in turn would help support the efforts of increased accountability pressure to increase student performance.

2

Do Housing Prices Account for School Accountability?

2.1 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

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

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 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

[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.

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 that exist in previous studies 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 within close proximity of two schools that otherwise have alike characteristics are consistently valued differently if their corresponding schools receive different recog-

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

nitions.

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 ongoing 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 ex-

[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.

hibited 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 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.

2.2 The North Carolina School Accountability System

2.2.1 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

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 2.1: ABCs Awards and Recognition Categories

and schools of "progress" have 60.0 to 79.9 percent of students at grade level.[8] Figure 2.1 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.

2.2.2 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

[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.

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 report 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.

2.3 Data

2.3.1 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

[10] Figure B.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'.

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 2.2 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 who purchase homes located within half a mile of a school likely believe their home will be assigned to 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 of the ABCs recognitions into housing

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

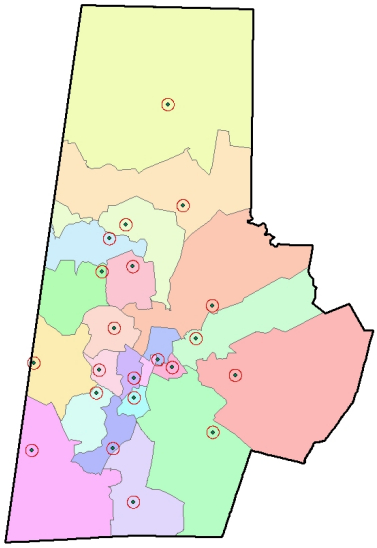


FIGURE 2.2: Example of Data Collection for One County: Durham

prices. Therefore, this study covers report cards released for school years 2002-03 through 2005-06, the first three school years following the passing of NCLB which mandated state accountability systems. The school report card data are 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.

2.3.2 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 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 2.1: 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

Table 2.1 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 in 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, and (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

Table 2.2: 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

and the fall in recognition is merely a reflection of the more rigorous requirements.

Table 2.2 highlights the differences in student performance on the End of Grade examinations. 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. 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 2.3 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.

Table 2.3: 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 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 main-

tained their recognition; only 14 percent failed to make "recognition" in 2004. The third and fourth sections of Table 2.3 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 of the state's rating system caused some schools to drop a level in recognition.

The bottom part of Table 2.3 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 2.4 makes a light comparison between the state's two different accountability systems, ABCs and AYP, for the schools relevant to this study. At

[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 2.4: Comparing School AYP and ABC Status

	AYP Status	
ABC Status	Did Not Meet Performance Standards	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

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.

2.4 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 re-

port. 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 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 (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

[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.

specification to be estimated by ordinary least squares takes the following form,

$$\ln price_{insmcy} = \alpha_c + \phi_m + \delta_{ny} + \eta' X_{sy} + \gamma' Z_i + \psi ABC_{sy} + \beta' AYP_{sy} + \epsilon_{icsmny} \quad (2.1)$$

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.

2.4.1 *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 school's 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, and 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

[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).

step function. However, it is a function that is discontinuous in x at the cutoff;

$$\lim_{x \to c_{90}} \Pr(d_i = 1|X = x) \neq \lim_{x \leftarrow c_{90}} \Pr(d_i = 1|X = x) \tag{2.2}$$

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

$$\hat{\tau}_{FRD} = \frac{\hat{\alpha}_{yr} - \hat{\alpha}_{yl}}{\hat{\alpha}_{dr} - \hat{\alpha}_{dl}} \tag{2.3}$$

where

$$\hat{\alpha}_{yr} - \hat{\alpha}_{yl} = \lim_{x \leftarrow c_{90}} \mathbb{E}(\tilde{y}|X = x) - \lim_{x \to c_{90}} \mathbb{E}(\tilde{y}|X = x) \tag{2.4}$$

and

$$\hat{\alpha}_{dr} - \hat{\alpha}_{dl} = \lim_{x \leftarrow c_{90}} \mathbb{E}(d|X = x) - \lim_{x \to c_{90}} \mathbb{E}(d|X = x) \tag{2.5}$$

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

$$(\hat{\alpha}_{\tilde{y}r}(x), \hat{\beta}_{\tilde{y}r}(x)) = \underset{\alpha_{\tilde{y}r}, \beta_{\tilde{y}r}}{\operatorname{argmin}} \sum 1_{X_i > x} \cdot (\tilde{y}_i - \alpha_{\tilde{y}r} - \beta_{\tilde{y}r}(X_i - x))^2 \cdot K\left(\frac{X_i - x}{h}\right) \tag{2.6}$$

$$(\hat{\alpha}_{\tilde{y}l}(x), \hat{\beta}_{\tilde{y}l}(x)) = \underset{\alpha_{\tilde{y}l}, \beta_{\tilde{y}l}}{\operatorname{argmin}} \sum 1_{X_i < x} \cdot (\tilde{y}_i - \alpha_{\tilde{y}l} - \beta_{\tilde{y}l}(X_i - x))^2 \cdot K\left(\frac{X_i - x}{h}\right) \tag{2.7}$$

$$(\hat{\alpha}_{dr}(x), \hat{\beta}_{dr}(x)) = \underset{\alpha_{dr}, \beta_{dr}}{\operatorname{argmin}} \sum 1_{X_i > x} \cdot (d_i - \alpha_{dr} - \beta_{dr}(X_i - x))^2 \cdot K\left(\frac{X_i - x}{h}\right) \tag{2.8}$$

and

$$(\hat{\alpha}_{dl}(x), \hat{\beta}_{dl}(x)) = \underset{\alpha_{dl}, \beta_{dl}}{\operatorname{argmin}} \sum 1_{X_i < x} \cdot (d_i - \alpha_{dl} - \beta_{dl}(X_i - x))^2 \cdot K\left(\frac{X_i - x}{h}\right) \tag{2.9}$$

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 whose 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,

$$\ln price_{inmcy} = \alpha_c + \phi_m + \delta_{ny} + \gamma' Z_i + \epsilon_{icmny} \tag{2.10}$$

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,

$$\hat{\tau}_{FRD} = \frac{\lim_{x \to c} \mathbb{E}(\tilde{y}|p = c_{90}) - \lim_{x \leftarrow c} \mathbb{E}(\tilde{y}|p = c_{90})}{\lim_{x \to c} \mathbb{E}(d|p = c_{90}) - \lim_{x \leftarrow c} \mathbb{E}(d|p = c_{90})} = \frac{\hat{\alpha}_{\tilde{y}r} - \hat{\alpha}_{\tilde{y}l}}{\hat{\alpha}_{dr} - \hat{\alpha}_{dl}} \tag{2.11}$$

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.

Table 2.5: 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

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 size are similarly distributed on either side of the thresholds.

Table 2.5 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 case 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 2.3 also provides a simple check of this assumption, showing 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 2.3 illustrate that schools with lower proportions of black students or 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 0.74, 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

[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.

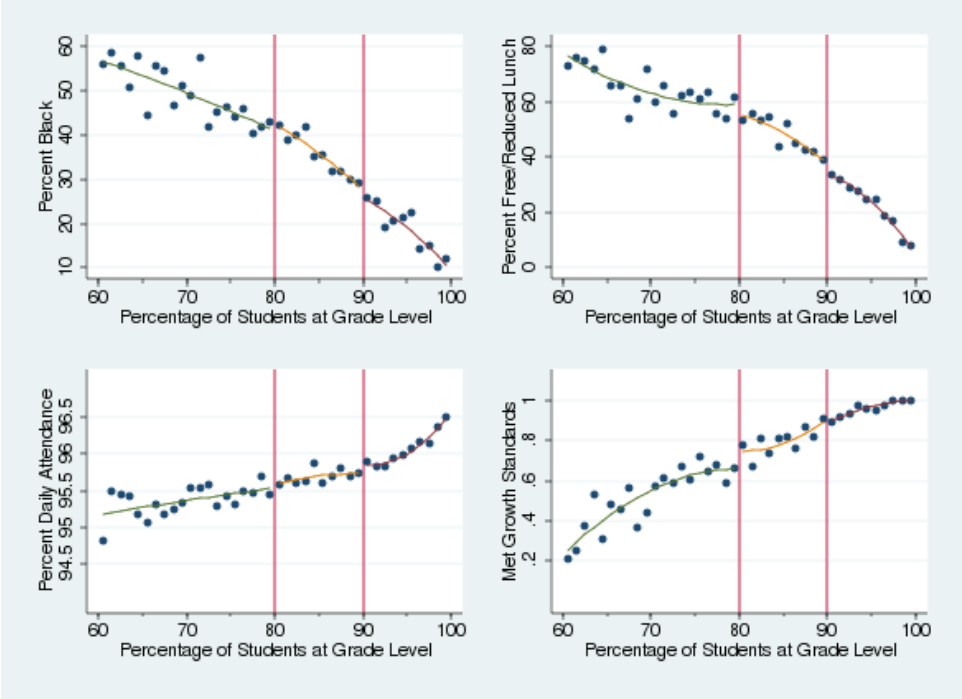


FIGURE 2.3: Covariates and Regression Discontinuity Estimation

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 2.4 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.

2.5 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

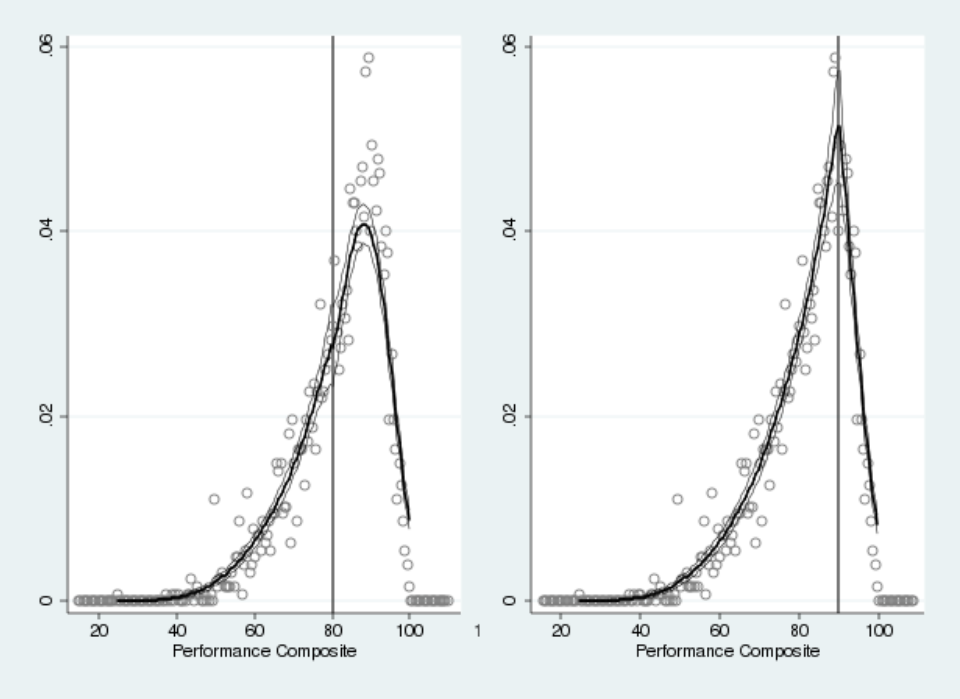


FIGURE 2.4: Density Smoothness Test of Underlying School Observations

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), and 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

Table 2.6: House Price Regression: Dept Variable - 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.

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.

2.5.1 School Recognitions and Housing Prices

Hedonic Analysis

Column 1 of Table 2.6 (and column 1 of Table B.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 characteristics.

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 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 2.6. 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

[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.

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.

Regression Discontinuity Analysis

The results in Table 2.6 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 2.5 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 2.5. Each point in the graphs is an average across 1-point, non-overlapping, intervals of the performance composite. Although it is not sharp, the

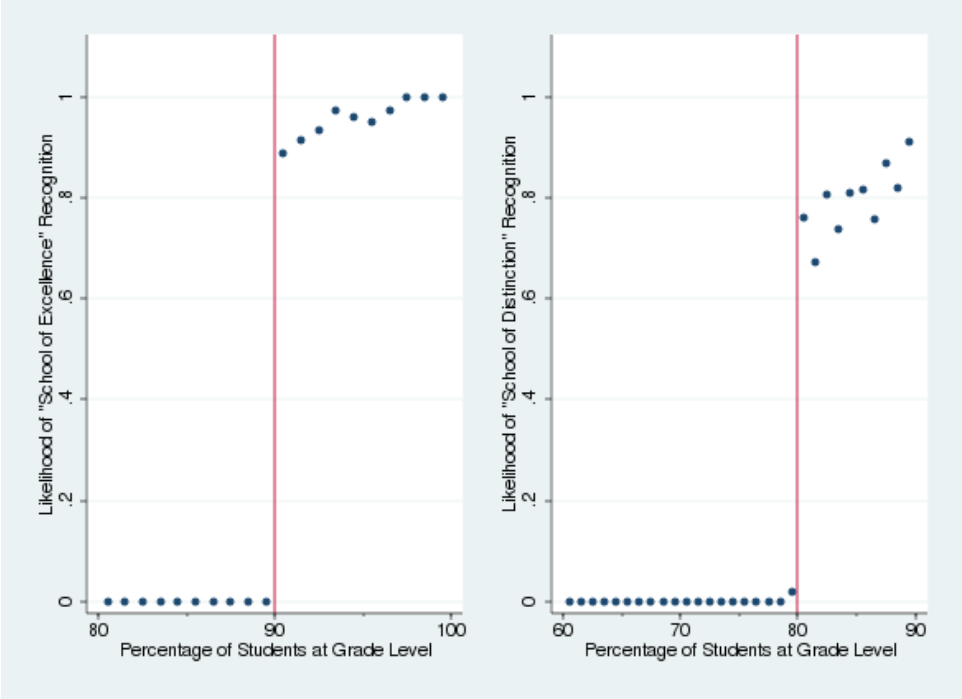


FIGURE 2.5: The Categorical Recognition Discontinuity

figures clearly shoe discontinuities at the 90 and 80 percent cutoffs.

Figure 2.6 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 thresh-

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

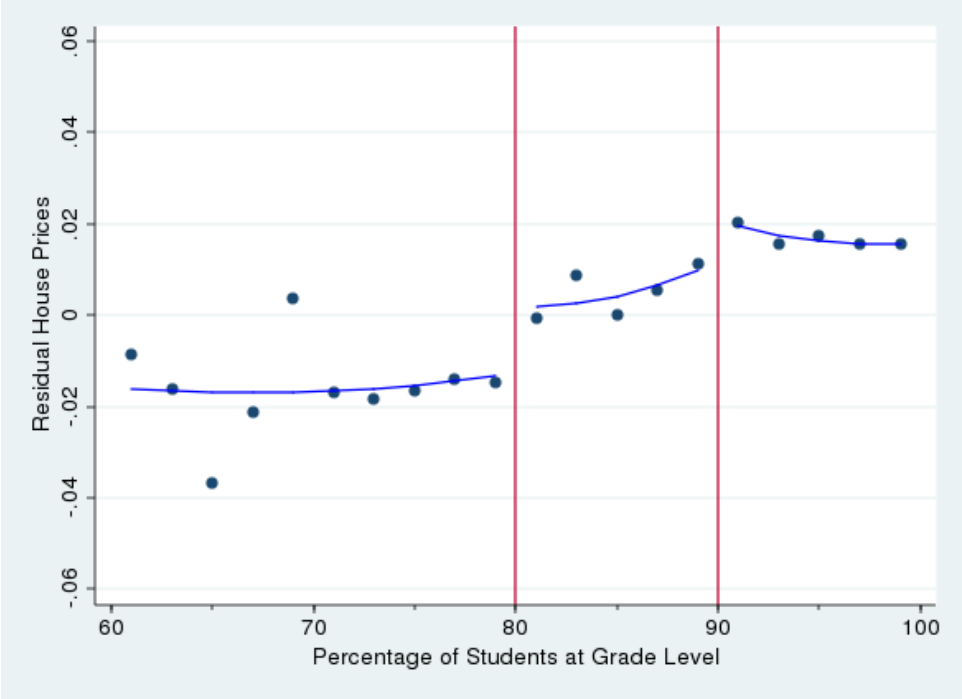


FIGURE 2.6: Outcome Variable and Regression Discontinuity Estimation

olds, corresponding to the thresholds for the "School of Distinction" and "School of Excellence" recognitions, there are clear and significant discontinuities.

Column 1 of Table 2.7 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

[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, $h_{opt} = C_K \left(\frac{\frac{\sigma_r^2(c)}{fr(c)} + \frac{\sigma_l^2(c)}{fl(c)}}{(m_r^{(2)}(c) - m_l^{(2)}(c))^2} \right)^{1/5} \cdot N^{-1/5}$ 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 2.7: 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).

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 are given in columns 2 and 3 of Table 2.7.

Recall from Table 2.3, substantial changes the ABCs assessment criteria in 2005 caused many schools, even those that had maintained the same recognition for several years, to be '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. In contrast, in each year prior to the change, 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 2.7. 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 Distinction" recognition is also positive (0.039, with a standard error of 0.024). Although the results are slightly less precise they are still significant and the magnitudes are similar to the baseline results.

2.5.2 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

Table 2.8: 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.

just after media reports are released. In fact the results, reported in Table 2.8, 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 months. It is worth noting that many parents choose to let their children finish out the school year before a move, because moving during sum-

mer break to allows them to start fresh in the new location for the beginning of school year. Education experts agree that it is 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 therefore are likely to reflect the higher willingness to pay of a different makeup of homebuyers in these months.

2.5.3 Reputation

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

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

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. Specifically, I test whether one-year lagged ABCs recognitions affect current housing prices. The results are presented in Table 2.9 and 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 2.9, may reflect willingness to pay just for access to a better school for the upcoming year.

In Table 2.10, 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 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

Table 2.9: 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.

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 does not matter. I observe

Table 2.10: 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.

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.

2.6 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 per-

Table 2.11: 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.

cent 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 2.7, indicate that there is no significant difference between the two sets of estimates.

I also run a series of falsification tests in Table 2.11 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 not show significant house price effects. Indeed, the results 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.

[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.

2.7 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 continuing distributional implications.

3

School Accountability and Public Perceptions: Future Work

3.1 Introduction

Market efficiencies hinge on the ability of citizens to make informed decisions. A recent article[1] blames the inability of school choice to serve as the panacea it was once believed to be partly on the failure of consumers to make informed choices. The author notes that it is "enormously difficult for parents in most communities to get useful information on school quality". Accountability systems aim to bridge the information gap and increase public awareness with impartial indicators of school performance.

In the case of North Carolina, the state does provide ready access to a myriad amount of information related to school quality; such as test scores, course size, student performance, safety, suspension/expulsion rates, access to books and technology, and teacher quality. In addition, the state provides summary material which essentially uses detailed performance information to break down

[1] Hess (2010)

schools into six different categories and then rank them. The category ranking provides no additional informational to the public and, certainly, taking advantage of the more detailed information would provide individuals with a more precise indication of school quality. However, gathering knowledge is costly and despite having access to more detailed information, homebuyers apparently refer to the category rankings as a signal of school quality information. In some instances the rankings suggest differences in school performance that do not exist, thereby causing a misperception of school quality. In this case market interaction with misinterpreted quality information can potentially produce an overestimation of school quality as well as systematic increases in some housing prices, decreases in other housing prices, and losses of market efficiency.

The previous chapter offers direct evidence suggesting that this is precisely what is occurring. Summary information provided by the North Carolina accountability system influences consumer perceptions, ultimately affecting their willingness to pay for access to local school services. Other studies have illustrated the causal effect school quality has on property values. The literature suggests that the marginal homebuyer is informed about school quality and that homeowners have monetary reasons to be concerned about the achievement of local schools. However, in this case it is apparent that homebuyers are willing to pay a premium for a perceived difference in school quality in spite of having access to information that reveals no such difference in quality exits.

However, it is not apparent that the disconnect between true quality and public perception of school quality holds for all groups of individuals. The costs and benefits of accumulating information about the quality of local schools undoubtedly varies systematically across groups. Research points to the possible existence of an "information gap between higher and lower income parents that creates a

disadvantage for lower income families in choosing good schools."[2] The authors do not find that any significant gap exists between these groups. But when we think about residential mobility as the most traditional form of school choice, it is clear that low income families will have less opportunities for mobility and may therefore be less concerned with obtaining accurate information on school quality. There is also existing evidence suggesting that individuals with greater connections to specific issues tend obtain more accurate information related to those issues.[3] This implies that individuals with school age children would have the incentive to obtain the most accurate information on school quality.

There is little analysis of observable or perceived ratings for school quality in the field of economics. The bulk of economics research related to consumer valuation of school quality is done using a revealed preference approach and looks for evidence of preferences for school quality revealed through the capitalization of school attributes into housing prices via hedonic valuation methods. To my knowledge, there is one empirical paper analyzing the degree to which citizen perceptions of the quality of government services correspond to actual service quality. [4] The authors find that "citizens' perceptions of the quality of specific public schools reflect publicly available information about the level of student achievement in those schools." The previous chapter addresses the extent to which accountability measures inform public perceptions. However, the chapter fails to answer - How do perceptions vary across groups? Do some groups get it 'right' while others do not? Using survey data coupled with the existing accountability data I can begin to examine these issues more carefully.

[2] Teske et al. (2006)

[3] Hutchings (2003)

[4] Henderson et al.(2010)

3.2 Considerations

3.2.1 Households with School-Age Children

Most individuals have little incentive to gather detailed information related to local school quality. The benefits of doing so, and certainly the direct benefits, are quite small, while the time and effort needed to obtain and process the information may be costly. But the benefits of acquiring such information are larger for some groups of people. Parents of school age children and homeowners may each have greater reasons to be concerned with public education and school quality.

Parents of school-age children will be making education consumptions decisions for their children and therefore have the greatest incentives to be accurately informed about the quality of the public schools. They also have more alternatives to access information relative to the average person. Social networks, conversations with their children, and parent-teacher associations each provide parents with opportunities to gather information that is not easily accessible by the general public. Even if parents only rely on public information through the accountability system they are much more likely to take advantage of greater detailed information and form more accurate perceptions of school quality, relative to individuals who depend on the summary recognitions to inform their perceptions.

Homeowners without school-age children may be concerned with local public school quality due to financial reasons. Literature examining the causal effect of school quality of house prices indicates that property values are linked to the performance of local schools.[5] Therefore, while not to the same extent as parents with school-age children, homeowners have some incentive to seek out information related to school quality. They would then be more likely to rely on the easily accessible, aggregated information provided by the school recognitions as an im-

[5] Black (1999)

perfect measure of school quality. In some cases, this would mean that they are willing to pay for proximity to a better school when no such "better" school exists. If this group of buyers were significantly, large their actions would subsequently drive up house prices in areas with perceived differences in school quality.

To summarize, parents may be less likely to benefit from the public release of information on school performance altogether because they already have opportunities to observe schools directly. Or, they may simply be less likely to rely on the broader classifications of schools and take the time to process the more detailed publicly released information. In contrast, non-parent homeowners may rely more heavily on broader categorical ratings issued by formal school accountability programs and the broadcasting of those ratings by local media. Therefore, school accountability recognitions, above and beyond other school accountability measures, may influence the perceptions of these groups of people quite differently.

3.2.2 Demographic Characteristics

The ability of parents to choose among private schools and public school districts are traditional mechanisms for school choice in America. It is not unreasonable to assume that individuals care about school accountability measures because it helps to inform them of the quality of local schools which in turn plays a role in their residential and schooling decisions. As discussed earlier, these traditional forms of school choice generate increased competition and lead to efficiencies with regard to the level of public services across communities. However, the availability of these choices varies greatly across regions as well as across groups of people.

Some metropolitan areas are quite large and contain many independent school districts and many privates schools, while other areas contain only one school district and/or few private schools. So the extent to which one can take advantage

of residential location as a form of school choice depends on the characteristics of the housing market of the districts nearest to their workplace. There are some metropolitan areas with upwards of 75 small independent school districts and others with only one that covers the entire metropolitan area. The metropolitan areas in North Carolina fall in between these two extremes, with a typical area having about 4 school districts. The availability of nearby choices leads to sorting across these districts and the result is districts with varying degrees of heterogeneity. For example, there are districts in North Carolina with large minority and/or low-income populations and others with large proportions of retirees. Certainly perceptions of school local school quality and the willingness to pay for access to better school quality will vary across these groups and communities in which they locate.

For instance, middle-income households in the United States typically choose a school by choosing their residence and have a significant amount of choice; high-income households can choose a school by choosing where to live but they can also afford to pay to send their children to private schools, allowing them even greater choice; and low-income households tend to have far less options over school choice. Minority households may also reluctant to move away from communities where their racial or ethnic group is heavily represented, for fear of discrimination or simply a loss of belonging. Either way the desire to remain close to 'the familiar' will also limit their choices. As a result, minorities and low-income individuals may be more constrained and therefore their perceptions of school quality may be less aligned with true quality since they have fewer incentives to obtain an process detailed information.

Conversely, the perceptions of individuals who live in more homogeneous communities may agree more with the truth. Since achievement levels and growth in achievement is often similar among children with like demographics, school

quality within these communities is likely to be similar across schools. Therefore, it is not necessary that an individual have knowledge about his or her particular local school but only an idea of the average school quality within the district.

Even with regard to more contemporary forms of school choice, such as charter schools and vouchers, policymakers are concerned with the role of an individual's demographic characteristics in forming perceptions of school quality. When referring to low-income minorities Teske et el. (2006) says, "choice can only help if these families can make well-informed decisions." The authors believe that disadvantaged parents are particularly uninterested in uninformed about school quality. In a 1998 study of New York City schools, Schneider et al. finds that "on average low-income parents have very little accurate information about objective conditions in the schools."

For all these reasons, it is important to analyze how school accountability measures may influence perceptions and the willingness to pay for access to better school quality across groups of individuals along racial/ethnic, education, and income dimensions as well as considerations across locations.

3.3 Research Approach

3.3.1 Data

Data limitations make it difficult, if not impossible, to link national surveys on individual perceptions of school services to actual local schools and on obtaining material information related to the performance of those schools. As a result there is little empirical research related to these issues.

The survey data necessary to carry out this project can be obtained through Knowledge Networks, a probability-based online research group. Knowledge Networks recruits households by randomly selecting residential addresses using

a process called "address-based sampling" (ABS). This method can provide a statistically valid representation of the North Carolina population as well as many difficult-to-survey populations, such as minorities, young adults, and households without home phone lines. It also means that one can identify the local public school of each individual respondent. Although the survey is an online based questionnaire, respondents are not limited to computer owners with internet access. Knowledge Networks equips respondents with free internet access interactive TVs if they choose to not use their own home computers . Background data are provided for all panelists, including gender, age, educational attainment, household income, race and Hispanic ethnicity, marital status, dependant information, and household size.

One can use the service to tailor specific questions necessary for this type of analysis. Since panelists can be identified by physical address before the survey is administered, the researcher can use that geographic information to identify several local public schools for each individual within his/her school district. The ideal survey would then ask respondents to identify/provide their local public school and to then rate the school according to some index. The North Carolina panel consists of 600 respondents; if each respondent gives their perceptions on the local elementary, middle, and high school, this results in 1,800 perception observations. However, it is likely that some respondents are unable to identify a local school at all, which will further reduce the number of observations. Once the public perceptions data are collected, it can be matched with data from the North Carolina Education Research Data Center (NCERDC) to obtain school accountability measures of quality for the same schools the respondents rated. The school accountability data can also be used to provide other measures that may influence public perception of school quality, such as the composition of the student body, enrollment size, or teacher quality.

3.3.2 *Empirical Strategy*

North Carolina's school accountability system uses the level of student performance as the primary means of assigning a categorical ranking to each school. The basic approach will be to regress the ratings panelists provide for a given school on the performance measure along with controls for respondent demographics and school characteristics.

Due to the amount of media attention surrounding the categorical ratings provided by the state, it is reasonable to expect the respondents' ratings to be correlated with those categories. If this is true then it is important to determine whether the categorical ratings have a causal influence on public perceptions or if there is merely a correlation between the ratings and perceptions.

To do this, I plan to implement a regression discontinuity strategy similar to that in the previous chapter. Instead of comparing the housing prices of homes located in the neighborhood of schools that fall just on either side of the performance cutoffs I would compare respondents perceptions of schools that are close to either side of the cutoffs. As before, the quality of educational services provided by schools changes smoothly around each cutoff. Therefore, a discontinuity in public perceptions at the cutoff can be interpreted as the effect of the categorical ratings themselves on respondents' perceptions. I could then determine whether any such discontinuity exits for different groups of people, such as those with school-age children and those without.

3.4 Conclusion

This chapter outlines a proposal for future work related to the school accountability measures and public perceptions of school quality. The previous chapter illustrated that school accountability recognitions influence the housing market,

above and beyond other measure of school quality. The findings showed that homebuyers are willing to pay a premium for a perceived difference in school quality when none truly exits. The narrative here gives reasons why we might expects this misalignment between perception and reality to be greater for some groups of people and less for others. The results of this study could lead to several policy recommendations.

For instance, premiums are paid for the perceived access to better school quality, which leads to increases or transfers of wealth to homeowners in the neighborhood of school that experiences a perceived increase in quality. If indeed the relationship between the perceptions of quality and the truth is stronger for parents, parents will not likely pay a premium for access to better school quality as reflected by the categorical recognitions. This may in turn decrease 'undeserved' changes in the wealth of homeowners. If this is true, it could show cause for alltogether abandoning categorical rating systems that suggest discrete differences in school quality when no such differences exist.

Appendix A

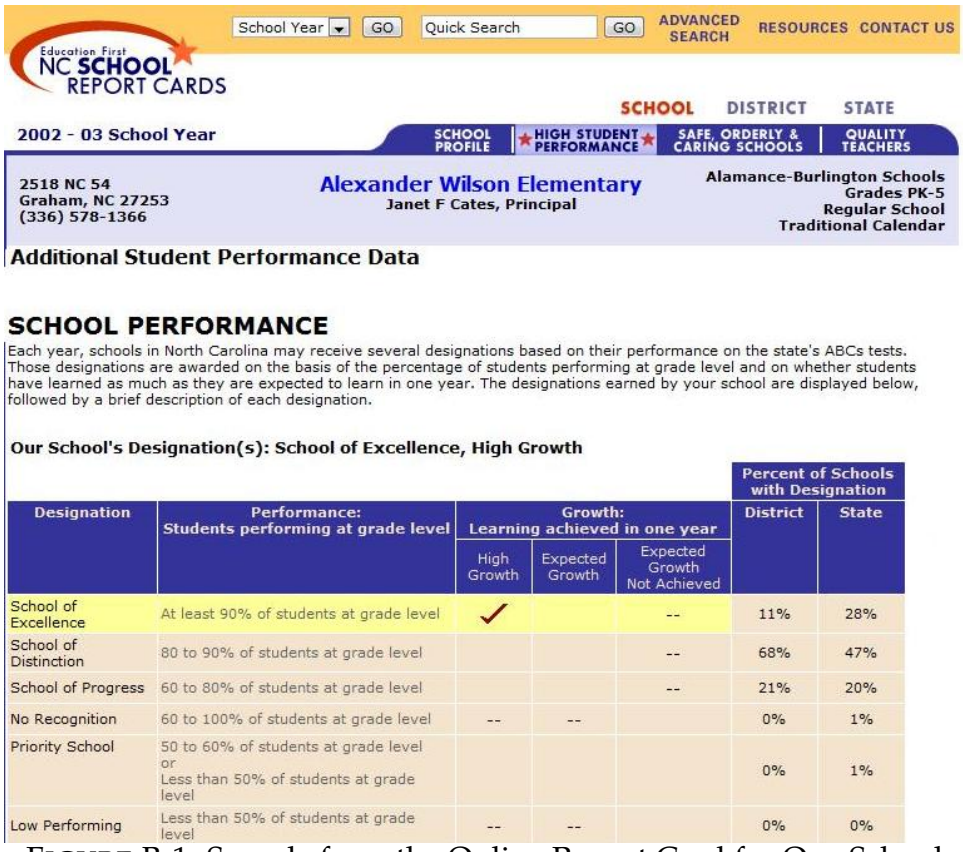
Appendix: Does School Accountability Influence Teacher Mobility?

Table A.1: Summary Statistics. Years 2003-2006.

Variable	Mean	Std.Dev.	Min	Max
Teacher Characteristics				
Female	85.7	35.0	0	1
Black	12.6	33.2	0	1
Other Minority	2.3	15.0	0	1
Age	32.3	9.8	21	77
Advanced Degree Holder	28.7	44.2	0	1
Very Competitive College	13.8	34.1	0	1
Experience, number of years	8.9	8.5	0	53
Salary	3505.9	715.9	2525	5515
School Characteristics				
Elementary	73.77	44.00	0	1
Middle	26.2	44.00	0	1
Percent at Grade Level	76.4	13.36	22.6	100
Percent Black	33.7	24.6	0	100
Percent Hispanic	8.48	9.82	0	100
Percent Free/Reduced Lunch	49.3	20.6	0	99.2
District Characteristics				
Percent at Grade Level	75.4	11.6	25.4	99.6
Percent Black	34.7	30.5	0.39	99.8
Percent Hispanic	7.4	10.7	0	90.7
Percent Free/Reduced Lunch	45.9	26.2	0	94.6
School Years				
2002-03	8.4			
2003-04	12.9			
2004-05	16.1			
2005-06	19.2			
2006-07	20.9			
2007-08	22.4			

Appendix B

Appendix: Do Housing Prices Account for School Accountability?



School Year GO Quick Search GO ADVANCED SEARCH RESOURCES CONTACT US

Education First NC SCHOOL REPORT CARDS

SCHOOL DISTRICT STATE

2002 - 03 School Year

SCHOOL PROFILE | HIGH STUDENT PERFORMANCE | SAFE, ORDERLY & CARING SCHOOLS | QUALITY TEACHERS

2518 NC 54
Graham, NC 27253
(336) 578-1366

Alexander Wilson Elementary
Janet F Cates, Principal

Alamance-Burlington Schools
Grades PK-5
Regular School
Traditional Calendar

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

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

Variable	Definition	Median	Mean	Std.Dev.
Performance Composite	The percent of students performing 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 B.2: Other Coefficients from Basic Hedonic Regression in Table 3[a]

Sample:	Specification 1 2003-06 < 0.5 miles	Specification 2 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.

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Biography

I was born in New York, NY on January 6th, 1982. I graduated cum laude from the University of Florida 2004 with a B.S.B.A degree in economics and a minor in mathematics. I received an M.A. in economics in 2007 from Duke University. In 2011, I received a Bass Fellowship for Undergraduate Instruction to develop my own course at Duke University, Economics of Education. In the fall of 2011 I will be joining the faculty community at the University of South Florida.