

School Quality, Neighborhoods, and Housing Prices

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We study the relationship between school characteristics and housing prices in Mecklenburg County, North Carolina, between 1994 and 2001. During this period, the school district was operating under a court-imposed desegregation order and drew school boundaries so that students living in the same neighborhoods were often sent to very different schools in terms of racial mix and average test scores of the students. We use differences in housing prices along assignment zone boundaries to disentangle the effect of schools and other neighborhood characteristics. We find systematic differences in house prices along school boundaries although the impact of schools is only one-quarter as large as the naive cross-sectional estimates would imply. Part of the impact of school assignments is mediated by differences in the characteristics of the population and the quality of the housing stock that have arisen on either side of the school assignment boundary.

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1. Introduction

The quality of local public schools is widely believed to be a key determinant of housing prices (e.g., Max, 2004). However, the strength of the consensus is puzzling, given the formidable empirical challenges facing any homeowner or empirical researcher seeking to answer the question carefully.¹ Good schools usually come bundled with other neighborhood qualities—such as proximity to employment, shopping and recreational conveniences, and neighborhood peers. Because the home buyers who enjoy (and can afford) such amenities tend to congregate together, it is difficult to isolate the effect of schools from the effect of these other traits that accompany good schools.

We study the impact of various school characteristics on housing prices using data from Mecklenburg County, North Carolina, from 1994 through 2001.² Because of its unique history, Mecklenburg County is the ideal place to study the effect of schools on housing prices.³ Under a court-imposed desegregation plan in place from 1971 through 2001, the district laid out school boundaries so that the typical school drew students from a range of noncontiguous geographic areas. Out of necessity, school boundaries often crossed the informal lines dividing neighborhoods, because those neighborhoods were often segregated along racial lines. Homes located within a few hundred feet of one another were often assigned to very different schools, with very different mean test scores and racial compositions. Like Black (1999), we focus on housing prices near school assignment boundaries to identify the effect of schools from the effect of other neighborhood characteristics.

We find significant differences in housing prices along school boundaries, implying that schools have an impact on housing values. However, the effects of school test scores are considerably smaller—one-quarter to one-fifth as large—as one would infer from the cross-sectional relationships between school assignments and housing prices. Our findings suggest

1. For recent examples, see Black (1999), Bogart and Cromwell (1997), Bogart and Cromwell (2000), Figlio and Lucas (2004), Weimer and Wolkoff (2001), and Kane, Staiger, and Samms (2003).

2. With a population of 695,000 in 2000, Mecklenburg County is home of the state's largest city, Charlotte.

3. In Kane, Staiger, and Samms (2003), we used data from Mecklenburg County to study the effects of changes in school test scores and school accountability ratings on housing prices.

that part of the effect of schools on housing values operates through the characteristics of the population living in different neighborhoods, and the subsequent impact this has on the quality of the housing stock in the neighborhood.

2. Background on School Assignment in Charlotte–Mecklenburg

In a landmark decision in 1971 (*Swann v. Charlotte-Mecklenburg Bd. of Ed.*, 402 U.S. 1 (1971)), the United States Supreme Court required the Charlotte–Mecklenburg Board of Education to redraw school attendance zones to integrate the district’s schools. Earlier court decisions had prevented schools from denying students’ admission based on race. However, given existing housing market segregation, this still left many neighborhood schools segregated along racial lines. The *Swann* decision required the Charlotte–Mecklenburg school (CMS) district to bus students from scattered neighborhoods to integrate schools.

Since 1971, the CMS board has tried a variety of strategies to ensure racial balance. For example, over the years, the district has utilized “satellite zones” (bussing students from neighborhoods with a high percentage of one race of students into a neighborhood consisting of another race of students), “mid-pointing” (placing a school at a midpoint between two neighborhoods while students from the surrounding neighborhood actually attend a different school), “pairing” (having students from two different neighborhoods spend several elementary grades in one neighborhood’s school and then spend the remaining grades in the other neighborhood’s school), and “magnet schools” (specialized programs to entice parents to voluntarily send their children to integrated schools).

Figure 1 plots the locations of the housing parcels assigned to four different elementary schools in 1997 (each parcel is identified by the distance in feet from the southern and western edge of the county). In the top left panel, Piney Grove Elementary drew students from three geographically distinct neighborhoods in 1997: one neighborhood was 82% African American and another was 3% African American. The school (identified by the circle symbol) was actually located in a third neighborhood that was 32% African American. Sharon Elementary in the bottom left panel was located on the northern edge of an affluent neighborhood that was 1% African American and had a median household income of \$122,398. The school also drew students from a

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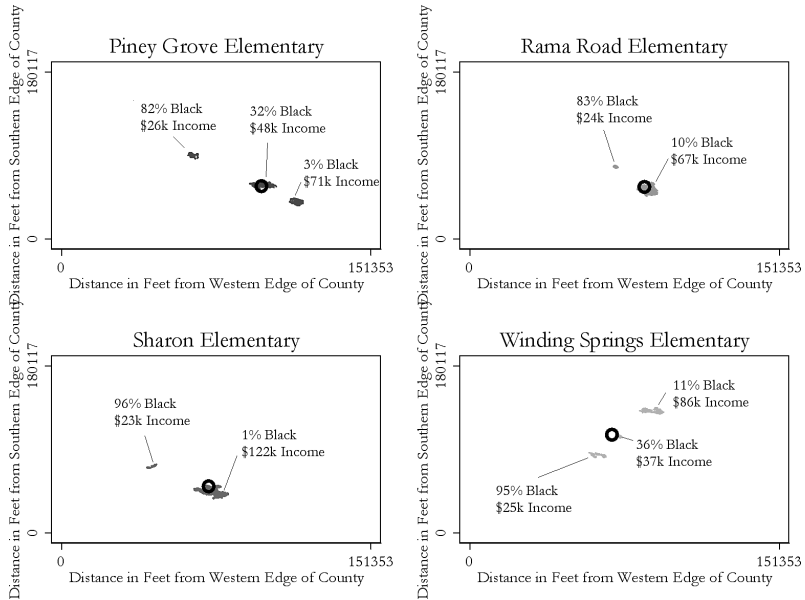


Figure 1. School Assignments in Four Elementary Schools in 1997.

noncontiguous neighborhood to the northwest of the school that was 96% African American and had a median household income of \$23,506.

Figure 2 identifies the school assignments of the Greenville/Lincoln neighborhood for the fall of 1997. Residents of the neighborhood were bussed to four different elementary schools, all of which were outside the neighborhood: Allenbrook Elementary, Nathaniel Alexander Elementary, Piney Grove Elementary, and Winding Springs Elementary. Although the Greenville/Lincoln neighborhood is predominantly of low income and African American, residents of the neighborhood were assigned to four very different schools outside their own neighborhood. The percentage of students in the four schools achieving proficiency on the state test in 1997 ranged from a low of 42% at Allenbrook Elementary (to the west of Greenville/Lincoln) to a high of 66% at Piney Grove Elementary. As noted in Figure 1, the Piney Grove Elementary school zone includes a higher income, predominantly white neighborhood to the southeast.

In Mecklenburg County, desegregation has proven to be an elusive target. Rapid population growth, demographic change, and the flight of

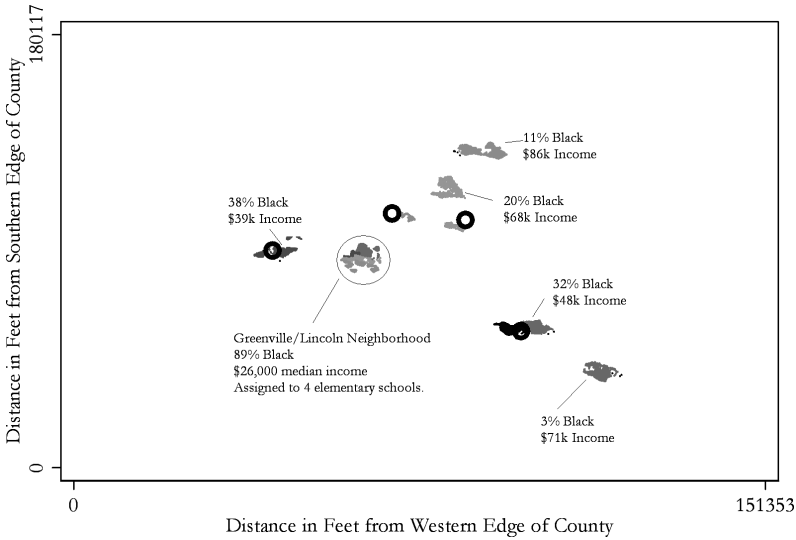


Figure 2. School Assignments of the Greenville/Lincoln Neighborhood for the Fall of 1997.

many white students from public to private schools led to the gradual “re-segregation” of previously desegregated schools. A court order in 1980 required the district to make reasonable efforts to keep each school’s percentage of African American enrollment within 15% points of the district-wide average. (*Swann v. Charlotte-Mecklenburg Board of Education*, No. 1974 (W.D.N.C. April 17, 1980).)

Given rapid population growth and the tendency for the population to sort itself along racial lines, such targets presented a difficult logistical challenge for the district’s planning department. The population of Mecklenburg County grew by 36% between 1980 and 1990 and by an additional 26% between 1990 and 2000.⁴ Meanwhile, the percentage of students in the CMS’s who were African American grew from 29% in 1971 to 40% in 1980 and to 45% by 2000. As a result, at irregular intervals, the district occasionally redrew school boundaries—particularly when new schools were opened—to maintain schools’ percentage of African American students within 15% points of the district average. (Despite their efforts, a handful of schools in outlying areas remained outside the 15% point bands.)

4. U.S. Bureau of the Census, *County and City Data Book 2000*.

As a result, in our analysis of school boundaries, we focus on those boundaries that remained stable throughout the 1990s.

In 1997, a white parent sued the school district to challenge the district's policy of creating separate lotteries for black and white students applying for admission at desirable magnet schools. The case led U.S. District Judge Robert Potter to re-open the *Swann* case to determine whether the vestiges of racial discrimination had been eliminated after 30 years of bussing. On September 21, 2001, the Fourth Circuit Court of Appeals ordered the district to dismantle the race-based student assignment plan by the beginning of the 2002–03 school year.⁵ In December of 2001, the district launched a new plan, assigning each parcel to a new home school not based on race, and allowing for public school choice.⁶

3. The Charlotte–Mecklenburg Housing and Test Score Data

We obtained data on real estate parcels and sales from the Property Assessment and Land Record Management division of Mecklenburg County, North Carolina (population 640,000). There are a total of roughly 330,000 real estate parcels in the county. Of these, approximately two thirds were single-family homes (including some vacant lots zoned for single-family use). We limited the sample to sales of existing homes between January 1, 1994, and December 31, 2001, and trimmed the data at the 1st and 99th percentiles of the price distribution (approximately \$21,909 and \$749,500 in 2002 dollars).⁷ After imposing these sample restrictions, we were left with a sample of 89,793 sales for 69,361 parcels.

For each parcel, we have detailed physical information about the property including its exact location (to the foot) and characteristics such as bedrooms, bathrooms, acreage, and so on. In addition, the tax assessor's office has identified 1,048 different neighborhoods within Mecklenburg County. The typical neighborhood is quite small: half of all parcels are within 400 yards of the center of the neighborhood and 95% of parcels are within 2,000 yards of the

5. A last-minute appeal to the U.S. Supreme Court failed in April 2002, when the justices declined to hear the case.

6. In a subsequent paper, we will be studying the effect of the end of court-ordered bussing in Charlotte on housing prices.

7. Because less than 1% of the sample had five sales during our sample period, very few transactions were truncated and we have sales price data for virtually all single family sales transactions occurring between 1994 and 2003.

center of their neighborhood. Moreover, because these neighborhoods are used for assessment purposes, they were intended to define fairly homogeneous neighborhoods in terms of likely property values for similar structures. We also have the assessor's evaluation of the building quality on each parcel, ranking the quality of building construction in 36 distinct categories. Finally, based on the location of each parcel, we merged data on median income and percent of African American in the census block group. (There were 398 distinct census block groups in the county in 1990 and 373 in 2000.)

3.1. School Assignments

The CMS district provided us with detailed school boundary information for the period 1993 through the fall of 2001, along with the exact location of every school (elementary, middle, and high schools). Changes in school assignments were generally announced in December or January. As a result, we categorize parcels by their school assignments as of January.

Combining the school location and boundary information with the exact location of each parcel (from the housing data), we calculated the straight-line distance of each parcel to its assigned school and to the nearest school assignment boundary (or more precisely, to the closest parcel with a different school assignment). We used all parcels within each school's assignment area to calculate school-level variables that capture the likely socioeconomic status of students at the school: the average percent of black and the average median income in the census block group.

3.2. School Data

During our sample period, the CMS system had 86 elementary schools, 26 middle schools, and 14 high schools (excluding magnet programs). For each school, we have annual data on student test scores and student demographics.

For 1993 through 1999, we have student-level micro-data on math and reading performance and race in grades 3 through 5 for all schools in North Carolina (we do not have the micro-data for 2000–02). Using these micro-data, we standardized math and reading scores by grade for all of the elementary schools in Charlotte–Mecklenburg. To generate an estimate of each school's impact on student achievement, we used these data to estimate the following specifications.

$$\begin{aligned}
 Test_{it} &= \gamma_0 + \chi_t + \delta_s + \varepsilon_{it} \\
 Test_{it} &= \beta_0 + \beta_1 Math_{it-1} + \beta_2 Read_{it-1} \\
 &\quad + \beta_3 Race_i + \beta_3 ParEd_i + \chi'_t + \delta'_s + \varepsilon_{it}
 \end{aligned}$$

The dependent variable, $Test_{it}$, represents the test score outcome for student i , in school s , in year t . Each of the equations was estimated separately by grade and subject area (reading and math). We then calculated the mean of $*_s$ and $*'_s$ across grades in reading and math. The $*_s$ are essentially mean scores adjusted for grade and year (data similar to these are reported in the Charlotte Observer each fall), whereas the $*'_s$ measure each school's mean "value-added," adjusting for baseline scores, race, parental education, grade, and year.

In addition, the North Carolina Department of Public Instruction provided us with data on schools' demographics and a performance composite for each year from 1997 through 2001. The performance composite is the proportion of students scoring above the "proficient" level in each grade and subject in a school and is both publicly reported and an integral part of a school accountability system. The performance composite seems to have been measuring the same attribute as the mean scaled score we calculated from the micro-data: the correlation between the annual performance composite and the mean scaled score ($*_s$) for 1997 through 1999 (the only 3 years in which we have both series) was .98.

In earlier work (Kane, Staiger, and Samms, 2003), we found that property values did not respond to year-to-year fluctuations in these school measures but did respond to long run averages of these measures. Therefore, we average over all years available (1993–99 or 1997–2002 depending on the measure) to construct measures of test scores and demographics in each school.

The school district also operates many magnet schools, which in the years before the choice plan were the only way for students to attend schools outside their attendance area. The presence of such options may lead us to understate somewhat the housing market value of school quality, to the extent that we focus on the assigned school. However, the most desirable magnet programs were oversubscribed and subject to lotteries.

4. Empirical Strategy

In the literature on school quality and housing values, the primary challenge has been to distinguish between the impact of school quality and the influence of other factors—such as neighborhood amenities and public services—which may be correlated with school quality. Following Black (1999), we focus on differences in housing values near school boundaries (parcels within 2,000 feet of a school boundary). We control for housing characteristics and a detailed set of fixed effects to capture differences across neighborhoods in house values.

Our analysis focuses on elementary school boundaries and limits the sample to parcels within 2,000 feet of a boundary (we find similar results using limits of 500 and 1,000 feet). We further limit the sample to boundaries that were stable throughout our sample period (1994–2001) to focus on properties for which owners were unlikely to be worried about the boundary changing. We run regressions of the following form:

$$\begin{aligned} \ln(\text{price}) = & \beta_1 \text{Elementary school characteristic} \\ & + \beta_2 \text{Distance to elementary school} \\ & + \beta_3 \text{House characteristics} \\ & + \beta_4 \text{Census tract characteristics} \\ & + \text{Geographic fixed effects} \\ & + \text{Fixed effects for year, month, high school,} \\ & \quad \text{middle school, and municipality} \end{aligned}$$

The primary school characteristic we use is the average scaled test score for grades 3–5 over the years 1993–99. In addition, we report results using other proxies for school quality based on test scores (the value-added measure discussed above and the performance composite averaged over 1997–2001) and demographics of the area assigned to each school (average income and percent black in census tracts assigned to each school). Distance is the straight-line distance to the assigned school. House characteristics include common features such as bedrooms, bathrooms, and acreage. When indicated in the relevant tables, we also include a full set of dummies capturing the assessors rating of the building grade. Census tract characteristics come from the 2000 census and include median income, percent black, and percent on public assistance.

Fixed effects are included for every unique boundary to capture any local neighborhood effects. Thus, the estimates rely on variation in prices within narrow geographic areas separated by an elementary school boundary. To the extent that the school boundaries coincide with natural boundaries between areas with different amenities and public services, our estimates would still be conflating the effects of school quality and other neighborhood characteristics. As a result, rather than simply include boundaries for pairs of schools, we sought other ways to identify differences between neighborhoods. The tax assessor's office has identified 1,048 different neighborhoods within Mecklenburg County, and we experiment with including fixed effects for each of these neighborhoods (interacted with boundary), thereby identifying the impact of school quality for properties in the same neighborhood assigned to different schools. The use of the neighborhood dummies also allows us to control for variation in housing prices along major roadways and other natural barriers to the extent that bordering properties are recognized as being in different neighborhoods. However, to the extent that the tax assessor distinguishes neighborhoods based on differences in prices (which may be the result of differences in school assignment), controlling for neighborhood may bias the results downward—because only those boundaries with small differences in prices would not be broken into different neighborhoods. Therefore, as a final alternative, we formed more exogenous “neighborhood” dummies by dividing the county into 2,500-foot square blocks.

Mecklenburg County includes the city of Charlotte as well as six additional municipalities (Cornelius, Davidson, Huntersville, Matthews, Mint Hill, and Pineville). Tax rates vary by municipality; the quality of city services may also vary. In most cases, the neighborhood definitions lie within municipality boundaries and, therefore, implicitly control for these factors too. However, neighborhood boundaries do cross municipality boundaries. As a result, we include fixed effects for municipalities, implicitly controlling for tax rate differences and other differences between municipalities.

Figure 3 summarizes the geographic dimensions of the data. On the left hand side, we plot the coordinates of all residential parcels with sales between 1994 and 2001 in Mecklenburg County by their distance in feet from the southern and western edges of the county. The right hand figure plots the locations of sales for the subset of parcels that were located within

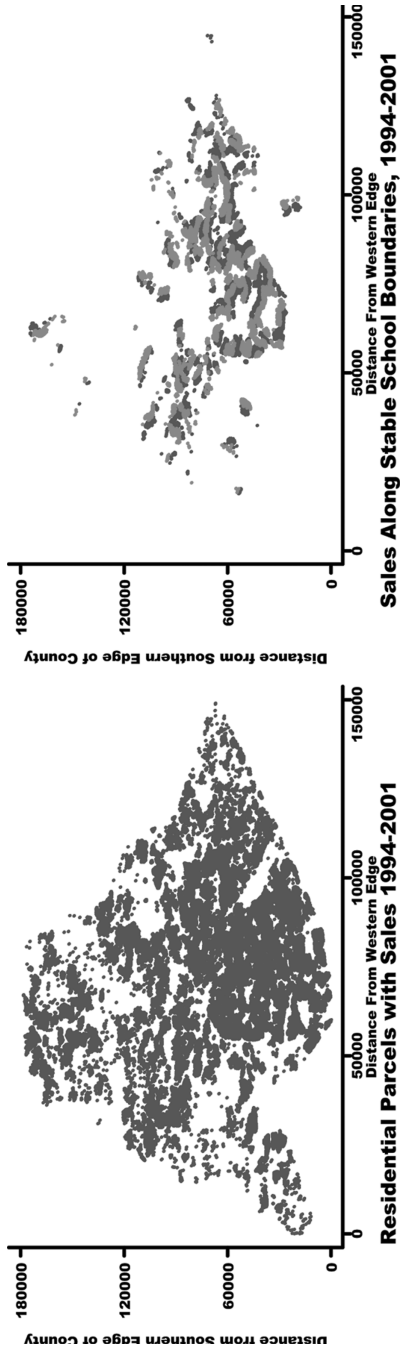


Figure 3. The Location of All Residential Parcels with Sales Between 1994 and 2001 in Mecklenburg County and the Locations of Sales for the Subset of Parcels Located Within 2,000 Feet of the Closest School Boundary.

2,000 feet of the closest school boundary. To highlight the location of the boundaries, the points on either side of each boundary were shaded a different color. Given the smaller lot sizes in the inner city, many of those parcels that were close to boundaries were drawn from the central part of the county. However, it is also apparent from Figure 3 that the effect of school assignments will be evaluated for properties in proximity to one another and that there are a large number of boundaries to exploit.

In focusing on school boundaries, we must assume that unobserved factors affecting house prices change “smoothly” across space and are not systematically correlated with school test scores across the boundaries themselves. Of course, simple models of residential choice suggest that there would be substantial sorting along these stable school boundaries. For example, families who are willing to pay more to live in a school attendance area with better schools may have higher income and may also invest more in their homes. Even if houses and neighborhoods are very similar on either side of a school border *when the boundary is originally drawn*, the similarity may not last long as properties are bought and sold, as neighbors change, and as houses depreciate and are improved. To the extent this sorting occurs, it will bias boundary estimates toward finding a positive association between school quality and property value, unless one fully controls for these other differences across boundaries.

Although we cannot test whether the unobserved factors systematically differ across school boundaries without an instrument, we do investigate whether there is sorting on observable variables at the boundary. We do this in three ways. First, we estimate the relationship between house prices and test scores at the boundary (as in equation (1)) using increasingly detailed covariates on the house and neighborhood. If the estimated effect of school quality is smaller with better controls, then this suggests that homes assigned to better schools are also better on other dimensions. More directly, we estimate models similar to equation (1) but using house and neighborhood characteristics as the dependent variable (e.g., acreage, number of bedrooms, heated square footage, income in census tract) to see whether these observable measures differ for those properties in areas assigned to higher performing schools. Finally, we conduct an explicit discontinuity analysis, looking at whether both house prices and house and neighborhood characteristics change discontinuously at the boundary between low- and high-performing schools. More specifically, we estimate the price in 400-foot

intervals from a regression with the same specification as in equation (1), replacing the test score regressor with indicators for each 400-foot interval distance from a boundary (distinguishing between intervals in the high- and low-scoring school zone). We limited this analysis to boundaries where there was at least a 0.25 student-level SD difference in mean test scores between the schools on the high- and low-scoring side of the boundaries.

5. Results

In this section, we report on differences in house prices along elementary school boundaries. The key identifying assumption is that neighborhood characteristics change “smoothly,” whereas school assignments change discontinuously at the boundaries. We find a significant positive relationship between test performance and housing values on the higher performing side of the boundary. However, other housing and neighborhood characteristics also seem to change discontinuously at the boundaries, suggesting that test performance may proxy for unmeasured characteristics of the house or its neighborhood.

5.1. Results Using School Boundaries

Table 1 presents the coefficients on elementary school test scores (in student-level SD units) and distance to the elementary school (in miles). In columns 1 through 5, we introduce increasingly detailed control variables. The dependent variable is the natural log of sales price. The sample consists of all sales between 1994 and 2001 for parcels within 2,000 feet of a stable school boundary, and where the minimum distance between residential parcels on either side of the boundary was less than 500 feet (to avoid boundaries at waterways and major thoroughfares). In the first column, we control for a set of base covariates including dummies for month and year of sale, dummies for the municipality in which the property may be located, dummies for the middle and high school assigned to the property, and house characteristics such as the number of bedrooms and bathrooms (for a full list of covariates, see notes to the table). The second column adds fixed effects for each boundary (a pairing of schools) to control for local conditions around each boundary. The third column goes even further, breaking up the area around each boundary into separate neighborhoods (as defined by the tax assessor’s office) and including

Table 1. Sensitivity of Regression Discontinuity Estimates to Neighborhood and Housing Characteristic Controls

Dependent Variable : Ln(Sales Price)	1	2	3	4	5
Elementary math and reading score 1993–99 (in student-level SD units)	0.527 (0.073)	0.311 (0.050)	0.138 (0.046)	0.098 (0.040)	0.128 (0.038)
Distance to elementary schools (miles)	-0.042 (0.011)	-0.032 (0.009)	-0.009 (0.007)	-0.005 (0.008)	-0.009 (0.005)
Other covariates	Yes	Yes	Yes	Yes	Yes
Base covariates		Yes	Yes	Yes	Yes
Boundary fixed effects		84			
Boundary-by-neighborhood fixed effects			496	496	556
2,500-square foot area fixed effects				Yes	Yes
Block group characteristics and building quality dummies					
R-squared	0.82	0.84	0.88	0.89	0.89
Observations	23,084	23,084	23,084	23,084	23,084

The dependent variable is ln(sales price). Sample was limited to existing home sales, on parcels with stable school assignments from 1993 through 2001, which were within 2,000 feet of a school boundary and where minimum distance at boundary was less than 500 feet. Base covariates included academic year dummies, month dummies, dummies for municipality, dummies for middle school and high school, number of bedrooms, bathrooms and half-baths, acreage, heated square feet, age, age² and dummies for basement, garage, and air conditioning. Columns 4 and 5 also include 36 building quality dummies and percent black and median household income in the census block group in 2000. Huber–White SEs allow for clustering at the school level.

fixed effects for every boundary–neighborhood combination. The fourth column includes control characteristics of the census tract and 36 building grade dummies from the assessor’s office.

All of the specifications in Table 1 suggest that mean test scores are significantly related to property values, but the estimated impact shrinks considerably with more detailed controls. With no fixed effects included for boundary or neighborhood (column 1), we estimate a one student-level SD difference in school test scores is associated with a 0.527 log point increase in housing values. Controlling for 84 boundary fixed effects cuts this estimate nearly in half, to 0.311 log points, and further controlling for neighborhoods within each boundary (by including boundary–neighborhood fixed effects) reduced the estimate to 0.138. Finally, the estimated effect of test scores drops to 0.098 when we add controls for the assessor’s rating of the building grade and census tract characteristics (median income, percent black, and percent on public assistance).⁸

By conditioning on neighborhood-by-boundary fixed effects in columns 3 and 4, our intention was to focus on differences in housing prices along school boundaries within physically and socially homogeneous neighborhoods. But the assessor’s office may also be drawing boundaries to identify neighborhoods that are homogeneous in price. When a school assignment leads to a difference in mean price within a pre-existing neighborhood, the assessor’s office may redraw neighborhood boundaries to reflect that new equilibrium—thereby leaving only the school boundaries with small differences in prices within neighborhoods. As an alternative, we arbitrarily overlaid the county with a square grid, identifying geographic areas that were 2,500 by 2,500-foot squares. Continuing to include only the houses near the school boundaries, we included fixed effects for each 2,500 by 2,500-foot block area while continuing to control for the full set of building characteristics and census tract controls. The resulting estimate may reduce the negative bias that would result if neighborhood boundaries are defined endogenously based on

8. The impacts of school test scores in columns 3 and 4 are similar to estimates in Black (1999), who found that a school-level standard deviation in elementary school test scores was associated with a 2.2% point difference in housing price after controlling for boundaries. In Charlotte, a school-level standard deviation is equal to 0.21 student-level standard deviations. Multiplying the coefficients from columns 3 or 4 in Table 1 by .21 implies a percentage point difference of roughly 2% points per one school-level standard deviation.

price, but it may also raise to introduce a positive bias due to physical and social differences between neighborhoods. The resulting estimate is only slightly larger—0.128 log points per SD in school test scores.

5.2. Private School Tuition as an Upper Bound

Of course, parents are not required to send their children to the local public schools. They may also choose to send their children to private schools. Assuming that a high-quality private school is available within a reasonable distance for each child, private school tuition provides an upper bound on the price families would be willing to pay to live in a high-quality school zone. Fourteen percent of the children in grades 1 through 12 in Mecklenburg County attended private schools at the time of the 2000 Census. Tuition at private schools in Mecklenburg County area averaged \$7,300 (ranging from an average of \$4,900 at the Christian schools to \$6,300 at the Catholic schools and \$11,368 at the nonreligious private schools).⁹ Assuming that there was a good private school option available at that price, a parent with one child would not be willing to pay more than \$7,300 per year on the margin for the additional capital costs associated with buying a house in a neighborhood with high-quality public schools. With a 30-year mortgage rate of 7% and a marginal federal tax rate of 25%, the \$7,300 capital cost would imply an upper limit on family's willingness to pay for a good school in the Charlotte area would be \$121,000 in additional mortgage value. In 2002 dollars, the median sales price of a single-family home was \$142,000. The results in Table 1 imply that families would be required to pay roughly 10% more to move from an elementary school at the 25th percentile to an elementary school at the 75th percentile (roughly a whole student-level SD difference in mean school test score). This would represent a difference of only \$14,000 in housing price. In other words, the estimated housing price differential to live in a high-quality school zone in Table 1 is much less than the upper limit implied by private school tuition.

5.3. Distance to Assigned Elementary School

Table 1 also reports the effect of distance to the assigned elementary school on housing price. At the school boundaries, distance to the assigned

9. These are the enrollment-weighted mean tuition for 88 private schools listed at the <http://www.charlotteparent.com> web site.

elementary school is also changing discontinuously. The coefficient on distance in column 2, with boundary fixed effects, implies that an additional mile in distance is associated with a 0.032 log point difference in house price. The implied impact of travel time on housing prices is quite large. In the same specification, a student-level SD in school mean test scores is associated with a 0.311 log point difference in price. A student-level SD represents the difference in score between the 10th percentile school and the 90th percentile school. So the estimates in column 2 imply that moving from the 10th percentile school to 90th percentile school in the district in terms of mean test scores is equivalent to an extra 10 miles in distance. The coefficient is not statistically distinguishable from zero in columns 3 and 4, with boundary by neighborhood fixed effects included. However, in column 5 with 2,500-square foot controls, the estimated coefficient implies that moving from the 10th percentile to the 90th percentile in terms of mean school test scores was equivalent to a 14-mile difference in distance. (Although somewhat imprecisely estimated, the coefficient has a p value of .070.)

5.4. Other Measures of School Quality

Table 2 reports the coefficient on four other measures of school quality, using the same specifications reported in Table 1. (For simplicity, we report only the coefficient on school quality from each of the specifications.) The first row reports the results using the mean percentage of students in each school scoring at the proficient level on the state test over the period 1997 through 2001. In column 3, with boundary-by-neighborhood fixed effects, a 10% point difference in proficiency is associated with a 3% point difference in price.

We also calculated the mean characteristics of the population in each school zone, using the characteristics of the population living in those areas in the 2000 census. The mean test score is highly correlated with both the median income in the elementary school zone ($\text{corr} = .77$) and the percent of the population in the school zone that was African American ($\text{corr} = -.77$). (These means are calculated for the whole school zone and are not estimated only for those block groups near the boundaries.) Given their relationship to school test scores, it should not be surprising that we find quite similar results as when using test scores as the regressor. Housing prices are positively associated with the median income in the school

Table 2. Similar Results Using Other Measures of Elementary School Characteristics

Dependent Variable : Ln(Sales Price)	1	2	3	4	5
Percent proficient on state test (/10)	0.122 (0.021)	0.049 (0.016)	0.028 (0.013)	0.016 (0.011)	0.021 (0.010)
Median household income in elementary school zone (/100,000)	1.054 (0.208)	0.567 (0.104)	0.448 (0.117)	0.261 (0.122)	0.179 (0.081)
Population percent black in elementary school zone (/100)	-0.753 (0.126)	-0.352 (0.098)	-0.286 (0.091)	-0.264 (0.087)	-0.016 (0.101)
“Value-added” test score 1994-99 (in student-level SD units)	0.377 (0.252)	0.043 (0.106)	-0.017 (0.099)	0.052 (0.096)	-0.140 (0.085)
Other covariates					
Base covariates	Yes	Yes	Yes	Yes	Yes
Boundary fixed effects		84			
Boundary-by-neighborhood fixed effects			496	496	556
2,500-square foot area fixed effects				Yes	Yes
Building quality dummies and block group characteristics					
Observations	23,084	23,084	23,084	23,084	23,084

Sample was limited to those parcels with stable school assignments from 1993 through 2001, which were within 2,000 feet of a school boundary and where minimum distance at boundary was less than 500 feet. Base covariates included academic year dummies, month dummies, dummies for municipality, dummies for middle school and high school, number of bedrooms, bathrooms and half-baths, acreage, heated square feet, age, age² and dummies for basement, garage, and air conditioning. Columns 4 and 5 also include 36 building quality dummies and percent black and median household income in the census block group in 2000. Huber-White SEs allow for clustering at the school level.

zone and negatively associated with the percent of the population in the school zone that is African American.

As noted earlier, we used micro-data for students in the CMS district to estimate an estimate of the mean “value-added” within schools—adjusting for students baseline scores, their race/ethnicity, their parental education, and their calendar year (and averaging the effects estimated separately by grade and subject area). In the fourth row of Table 2, we report the results of similar specification using the “value-added” measure to rate school quality. The coefficient on school-level “value-added” was indistinguishable from zero in all of the specifications. The results imply that while housing prices respond to the characteristics of peers in the various schools, but not to estimated “value-added” by the school. This is consistent with the results in Rothstein (2006) and may reflect the difficulty parents face in distinguishing differences in school quality, beyond observing the characteristics of potential peers.¹⁰

5.5. Subsamples of Parcels

Table 3 tests the robustness of the findings, by replicating the results of various subsamples of parcels. Column 1 replicates the result in column 3 of Table 1 (including boundary by neighborhood fixed effects), where the sample was limited to parcels within 2,000 feet of a home on the other side of a boundary. Column 2 limits the sample to parcels within 1,000 feet of a home on the other side of a boundary. The results suggest that a one SD difference in mean school test score is associated with a 0.153 log point difference in home price. Column 3 limits the sample even further to parcels within 500 feet of a home on the other side of the boundary. (In many cases, this would comprise a single row of housing on either side of the boundary.) Even for such a narrowly defined sample, the coefficient on test scores suggests that a one SD difference in mean test scores is associated with a 0.086 log point difference.

The last two columns of Table 3 test for any differences in the housing price differential associated with test scores in predominantly white and black neighborhoods. Column 4 reports the results for parcels within census block groups less than 12% African American (roughly the median

10. Alternatively, the result may be attributable to the relatively low signal-to-noise ratio in such value-added measures reported in Kane and Staiger (2001, 2002a, b).

Table 3. Sensitivity of Regression Discontinuity Estimates to Choice of Subsample

Dependent Variable : Ln(Sales Price)	<2,000 to Boundary (1)	<1,000 to Boundary (2)	<500 to Boundary (3)	Block Group <12% Black (4)	Block Group >30% Black (5)
Elementary math and reading score 1993-99 (in student-level SD units)	0.138 (0.046)	0.153 (0.045)	0.086 (0.043)	0.366 (0.078)	0.011 (0.036)
Distance to elementary school (miles)	-0.009 (0.007)	-0.008 (0.005)	-0.009 (0.007)	-0.010 (0.012)	0.007 (0.006)
Other covariates					
Base covariates	Yes	Yes	Yes	Yes	Yes
Boundary-by-neighborhood fixed effects	Yes	Yes	Yes	Yes	Yes
R-squared	0.88	0.89	0.87	0.85	0.72
Observations	23,084	9,757	3,028	9,279	7,770

The dependent variable is ln(sales price). Sample was limited to existing home sales, on parcels with stable school assignments from 1993 through 2001, which were within 2,000 feet of a school boundary and where minimum distance at boundary was less than 500 feet. Base covariates included academic year dummies, month dummies, dummies for municipality, dummies for middle school and high school, number of bedrooms, bathrooms and half-baths, acreage, heated square feet, age, age² and dummies for basement, garage, and air conditioning. Huber-White SEs allow for clustering at the school level.

parcel). The results suggest a considerably larger impact than for the pooled sample, with a 0.366 log point difference in housing price for each one SD difference in school test scores. The results in column 5 were estimated for census block groups more than 30% African American (roughly the 75th percentile). The impacts of school test scores and distance are both indistinguishable from zero.

It seems that home buyers paid a higher price on the margin for school quality in predominantly white neighborhoods than in predominantly black and integrated neighborhoods. This need not reflect any difference in valuation of school quality by race. Under the district's desegregation plan, African American youth were granted preference in attending the magnet programs in the district. Although such programs were often over-subscribed and rationed by lottery for white youth, the odds of admission were typically much higher for African American youth.

5.6. Differences in Observable Housing and Neighborhood Characteristics at Boundaries

By focusing on boundaries, we have assumed that unobserved neighborhood amenities change “smoothly” at school boundaries. Although we obviously cannot test whether the unobserved factors systematically differ across school boundaries, we can test whether observed housing (e.g., building grade, number of bedrooms) and neighborhood (e.g., percent black, median household income) characteristics shift discontinuously at the school boundaries.

In Table 4, we use housing and neighborhood characteristics as dependent variables and report the coefficient on each of the various school characteristics. (We converted the categorical building quality measure into an index, using the coefficients from a regression of log housing price on the 36 building quality categories as the weights.) The sample is limited to parcels within 2,000 feet of school boundaries, and the specification includes boundary-by-neighborhood fixed effects, year and month dummies, and municipality dummies. In many of the specifications, observable housing characteristics—such as the number of bathrooms, heated square footage, building quality, and air conditioning—were positively associated with mean test scores and median income in the school zone and negatively associated with the percent African American. (The above

Table 4. Discontinuities in Housing Characteristics at Elementary School Boundaries

School Characteristic as Regressor	Selected Housing & Neighborhood Characteristics as Dependent Variables							
	Number of Bedrooms (1)	Number of Bathrooms (2)	Heated- Square Feet (3)	Age (4)	Building Quality Index (5)	Air Conditioning (6)	Block Group % Black (7)	Block Group Median Income (8)
Elementary math and reading score (in student-level SD units)	-0.186 (0.166)	0.245 (0.091)	0.663 (1.221)	-7.836 (3.002)	0.193 (0.126)	0.181 (0.065)	-0.010 (0.036)	-7817 (6411)
Percent proficient (10)	-0.059 (0.042)	0.050 (0.026)	-0.114 (0.372)	-2.419 (0.957)	0.043 (0.028)	0.043 (0.018)	0.004 (0.011)	-1536 (1095)
Median HH income in zone (/100,000)	0.022 (0.253)	0.228 (0.327)	3.543 (2.273)	-18.119 (8.067)	0.660 (0.235)	0.422 (0.154)	-0.136 (0.061)	58,250 (14,686)
Percent black in zone (/100)	-0.012 (0.167)	-0.473 (0.204)	-5.993 (1.458)	19.987 (10.368)	-0.206 (0.064)	-0.521 (0.087)	0.032 (0.057)	722 (7803)
“Value-added” measure (in student-level SD units)	-0.661 (0.407)	0.380 (0.233)	-2.770 (3.666)	-1.244 (6.105)	-0.185 (0.144)	-0.088 (0.164)	0.178 (0.106)	-39,897 (16,269)
Boundary-by- neighborhood effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23,103	23,103	23,103	23,103	23,103	23,103	23,103	23,103

Each cell reports the coefficients for separate regressions, using the housing characteristic in the column as the dependent variable and the school characteristic in the row as a regressor. Sample was limited to existing home sales, on parcels with stable school assignments from 1993 through 2001, which were within 2,000 feet of a school boundary and where minimum distance at boundary was less than 500 feet. Each regression also included academic year dummies, month dummies, and dummies for municipality. The building quality index uses the coefficients from a regression of ln(house price) on quality categories to construct an index for each category. Huber-White SEs allow for clustering at the school level.

characteristics were also associated with building age.) Interestingly, the value-added measure was unrelated to all of the housing characteristics except census tract median income. Moreover, the characteristics of the population in the census block group also seemed to change discontinuously at the boundary.

These findings are not inconsistent with Black (1999, Table III), who also found differences in observed housing characteristics between homes on the high- versus low-scoring side of school boundaries. However, the magnitude of the differences, and the sensitivity of the estimates to controlling for these differences in observed housing characteristics, is more pronounced in our data. One potential reason for this difference may be our focus on parcels with stable school assignments throughout the sample period. One could argue that school boards are less likely to change school boundaries where housing quality is starkly different on either side of the boundary (because of pressure from homeowners) or that housing quality differences are more likely to arise in areas with stable boundaries (as high income families move in to areas with good schools). In either case, school boundaries in which differences in school test scores are more strongly correlated with differences in housing and neighborhood characteristics would tend to be overrepresented in our sample.

In Figures 4 through 7, we investigate the discontinuity in housing prices at school boundaries. If school assignment is the primary factor underlying the increase in property values, then housing prices should rise abruptly at the boundary while other housing and neighborhood factors should not show any sign of discontinuity at the boundary. To test for discontinuities at the boundary, we estimated models identical to those reported in column 2 of Tables 1 and 2 (with boundary fixed effects). But rather than including test scores, we included dummy variables for 400-foot intervals from the boundary. The interval 0–400 feet from the boundary with a better school is the omitted reference category. The intervals were defined so that, for example, a home which is 350 feet from the boundary with a better school is assigned a distance of *negative* 350 and a home which is 350 feet within the better school's boundary is assigned a distance of *positive* 350. We limited the analysis to boundaries where there was at least a 0.25 student-level SD difference in mean test scores between the schools on the high- and low-scoring side of the boundaries. There were roughly 3,000 home sales in each interval, except for the two intervals

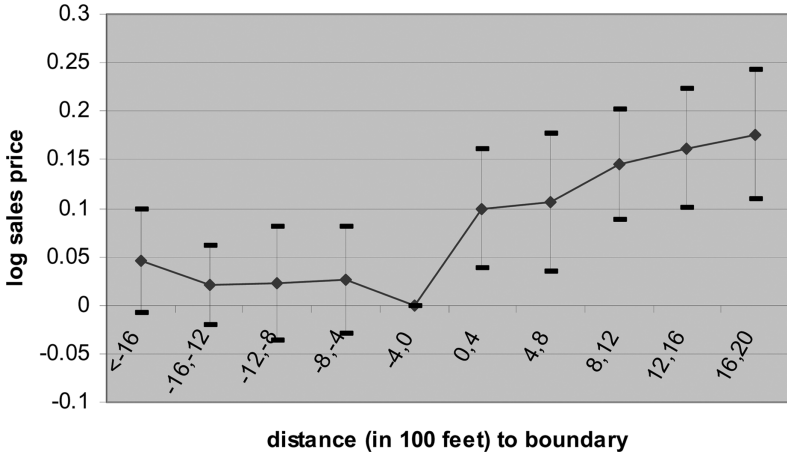


Figure 4. The Discontinuity in Housing Prices at School Boundaries.

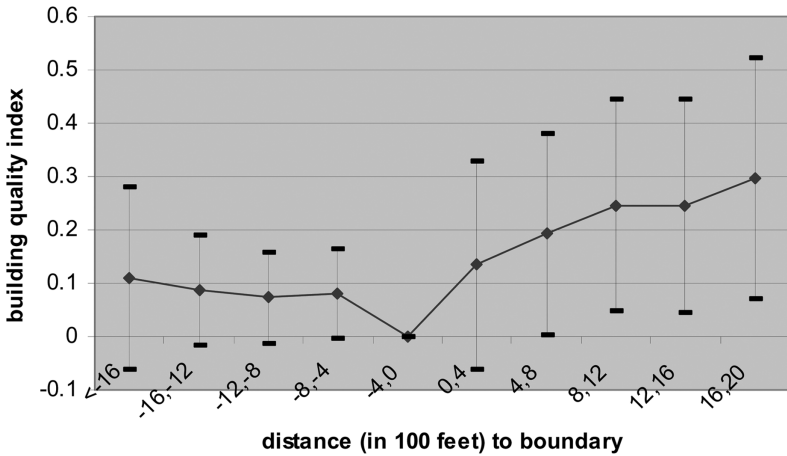


Figure 5. The Discontinuity in Building Quality Index at School Boundaries.

within 400 feet (either side) of the boundary that each had roughly 1,000 home sales.¹¹

As seen in Figure 4, there is a sharp increase in housing prices at the boundary, with prices being roughly 12% higher for houses just inside the

11. The lower numbers of sales within 400 feet of the boundary is an artifact of the way in which we define distance to the boundary. We actually measure distance to the nearest house that sold in a different school attendance area. So 400 feet is an over estimate of how far these homes are from the boundary.

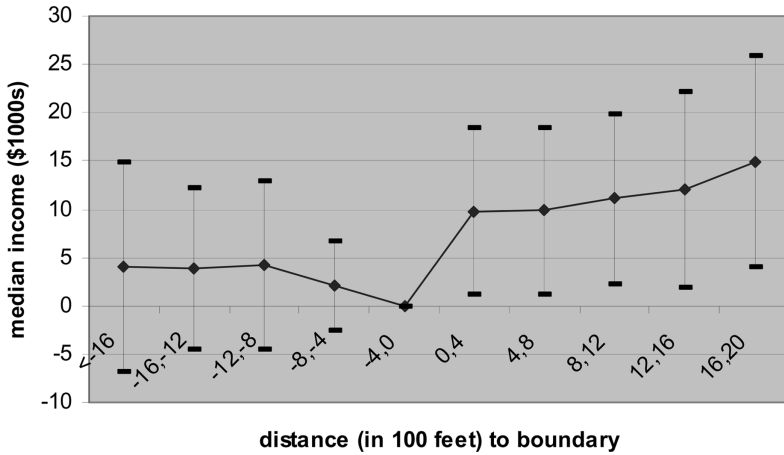


Figure 6. The Discontinuity in Median Census Tract Income at School Boundaries.

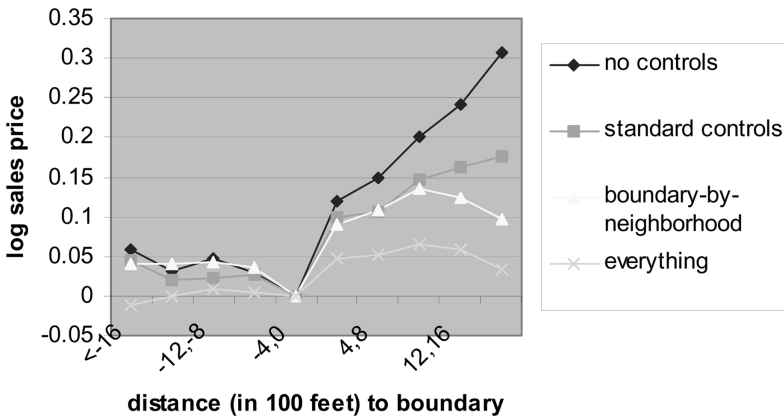


Figure 7. Comparing the Discontinuity in Housing Prices at School Boundaries Using More or Less Detailed Control Variables.

high-scoring district. The magnitude of this effect is consistent with our earlier estimates: the average difference in scores between the high-scoring school and the low-scoring school was 0.32, which multiplied by the coefficient from column 2 of Table 1 (0.311) would yield an effect on house prices of 9%. Thus, we do observe a discontinuity in house prices of about the expected magnitude at the boundary.

However, other housing and neighborhood characteristics also change discretely at the boundary, as can be seen in Figures 5 and 6. Figure 5 plots

estimates of the building quality index in 400-foot intervals from the boundary (controlling for boundary fixed effects and the other controls listed in Table 2), whereas Figure 6 plots analogous estimates of census tract median income. Both building quality and median income follow patterns that are quite similar to that seen for house prices, with building quality increasing by 10%–20% and median income increasing by about \$10,000 on the side of the boundary with better test scores.

Not surprisingly, the magnitude and abruptness of the discontinuity in house price is quite sensitive to controlling for house and neighborhood characteristics that change at the boundary. In Figure 7, we plot the price effects in 400-foot intervals, estimated as in Figure 4 but altering the control variables to be more or less detailed. When we include no controls, the discontinuity at the boundary is of similar magnitude, but prices appear to drift steadily upward inside the high-scoring school zone (and to a lesser extent inside the low-scoring school zone). Controlling for boundary effects and standard house characteristics eliminates much of this upward drift, and controlling for boundary neighborhood effects eliminates the drift even further. When we add the controls for census tract characteristics and building grade, the size of the price discontinuity at the boundary is cut in half, and prices are estimated to be fairly stable on each side of the boundary. Thus, although the specification with a full set of controls (corresponding to column 4 of Table 1) yields what appears to be a clean discontinuity at the boundary, one could certainly argue that this is the result of additional unobserved house or neighborhood characteristics that change at the boundary rather than school quality per se.

Although these results do call into question the practicality of disentangling the effect of school quality from other neighborhood variables, they should not be surprising. Some neighborhood amenities—such as proximity to local shopping or soothing ocean breezes—do not change discontinuously at school boundaries. However, the property right to good schools does change discontinuously at the boundaries. Families who are willing to pay more to live in a school attendance area with higher test scores may also invest more in their homes. Even if houses are very similar on either side of a school border *when the boundary is originally drawn*, then the similarity may not last long as properties are bought and sold and as houses depreciate and are improved.

6. Conclusion

In the local public finance literature, there is a long tradition of attempting to disentangle the value of school quality from other neighborhood amenities. It is a difficult empirical challenge, given that we would expect unmeasured differences in neighborhood characteristics to be correlated with school quality. Using Black's (1999) approach of focusing on the values of properties near school boundaries, we find that a one student-level SD difference in a school's mean test score was associated with a 10% point difference in house value.

However, our results suggest that the population living in a school assignment zone is itself a function of school assignments. Proximity to shopping amenities and pleasant breezes may not change discontinuously at school boundaries, but the property right to schools of varying quality does change at the boundary and such rights may be of different value to different groups of people. Bayer, McMillan, and Reuben (2005) make the same point in the context of a general equilibrium model and find that much of the apparent difference in housing value associated with schools is the result of residential sorting. We also observe discontinuous changes in observable housing and population at school boundaries. Thus, the impact of schools on housing values appears to be largely indirect through the residential sorting that goes hand-in-hand with school boundaries.

In December of 2001, in response to a court order, the CMS announced a new plan, which guaranteed residents a seat at a neighborhood school. The plan also created four "choice zones" and offered residents a choice of schools within their zones. The impact of the plan remains to be seen. Our results suggest that residential sorting is a key source of the impact of schools on housing prices. With court-ordered bussing, the school district was putting constraints on households' ability to segregate themselves into all-white or all-black schools.

Simulating the effects of a public school choice and private school voucher plans with computable general equilibrium model, Epple and Romano (2003) and Nechyba (2003) predict choice plans that will generate increased residential integration (at least by income) and reduce the variance in housing prices. The early results in Charlotte run counter to those predictions. Figure 8 portrays the trend over time in the proportion of African American students attending schools that were greater than 80%

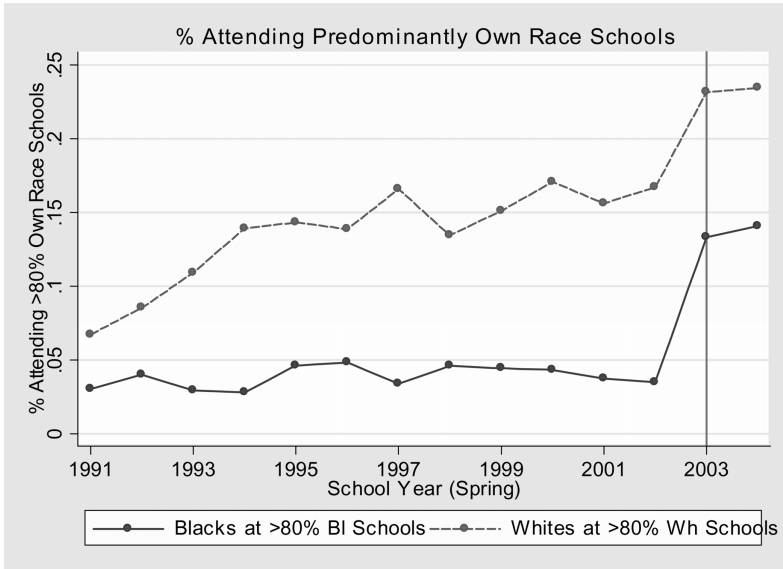


Figure 8. Trend in the Proportion of African American and White Students Attending Predominantly (>80%) Own Race Schools.

African American and the proportion of white students attending schools that were greater than 80% white.¹² In the spring of 2003 (the first year of choice), the percentage of African American students attending predominantly African American schools roughly tripled from less than 5% to nearly 15%. The proportion of whites attending schools that were more than 80% white rose from 16% to 23%. Figure 9 portrays the trend over time in the difference in ln sales price between the 90th and 10th percentiles in Mecklenburg County.¹³ Soon after the choice plan was announced in December 2001, the dispersion in housing prices began to grow, with the gap between the 90th and 10th percentile growing from 1.4 to 1.6 log points.¹⁴

12. Based on enrollment by race and school from the Common Core of Data for spring 1991 through 2001. Data for 2002 through 2004 are from the North Carolina Department of Public Instruction.

13. This figure is unadjusted for housing characteristics and neighborhood. However, the time-series pattern is quite similar if one includes a regression adjustment for housing characteristics and neighborhood fixed effects.

14. The gap in median sales price between neighborhoods that were less than 10% black and neighborhoods that were greater than 60% black also grew.

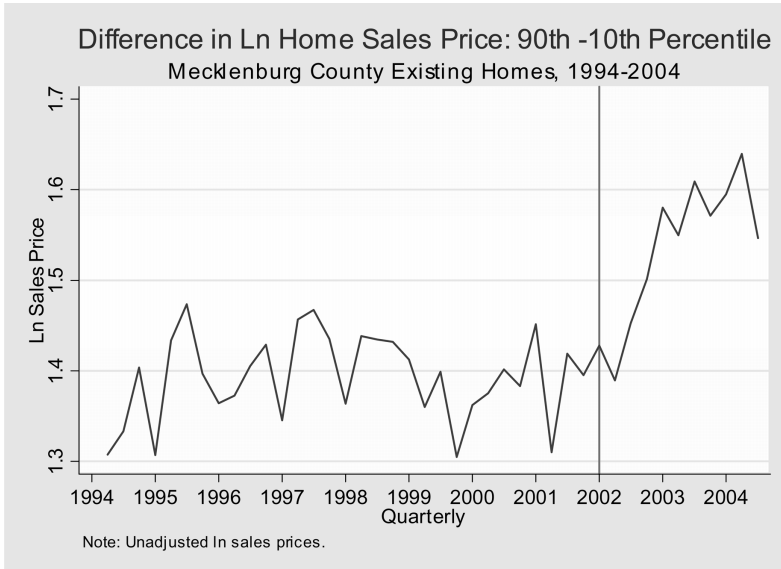


Figure 9. Trend in the Difference in Log Sales Price Between the 90th and 10th Percentiles in Mecklenburg County.

What aspects of the Mecklenburg County housing market might the earlier simulations have missed? First, at least in districts that are operating under desegregation plans, the school boundaries are not exogenously determined. Rather, in Mecklenburg County, they were periodically redrawn to limit the ability of home buyers to choose to attend racially segregated schools—thus limiting the impact of residential mobility. Second, the computable general equilibrium models typically assume that travel distance to schools does not matter. However, if the accessibility of schools matters to parents, then housing prices will presumably continue to reflect proximity to quality schools even after school assignment boundaries have been erased. If proximity matters, access to high-quality schools may still be rationed by housing price in a public school choice scheme. The new housing market equilibrium in Mecklenburg County under school choice remains to be seen. Ironically, housing market reactions to the absence of race-based bussing will provide us with a useful counterfactual with which to study the impact those plans were having while they were in place.

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