8-1-2009

School Choice in Suburbia: Test Scores, Race, and Housing Markets

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Home buyers exercise school choice when shopping for a private residence due to its location in a public school district or attendance area. In this quantitative study of one Connecticut suburban district, we measure the effect of elementary school test scores and racial composition on home buyers' willingness to purchase single-family homes over a 10-year period, controlling for house and neighborhood characteristics. Overall, while both test scores and race explain home prices, we found that the influence of tests declined while race became nearly seven times more influential over our decade-long period of study. Our interpretation of the results draws on the shifting context of school accountability, the Internet, and racial dynamics in this suburb over time.

Introduction

While most school choice research focuses on relatively new charter and voucher programs in urban areas, this study examines one of the nation's oldest and largest choice systems: the willingness to pay for better public schools through the private real estate markets of suburbia. Using econometric and spatial analysis methods, our study asked three questions. First, how much more were suburban home buyers willing to pay to live on the higher-scoring side of an elementary school attendance line, when controlling for house and neighborhood characteristics? Second, to what extent did school racial composition influence home buyers' willingness to pay? Third, how has the relationship between test scores, race, and house prices changed over the past decade, given the increasing accessibility of school-level data on the Internet?

As Sandra Black (1999) has noted, most prior research on the relationship

Electronically published June 4, 2009
American Journal of Education 115 (August 2009)

0195-6744/2009/11504-0003$10.00

between school quality and home price has used a standard hedonic price model, which does not adequately control for neighborhoods. Since better schools tend to be located in better neighborhoods, not controlling for neighborhood would result in an overestimation of the effect of school quality on house price. This problem was circumvented by drawing upon Black's method of identifying homes in close proximity to a school attendance boundary and defining each "neighborhood" as the cluster of homes of opposite sides of this dividing line. By restricting geographical barriers and varying the distance from these boundaries, we identify homes that are more likely to share the same neighborhood characteristics.

Our findings from the suburb of West Hartford, Connecticut, indicate that elementary school test scores are significantly and positively correlated with single-family home prices, controlling for house characteristics, neighborhood effects, and school racial composition. For homes located in geographically similar neighborhoods and very close to school attendance boundaries, a 1 standard deviation increase in the number of fourth graders meeting the state achievement test goal is associated with a 1.9 percent (or $3,824 increase) in the price of an average home in year 2000 dollars. While we do control for school minority composition and Black (1999) does not, our finding is similar to her result (where a 1 standard deviation increase in test scores was associated with a 2.1 percent increase in home prices). Furthermore, in the pre-2001 period, buyers were willing to pay $2,641 more for a 1 standard deviation increase (12 percentage point) in test scores and $435 more for a 1 standard deviation (13.8 percentage point) reduction in school minority composition. In the post-2001 period, buyers were willing to pay $1,054 more for a 1 standard deviation increase in test scores and $7,468 more for a 1 standard deviation reduction in school minority composition. Overall, these quantitative findings clarify our understanding of suburban home buyers' awareness of neighborhood school characteristics. Although test scores matter, their power has diminished over time, and the racial composition of the school has played a dramatically more influential role in determining house prices in West Hartford in recent years.

This article represents a collaborative effort between faculty and student coauthors at Trinity College. JACK DOUGHERTY is an associate professor of educational studies who leads the Cities, Suburbs, and Schools project (http://www.trincoll.edu/depts/educ/css). DIANE ZANNONI is the G. Fox and Company Professor of Economics, and JEFFREY HARRELSON, LAURA MALONEY, DREW MURPHY, RUSSELL SMITH, and MICHAEL SNOW all began this project as her econometrics students before receiving their undergraduate degrees in 2007.

Literature Review

Traditional hedonic regression models estimated home prices based on their internal characteristics (e.g., square footage, number of bedrooms, age of home) and their location. As economists began factoring the role of public schools into this model, they initially included district-level inputs, such as expenditures per pupil (Oates 1969). After the mid-1970s, this variable was replaced by school-level performance outcomes, such as standardized test scores, which became increasingly prevalent with rising levels of state education accountability in later decades (Brasington and Haurin 2006; Rehm and Filippova 2008). More recently, economists have explored ways of distinguishing neighborhood effects from the relationship between school test scores and home prices. In other words, how can we determine whether home buyers are paying for school quality versus neighborhood quality since the two are so closely related?

Black (1999) offered an innovative solution: the boundary fixed-effects model. In her study of test scores and home prices in suburban Boston during the mid-1990s, she used computer mapping techniques to identify homes located very close to an elementary school attendance boundary (0.15 mile, or less than 800 feet). By assigning a dummy variable to code houses on opposite sides of this boundary line, her model captured the unobservable neighborhood characteristics that they most likely share due to their close proximity. In Black's regression analysis, home prices are a function of the observable house characteristics, the unobservable neighborhood characteristics, and school test scores. This boundary fixed-effects model has been adopted by other economists (Figlio and Lucas 2004) and was expanded on in Kane et al.'s (2005) study of 1990s court-mandated desegregation and housing in Charlotte, North Carolina, with school race as an additional variable. It also has generated related lines of research in Australia, New Zealand, and the United Kingdom, though scholars in these countries note that school attendance boundaries are not nearly as tightly linked to individual homes as they are in the United States (Davidoff and Leigh 2008; Gibbons and Machin 2003).

Some economists have criticized Black's boundary fixed-effects model. By identifying narrow bands of home sales on opposite sides of a school attendance boundary, the method necessarily creates relatively small samples, with the assumption of neighborhood continuity (Brasington and Haurin 2006). Others argue for a spatial econometric model, which could resolve two potential problems in hedonic house price models. One problem is spatial autoregression: home prices are not independent of one another and living next door to several "better" homes might, by itself, raise the price

of one's home. If this effect exists and spatial lagging of the dependent variable is overlooked, the regression coefficient estimates may be biased. A second problem is spatial correlation in the error terms that, if unchecked, may generate larger standard errors (and consequently smaller *t*-statistics) than warranted (Brasington 1999; Cohen and Coughlin 2008; Gibson et al. 2005). However, as Bowen et al. (2001) observed in their study of housing prices, explicit spatial modeling is not always required. Overall, economists of schools and housing have not reached a methodological consensus on the best ways to address neighborhood effects (Brasington and Haurin 2006).

Bayer et al. (2007) expanded on Black's technique by embedding it within a sorting model to measure the relationship between test scores and house prices as home buyers are also sorting themselves demographically, based on preferences for same-race and same-income neighbors. This San Francisco Bay area study raises an important conceptual distinction and attempts to separate observable neighborhood characteristics (using block-level sociodemographic data from a restricted-access version of the 1990 Census) from unobservable neighborhood characteristics. But theoretically Bayer et al. recognize the existence of a fundamental endogeneity problem in their model, which includes sociodemographic data from census units that could, by itself, influence the price of the house. Furthermore, on a more pragmatic level, Bayer et al.'s approach is limited by the fact that census block boundaries are not necessarily aligned with school attendance boundaries and they could obtain only one-third of the latter geography for this study. Finally, given that this study relies on one year (1990) of decennial census data, it cannot easily address change over time.

Our study of homes and schools in suburban West Hartford, Connecticut, builds on Black (1999) and related studies in three dimensions: test data, school race, and change over time. First, our analysis created an annual composite achievement score from the Connecticut Mastery Test (CMT) that most closely resembled how prospective home buyers might have seen data reported each year (from 1996 to 2005) in the mass media. By contrast, Black (1999) averaged raw test scores over three different years (1988, 1990, and 1992). Kane et al. (2005) averaged a composite test score over all available years (between 1993–99 or 1997–2001, depending on availability), based on their previous finding that property values responded to long-run measures rather than year-to-year fluctuations (Kane et al. 2003). Furthermore, Figlio and Lucas (2004) used Florida's system of assigning each school a letter grade, which fluctuated significantly from year to year, based upon a formula that included school attendance, demographic variables, and test scores.

Our second contribution is including race in the model. Although a growing social science literature addresses the relationship between school racial composition and residential choices (Holme 2002; Saporito and Sohoni 2006), neither Black (1999) nor Figlio and Lucas (2004) incorporated school-level racial

data into their econometric models. Although Kane et al. (2005) included school racial composition as a variable, their study of Charlotte-Mecklenberg, a southern metropolitan region under court-ordered racial desegregation during their period of study, differed substantially from the context of our northern suburban community, where mandated school desegregation was virtually nonexistent. Although we did not have access to the same type of restricted census block sociodemographic data as Bayer et al. (2007), we would not have chosen to use them due to the theoretical and pragmatic issues noted above. In West Hartford, where we focused on elementary school attendance zones in residential areas, we discovered several cases where boundary lines had been drawn through the middle of census blocks.

A third contribution in our decade-long study is our time period analysis, where we compare the school test, race, and home price relationship during the first half (1996–2001) to the second half (2002–5). This pre- and post-2001 division is important because school-level data became more readily and widely available to prospective home buyers through the expansion of state education accountability politics as well as the Internet during our period of study. In contrast to Bayer et al. (2007), since our study sought to measure change over time from 1996 to 2005, relying on census variables from one data point (such as 2000) would have limited our analysis.

Our study of one large Connecticut suburb shares some similarities with a state-wide analysis of Connecticut school districts and home prices by Clapp et al. (2008). Their model also includes annual composite CMT test scores, school racial composition, and home sale data from 1994 to 2004. But Clapp et al. is essentially a district-to-district study because it only compares districts with one middle school for the entire town to simplify the spatial analysis due to the lack of digitized school attendance zone maps. As a result, Clapp et al. analyze Connecticut's rural towns and smaller suburbs and omit urban areas and larger suburbs with more than one middle school zone for potential home buyers to choose (like West Hartford). Their fixed-effects model relies on census tract boundaries, but these are not meaningful to home buyers in the same way as school attendance zones. Furthermore, while Clapp et al. categorize school districts from across Connecticut into 10 different labor market areas to improve comparability, this step does not consider each house's location relative to the central city, which in the Hartford area labor market can vary between zero and over 35 miles. By contrast, our West Hartford study focuses on home-to-home differences within neighborhoods of one large suburb, located adjacent to a major city, to determine how much home buyers were willing to pay to live on what they perceive as the more desirable side of an elementary school attendance boundary, based on test scores and school racial composition over a 10-year period.

Context of the Study

Our case study focuses on the suburb of West Hartford, Connecticut, and its 60,000 residents. Located adjacent to the impoverished state capital of Hartford, West Hartford is often described as a middle- to upper-middle-class suburb, enjoying a per capita income of $33,468 (above the Connecticut state average of $28,700 and Hartford's figure of $13,428, according to Census 2000). Overall, the West Hartford Public School district enrolls over 9,000 students, with 11 elementary K–5 schools that fed students into two middle–high school zones during our study. Previously, West Hartford had been a virtually all-white suburb, enrolling fewer than 5 percent minority students during the 1970s. But the proportion of African American, Hispanic, and Asian students increased steadily during our 10-year period of study, from 24 percent in 1996 to 32 percent in 2005.[1]

West Hartford serves as an ideal location to explore our research questions because residents of this suburb have been very aware of the relationship between their public neighborhood elementary schools and the private real estate market. In 1995, immediately before our period of study, West Hartford citizens engaged in a heated debate over plans to redraw elementary school attendance boundaries. Plans were motivated by efforts to relieve overcrowding in schools located in less affluent neighborhoods and to comply with Connecticut's racial balancing law, which required districts to maintain individual school minority enrollments within 25 percentage points of the district average. West Hartford parents clashed over different redistricting proposals, with some public meetings attracting up to 500 people. At one meeting, a parent from a more affluent neighborhood who questioned the audience asked: "How many people moved here to West Hartford specifically because of the quality of the neighborhood schools?" According to a local reporter, "hands shot up around the packed floor of the town hall auditorium," demonstrating the intensity of the perceived link between public school quality and private residential choice (Stansbury 1995).

West Hartford eventually implemented a major redistricting plan in September 1995, which affected approximately one-quarter of the student population. These school attendance boundary lines remained virtually unchanged over the next decade.[2] Residential attendance areas determine the enrollment for a vast majority of public school students, with only a few minor exceptions. For example, three West Hartford elementary schools were designated as intradistrict magnets during this period, meaning that any West Hartford student could apply to enroll via a lottery. Furthermore, residents in these three school attendance areas could choose to "opt out" and attend a different elementary school in the same secondary school feeder pattern if space allowed. But, in practice, only 3 percent of West Hartford's public elementary

school students left their assigned neighborhood to enroll in an intradistrict magnet school, and even fewer elected to "opt out" to another zone.[3] In any case, magnet school applications are subject to a lottery while neighborhood school attendance is guaranteed when a family moves into the attendance zone. As a result, West Hartford home owners perceive a very strong link between their home and their designated public elementary school.

After redistricting, West Hartford elementary school students continued to take a statewide standardized exam (the Connecticut Mastery Test, or CMT), in a format that remained relatively consistent for one decade.[4] This allowed us to concentrate our study on an uninterrupted 10-year span of stable elementary school boundaries and test results, beginning with the first calendar year after redistricting (1996) and ending the year before a major change in CMT testing (2005). Interestingly, public access to school-level CMT scores became much more accessible during this period due to the combined influence of state and federal school accountability politics and the expanded consumer usage of the Internet. The turn of the twenty-first century serves as a convenient midpoint for our study. During the first half of the study, test scores for individual West Hartford elementary schools probably were seen by a smaller proportion of home buyers. Although Connecticut required each district to report school test results, copies typically circulated only in paper format, issued by the superintendent's office. A newspaper graphic with school results appeared only once a year in the daily newspaper (often during the busy Christmas and New Year holiday season) in the local edition delivered only to West Hartford and nearby areas (see fig. 1).[5]

The World Wide Web was still in its pioneer phase during this first half of our time period. In 1995, the Prudential Connecticut Realty company opened its first experimental "computerized library," located at their West Hartford office, for potential buyers to browse photographs of homes and "information on communities' demographics and school systems" (Hathaway 1995). Although the Connecticut Department of Education launched its own Web site in 1996, it did not include test score data on individual schools until late 1997 for the first generation of consumers who explored the Internet.[6]

After 2000, during the second half of our study period, home buyers with computer access could easily and instantaneously view details about local schools, whether located around the corner or across the country. Part of the data revolution was driven by state education agencies to comply with the No Child Left Behind Act of 2002. But nongovernmental education advocates and private real estate interests also made significant contributions. GreatSchools.net, founded in 1998, described itself as "the nation's premier provider of K–12 school information to parents" (2007). This nonprofit organization received funding from philanthropists and advertisers, including partnerships with several leading real estate firms. Its Web site fea-

Scores, Spirits Soar

Connecticut Mastery Test results

■ The following gives a five-year look at West Hartford district results on the Connecticut Mastery Test. The numbers reflect the percent of students districtwide who met state goals in each subject area.

Grade 4

SUBJECT	1994	1995	1996	1997	1998
Reading	60	61	66	71	76
Writing	39	55	51	72	74
Math	65	68	61	78	85

Grade 6

SUBJECT	1994	1995	1996	1997	1998
Reading	74	72	67	73	75
Writing	46	44	59	59	71
Math	59	60	57	70	70

Grade 8

SUBJECT	1994	1995	1996	1997	1998
Reading	78	73	73	76	79
Writing	63	56	68	65	74
Math	66	59	58	68	69

■ The following gives school-by-school results on the 1998 Connecticut Mastery Test, given statewide each fall to fourth-, sixth- and eighth-graders. The results reflect the percent of students at each school who met state goals on the exam.

SCHOOL	READING	WRITING	MATH
Aiken	91%	78%	97%
Braeburn	**78%**	**62%**	**81%**
Bugbee	89%	84%	93%
Charter Oak	**52%**	**54%**	**66%**
Duffy	86%	86%	94%
Morley	**74%**	**76%**	**75%**
Norfeldt	82%	82%	89%
Smith	**59%**	**67%**	**71%**
Webster Hill	82%	82%	92%
Whiting Lane	**75%**	**68%**	**82%**
Wolcott	68%	68%	87%
King Philip, grade 6	**77%**	**68%**	**75%**
Sedgwick, grade 6	73%	73%	64%
King Philip, grade 8	**83%**	**75%**	**77%**
Sedgwick, grade 8	76%	74%	63%

SOURCE: West Hartford Public Schools

FIG. 1.—School test scores as reported annually in the local newspaper, 1999

tures school-level test score and demographic data and claims to have reached 33 million users in 2006 (see fig. 2).

Method and Data

Hedonic price models are used when the good purchased is valued for its characteristics or services it renders. In these models the good already purchased can be reduced to its parts, and the coefficients in a regression capture the willingness of consumers to pay (or the implicit prices) for the different characteristics (Rosen 1974). Applied to home purchases, hedonic regression uses information on the home purchases made, including the price of the home and all relevant characteristics, to identify what characteristics were important to buyers. Therefore, in addition to school quality, both the char-

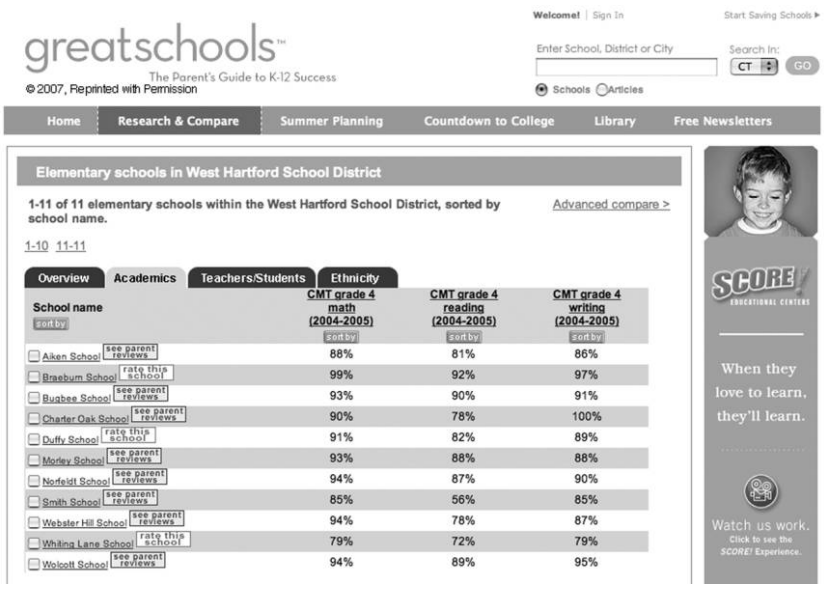

FIG. 2.—School test scores as presented on the GreatSchools™ Web site, 2007

acteristics of the house and its location are included in hedonic models explaining house price. In general,

$$\text{house price} =$$

$$f(\text{house characteristics, school quality, neighborhood characteristics}).$$

We follow Black's (1999) methodology and estimate the following model:

$$\ln(\text{house price})_{iab} = \alpha + X'_{iab}\beta + \gamma \text{test}_{ab} + K'_b\theta + \epsilon_{iab},$$

where price *iab* is the sales price of house *i* in attendance area *a* in neighborhood *b*, X'_{iab} are the characteristics of the house, test *ab* is the elementary school test score in attendance area *a* in neighborhood *b*, and K'_b is a vector of neighborhood dummy variables that account for neighborhood characteristics shared by houses on either side of the attendance boundary (provided to avoid omitted variable bias).

Better schools tend to be located in better neighborhoods, and the failure to control for neighborhood might overestimate the influence of school quality on house prices. Given that we lack data to fully capture differences in neighborhood quality, a different approach is required. Our study relied on Black's method (1999), which improves upon the standard hedonic price model by

identifying homes located very close to school attendance boundaries and creating a dummy variable to account for neighborhood characteristics shared by homes on opposite sides of that line. Black's approach assumes that houses in close proximity share more neighborhood characteristics than houses farther apart. This methodology is preferable to using census variables to control for neighborhood effects for three reasons. First, school attendance zones are not necessarily aligned with census geography boundaries. Second, census data are collected once a decade and preclude an analysis of change over time during our study period. Finally, and most importantly, even with census variables, the problem of omitted variable bias still remains. An alternative methodology would be to use spatial hedonic modeling to test for spatial effects (Brasington 1999; Brasington and Haurin 2006; Gibson et al. 2005).

To create the neighborhood dummy variables, we constructed a spatial database to connect the location of home sales with public school attendance zones. Using Geographic Information System (GIS) software, we linked each home sale to the nearest attendance zone boundary line shared by two elementary schools. We eventually focused on homes located in very close proximity—within 0.15 mile (about 800 feet, or 240 meters)—of these shared school boundary lines, as illustrated in figure 3. In West Hartford, our total sample included 26 neighborhoods, which we define in this study as homes on opposite sides of a common boundary line.[7] A typical neighborhood consists of a pair of elementary schools and the homes along their shared boundary, as illustrated in figure 4. In each of these areas, homes are located so close together that we believe them to share the same neighborhood characteristics, with one key exception: children are zoned for two different elementary schools.

This study uses pooled cross-sectional data, independently sampled observations on house prices, house characteristics, and school quality for each year over a 10-year period. With pooled data, observations are independently distributed over time. Therefore, standard regression techniques can be used for estimation. Since the sample is drawn from the population at different points in time, the relationship may change over time, which was found to be the case between two time periods: 1996–2001 and 2002–5. Were this study based on panel instead of pooled date, the observations would not be independently distributed over time, and either a fixed effect or random effects estimation technique would be required to ensure efficient coefficient estimates (Wooldridge 2009).

House price is the sale price of qualified single-family residential homes (excluding all condominiums, duplexes, etc.) with lot sizes of at least 500 square feet sold in West Hartford, Connecticut, between 1996 and 2005.[8] In order to compare houses sold across the time period (when the average home price rose dramatically from approximately $150,000 to $325,000), all house prices were deflated to year 2000 dollars by constructing an index of average single-

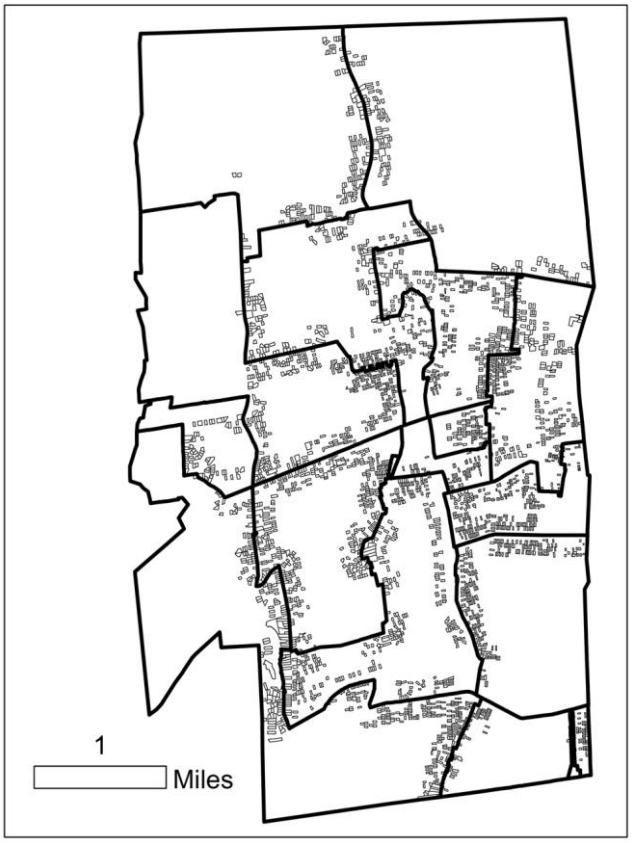

FIG. 3.—West Hartford elementary school zones and home sales within 0.15 mile of boundaries, 1996–2005.

family home sales prices for each year in West Hartford. Standard measures of housing characters were available from the West Hartford property assessor's database. They include the number of bedrooms, the number of bathrooms, age of building at time of sale, property lot size, and internal house size.[9]

As a proxy for school quality, we created an annual elementary school composite test score that most closely resembled how results from the CMT were publicly reported in the graphics of the local newspaper. For each of the eleven K–5 elementary schools in West Hartford, an annual test score was calculated based on the percentage of fourth-grade students meeting the state goal, averaged across three separate tests: reading, writing, and mathematics.[10] Meeting the goal is defined as scoring at or above a level specified by the state. Reported test scores are those most likely to influence home-buying

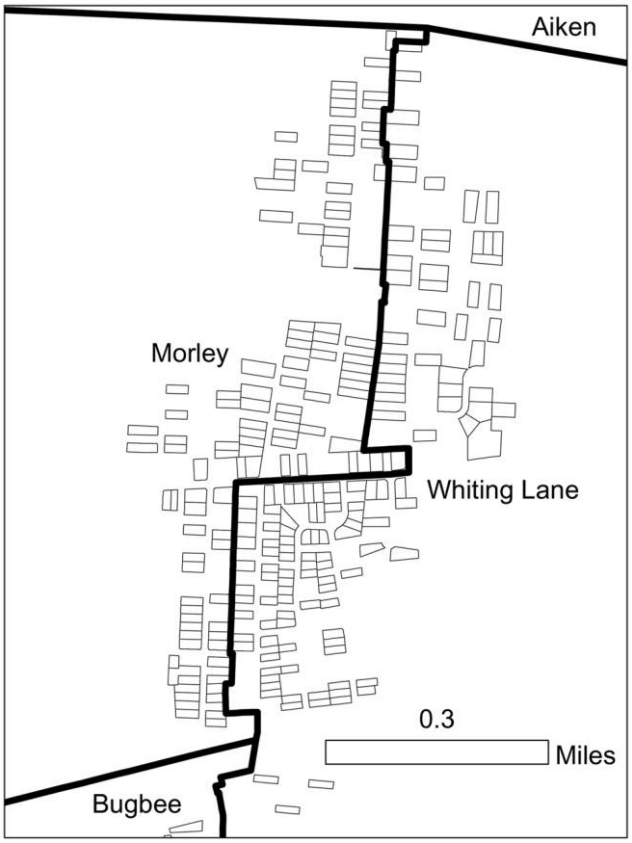

FIG. 4.—Home sales within 0.15 mile of boundary between two West Hartford elementary schools, 1996–2005.

decisions. As results from the CMT given in the fall of a year typically are reported in the press early the following year, in this study the test score recorded in year t is based on the CMT taken in year $t - 1$.

This model explores the effect of test scores from last period on house price this period. It is reasonable to expect that families with higher socioeconomic status may move into a neighborhood and drive up both test scores and home prices. In this case it would be impossible to specify a causal relationship. If our model has specified house prices in year t as a function of tests scores in year t, then endogeneity would be a problem. But this is avoided in our model by making house price a function of last period's test scores.

The model in this study explores the effect of school quality on house prices, but it limits the measure of school quality to that of the elementary school.

TABLE 1

Summary Statistics of Key Variables in the Data Set of Single-Family Qualified Home Sales, 1996–2005

Variable	Mean	SD	Minimum	Maximum
Home price (in year 2000 dollars)	198,300	100,639	50,658	1,500,000
School test score	73	12	34	94
School minority percent	25	13.8	9	70
Number of bedrooms	3.3	.9	1	9
Number of bathrooms	2.4	.9	1	8
Age of building when sold	55	18	0	270
Lot size (square feet)	12,181	7,217	600	114,099
Internal size (square feet)	1,870	776	598	8,624

NOTE.—N = 8,736.

Home purchasers also may be willing to pay for higher-quality secondary schools. In West Hartford there were only two middle–high school zones during the period of this study; their attendance boundaries did not change, and their test scores remained relatively similar during the decade. The secondary school is highly correlated with neighborhood. If both are used as independent variables, it is not possible to isolate the effect of middle and high school from the effect of shared neighborhood characteristics in determining house prices. If there were variation in secondary schools for a significant number of neighborhoods, one could include secondary school in the model. Unfortunately, there are only four neighborhoods that stretch across the secondary school attendance boundary that divides West Hartford, too few to analyze separately in this study.

Our sample consists of 8,736 single-family home sales over a decade-long period, each linked to its assigned elementary school and its closest attendance area border. According to the summary statistics found in table 1, the mean home price is just below $200,000 (in year 2000 dollars) and an average of 73 percent of fourth graders met the state goal.

Results

Geographic Restriction and Variable Distance Analysis

The purpose of defining a neighborhood is to be able to control for the characteristics of the area around the school attendance boundary that are

TABLE 2

Regression Results for Geographic Restriction and Variable Distance for Houses in All Time Periods (1996–2005)

Geographic Restriction	.15 Mile from the Boundary (1)	.25 Mile from the Boundary (2)	.35 Mile from the Boundary (3)	All Houses (4)
Set A: Natural boundaries	.0020	.0020	.0018	.0015
	(4.77)	(5.56)	(5.52)	(5.18)
Set B: Natural + Transportation I	.0020	.0019	.0017	.0014
	(4.34)	(4.94)	(4.61)	(4.28)
Set C: Natural + Transportation II	.0015	.0016	.0013	.0010
	(3.23)	(3.97)	(3.45)	(3.20)
Set D: Natural + Transportation III	.0016	.0020	.0019	.0016
	(3.50)	(4.71)	(4.76)	(4.61)

NOTE.—Dependent variable = ln (house price). Heteroskedastic-adjusted standard errors; *t*-statistics in parentheses.

shared by all houses and may affect home prices. Intuitively, the closer the homes are to the school attendance boundary, the more neighborhood characteristics will be shared. In addition, if a major road or wooded area divides the neighborhood, there are obvious characteristics that are not shared. Similar to Black (1999), this study considers neighborhoods that are geographically similar on both sides of the school attendance boundary and only includes houses that are close to the school attendance boundaries.

The model was estimated using four increasingly restrictive geographical criteria. The goal was to gradually eliminate neighborhoods where school attendance boundaries were shaped by rivers, parks, and major roads since homes divided by these geographical barriers were less likely to share neighborhood characteristics.

Set A: Natural boundaries (rivers, large green spaces such as parks and country clubs).

Set B: Natural + Transportation boundaries I (Interstate I-84).

Set C: Natural + Transportation boundaries II (I-84 + Farmington Ave.).

Set D: Natural + Transportation boundaries III (I-84 + all four-lane major streets).

The model was also estimated for samples of houses of varying distances from the school attendance boundary (within 0.35 mile, 0.25 mile, and 0.15 mile), based on Black's (1999) assumption that homes in closer proximity are more likely to share neighborhood characteristics than homes located further away from one another. Table 2 provides a summary of the results of estimating

TABLE 3

Regression Results for Most Restrictive Geography (Set D) and Distance within .15 Mile for Houses in All Time Periods (1996–2005)

Variable	House Distance from Attendance Area Boundary within .15 Mile
Test score	.0016
	(3.50)
Number of bedrooms	.0132
	(1.56)
Number of bathrooms	.2366
	(7.18)
(Number of bathrooms)^2	−.0331
	(−4.91)
Lot size (square feet)	.000005
	(4.38)
Internal size (square feet)	.0003
	(15.24)
Neighborhood dummys	Yes
N	1,684
R^2 (adjusted)	.7697

NOTE.—Dependent variable = ln (house price). Heteroskedastic-adjusted standard errors; *t*-statistics in parentheses.

the model with the entire sample and with varying geographical and distance restrictions. In all cases, the coefficient on test score is positive and significant. In subsequent estimations and analyses, the most restrictive geography (Set D) and distance (0.15 mile from the school attendance boundary) will be used to increase the likelihood that differences in house price are due to school quality and not neighborhood differences.

As the results in tables 3 and 4 below show,[11] for homes located in neighborhoods geographically similar and very close to elementary school attendance boundaries (within 0.15 mile, or less than 800 feet), a 12 percentage point increase (or a 1 standard deviation) in the number of fourth graders meeting the state testing goal is associated with a 1.97 percent, or a $3,917, increase in the average price of a house. Black (1999) found that a 1 standard deviation increase in test score is associated with a 2.1 percent increase in the average home price, or $3,948.

School Minority Percentage Analysis

Both qualitative and quantitative social scientists have argued that the racial composition of a school significantly influences parents' perceptions about its

TABLE 4

Increase in Test Scores on House Prices (Year 2000 Dollars) for Most Restrictive Geography and Distance, within .15 Mile, for All Time Periods (1996–2005)

Test Score Percentage Point Increase	House Price Increase
1	326
6	1,958
12 (1 standard deviation)	3,917

quality and therefore influences their home-buying decisions (Holme 2002; Saporito and Sohoni 2006). Therefore, we expanded the econometric model to include two school characteristics: test score and racial minorities. For race, we adopted the classification scheme of the Connecticut Department of Education: minority students are defined as Black, Hispanic, Asian American, and American Indian students (all of the nonwhite students). In West Hartford, the average elementary school minority composition was 25 percent, with a wide range from 9 to 70 percent across schools during our 10-year period.

If, in addition to test score, home buyers consider the school minority composition, then omitting race from the model would bias the coefficient on test score. If there is a negative correlation between test score and race and if buyers prefer schools with fewer minority children, then the coefficient on test score would be biased upward if minority composition were excluded from the model; that is, it would capture both the willingness to pay for higher test scores and lower minority enrollment.

While excluding a relevant variable, such as school minority composition, can bias the coefficients of the included variables, factoring in race can cause another estimation problem. Since school test scores and race are highly collinear in our sample, including both variables may result in increased standard errors of the coefficients; the coefficients will remain unbiased. It would then appear that one or both of the collinear variables are not significant in explaining house price. This is not the case; both test score and minority composition are significant in explaining house price when included without the other in the model. Both variables should be included in the model.

As table 5 illustrates, when school minority composition is included in the model, the effect of test score on home price remains stable. For a 1 standard deviation increase in test score, the price of a house increases by 1.93 percent, or by $3,824, when holding minority composition constant.

The influence of race on house prices appears in table 6. For a 1 standard deviation increase in school minority composition (13.8 percentage points), buyers' willingness to pay for a house falls by 0.28 percent, or $547, holding

TABLE 5

Regression Results Excluding and Including School Minority for Houses in Most Restrictive Geography, within .15 Mile Distance, for All Time Periods (1996–2005)

	House Distance from Attendance Area Boundary	
Variable	Within .15 Mile	Within .15 Mile Including School Minority
Test score	.0016	.0016
	(3.498)	(3.302)
School minority		−.0002
		(−.325)
Number of bedrooms	.0132	.0132
	(1.558)	(1.556)
Number of bathrooms	.2366	.2364
	(7.181)	(7.190)
(Number of bathrooms)^2	−.0331	−.0332
	(−4.913)	(−4.916)
Lot size (square feet)	.000005	.000005
	(4.379)	(4.379)
Internal size (square feet)	.0003	.0003
	(15.235)	(15.186)
Neighborhood dummys	Yes	Yes
N	1,684	1,684
R^2 (adjusted)	.7697	.7697

NOTE.—Dependent variable = ln (house price). Heteroskedastic-adjusted standard errors; *t*-statistics in parentheses.

test scores constant. This finding is consistent with prior research (Saporito and Sohoni 2006) regarding the significant influence of race: when the percentage of minority students increased, home buyers were willing to pay less to purchase a home in the elementary school attendance zone.

Test and Race over Time Period Analysis (1996–2001 vs. 2002–5)

Our 10-year data set provided us with a unique opportunity to examine the influence of test scores and school racial composition in one suburb over time. From 1996 to 2005, the West Hartford elementary attendance zones remained relatively stable, as did the statewide standardized testing format. Yet, due to the expansion of the school accountability movement and the Internet, public access to school-level testing and racial data became more readily (and instantly) available to prospective home buyers. In addition, the West Hartford Public Schools experienced significant racial change during this period. Across

TABLE 6

Decrease in School Minority on House Prices (Year 2000 Dollars) Including Test Score for Most Restrictive Geography, within .15 Mile Distance, for All Time Periods (1996–2005)

School Minority Percentage Point Decrease	House Price Increase
1	40
6.9	274
13.8 (1 standard deviation)	547

all elementary schools combined, the percentage of minority students rose 19 percentage points (from 27 to 46 percent). But racial change varied widely across neighborhood schools. At one end of the spectrum, some schools experienced flat (or negative) growth in the percentage of minority students, while at the other end some schools experienced pronounced growth (up to 26 percentage points). Furthermore, in our most restrictive sample of neighborhoods, both the variation and the average size of the student racial gaps increased between schools sharing a common border while the test score gaps remained relatively constant over time.

Therefore, to expand our study, we sought to measure the influence of school test scores and minority composition over the decade, which we divided into two time periods (pre-2001 and post-2001). In light of the increased availability and awareness of school-level data, suburban home buyers should be more responsive to school characteristics after 2001 than before.

As tables 7 and 8 show, the effect of test score on home buyers declined 60 percent between the two periods while the effect of minority composition rose dramatically. To live in a school zone with higher test scores, home buyers were willing to pay $2,641 more for a 1 standard deviation increase (12 percentage points) during the pre-2001 period but only $1,054 more during the post-2001 period. But race became much more influential over the same time span. To live in a school zone with a lower percentage of minority students, home buyers were willing to pay only $435 more for a 1 standard deviation reduction (13.8 percentage points) during the pre-2001 period but were willing to pay $7,468 more during the post-2001 period. In other words, the racial composition of elementary schools became nearly seven times more influential than test scores in the latter half of this study. In the previously all-white suburb of West Hartford, home buyers demonstrated the increasing significance of race over time rather than its decline (Massey and Denton 1993; Wilson 1978).

TABLE 7

Regression Results for Time Period Analysis for Houses in Most Restrictive Geography, within .15 Mile of Boundary

Variable	All Periods (1996–2005)	First Period (1996–2001)	Second Period (2002–5)
Test score	.0016	.0011	.0004
	(3.302)	(1.920)	(.3284)
School minority	−.0002	−.0012	−.0027
	(−.3248)	(−.1659)	(−2.543)
Number of bedrooms	.0132	.0104	.0180
	(1.556)	(.8986)	(1.496)
Number of bathrooms	.2364	.2533	.1867
	(7.190)	(6.080)	(6.305)
(Number of bathrooms)^2	−.0332	−.0356	−.0251
	(−4.916)	(−4.118)	(−4.259)
Lot size (square feet)	.000005	.000005	.000003
	(4.379)	(3.915)	(1.798)
Internal size (square feet)	.0003	.0003	.0003
	(15.186)	(12.096)	(9.952)
Neighborhood dummys	Yes	Yes	Yes
N	1,684	995	689
R^2 (adjusted)	.7697	.7580	.7964

NOTE.—Dependent variable = ln (house price). Heteroskedastic-adjusted standard errors; *t*-statistics in parentheses.

Discussion

At one level, our findings confirm an emerging consensus regarding the magnitude of the relationship between test scores and home prices in different regions of the United States. Black's (1999) study of suburban Boston in the mid-1990s found that, with boundary fixed-effects to control for unobservable neighborhood characteristics, a 1 standard deviation increase in elementary school test scores resulted in a 2.1 percent increase in house prices. Our West Hartford study, which followed Black's boundary fixed-effects method and also controlled for school racial composition, produced a similar finding: a 1 standard deviation increase in elementary school test scores resulted in a 1.9 percent increase in house prices. Other comparable studies using boundary fixed-effects methods (and additional controls for school race and/or neighborhood sociodemographics) also report that a 1 school-level standard deviation increase in test scores resulted in increased housing costs ranging from 1.4 to 2 percentage points (Bayer et al. 2007; Clapp et al. 2008; Kane et al. 2005), as summarized in table 9.[12]

TABLE 8

Change in Test Scores and School Minority on House Prices (Year 2000 Dollars), for Different Time Periods for Most Restrictive Geography, within .15 Mile Distance

	Increase in House Price		
	All Periods (1996–2005)	First Period (1996–2001)	Second Period (2002–5)
Test score percentage point increase:			
1	318	220	88
6	1,912	1,321	527
12	3,824	2,641	1,054
School minority percentage point decrease:			
1	38	32	541
6.9	265	218	3734
13.8	531	435	7,468

On another level, when analyzing the school and housing relationship over time, our study underscores an initially puzzling result: the declining influence of standardized tests. In West Hartford, while both elementary school test scores and race explain home buyers' willingness to pay for a suburban home, the impact of test scores declined while race became nearly seven times more influential than tests over the decade. Clapp et al.'s (2008) district-level study

TABLE 9

Comparable Studies Estimating the Effect of 1 School-Level Standard Deviation Increase in Test Scores on Housing Prices

Studies with Boundary Fixed Effects (and Other Controls)	Context	Percentage Point Increase in Housing Prices
Black (1999)	Suburban Boston, MA, 1993–95	2.1
Kane et al. (2005)	Charlotte-Mecklenberg, NC, 1994–2001	2
Bayer et al. (2007)	San Francisco Bay area, CA, 1992–96	1.8
Clapp et al. (2008)	Connecticut towns, 1994–2004	1.4
Dougherty et al. (current study)	West Hartford, CT, 1996–2005	1.9

NOTE.—See the individual studies for details and other controls.

of much of the state during the same period also reported that "in general, we find that people in the state of Connecticut seem to be more concerned about the changes in demographic attributes, particularly percent Hispanic students, than the changes in test scores when deciding how much to pay for homes" (463). However, in their cross-time analysis, Clapp et al. detected trends in the opposite direction from ours, with the declining influence of Hispanic students and the increasing importance of test scores on house prices over time. Comparing these results raises new questions and also suggests some possible interpretations.

First, in our West Hartford study, why did school race become more influential over time compared to Clapp et al.'s (2008) finding that it became less influential elsewhere in Connecticut? Interestingly, the percentage of minority elementary students in West Hartford increased steadily during the 10-year span, and there was no sudden leap in the district during the second period. But while the test score gaps between schools in our most restrictive sample stayed relatively constant during our study period, the racial composition gaps between schools on opposite sides of the same boundary became more pronounced over time.

Paying closer attention to the local politics of race helps to interpret these results. During the 1995 redistricting battle, before our study period began, there was a heightened awareness of race inside West Hartford amid charges that the district had violated Connecticut's racial imbalance law. But when the controversial decision to redraw those lines was made, suburban leaders persuaded the state legislature to suspend the racial imbalance law for a two-year review period. Meanwhile, a 1996 state supreme court ruling in the *Sheff vs. O'Neill* metropolitan desegregation case diverted attention to race outside of West Hartford as many suburbanites wondered whether their district would be merged in some way with the city schools. From 1996 to 2000, the local newspaper ran several news stories comparing Hartford's plight with those of nearby suburbs, but it does not appear to have run a single article about the increasing racial imbalance between schools in West Hartford. However, all of this changed again in 2000, with a renewed emphasis on race inside the suburb, as the state racial imbalance law was renewed and questions also surfaced about the West Hartford's racial achievement gap. Candidates for the school board began to speak openly about internal racial issues as their central concern, bolstered by headlines in the local press proclaiming, "Racial Balance in Schools Is Campaign Issue" (Moreau 2005). Clearly, racial differences inside West Hartford's public schools became a more publicized issue in the latter half of the study period, which may help to explain its growing influence. Clapp et al. (2008) suggest that Connecticut residents may make judgments about school quality using the most readily available signals in their minds, and in West Hartford the racial composition of a school may have

become more salient over time due to the changing local demographic and political contexts.

Second, given that school data accessibility increased with the Internet, and if we assume that home buyers actually read these data, then why did test scores not become more influential over time in West Hartford? Indeed, this econometric model rests on a key assumption, that is, that school data are processed in some way by home buyers. Based on a parallel study of door-to-door interviews with 89 recent home buyers in West Hartford (Ramsay et al. 2006), we know that fewer than 35 percent of those with (or expecting) children reported "researching" schools by examining test scores or Strategic School Profiles or by visiting schools in person. By contrast, over 50 percent relied primarily upon social networks of family, friends, and coworkers for school quality information (see related findings in Holme [2002]). Yet these interviews do not necessarily conflict with the assumption behind our econometric model. Using the vocabulary of Malcolm Gladwell (2000), as long as a sufficient number of "market mavens" and "connectors" spread the word about school quality to their broader social networks, then most consumers may still act on school data, though indirectly. In fact, it is possible that the expansion of the Internet may amplify the roles played by key individuals—such as real estate agents—in this social networking process.

Yet we must be careful not to confuse what home buyers report in a survey versus their actual school choice behavior. In an innovative study by Buckley and Schneider (2007), researchers constructed a public school choice informational Web site in Washington, DC, and then monitored parents' online search behaviors, based on the assumption that these behaviors would reveal more about their true preferences than surveys. The sample of users was not representative of the city; college-educated parents were more likely to visit the Web site than other parents. Overall, the authors found "a strong bias toward accessing the demographic characteristics of the student population" on the Web site, in contrast to questionnaire-based studies where parents claim to be more interested in academic quality. Furthermore, as parents progressed through their Web searches, they tended to focus on schools with lower percentages of black students, revealing their racial preferences for whiter schools (Buckley and Schneider 2007, 127, 133).

These findings may help us to interpret our econometric results from suburban West Hartford. First, parents do not view data equally; those who do access school data Web sites may be more highly educated and possibly may have more influence through expanded social networks. Second, not all data are equal in the eyes of parents. Although our findings show that West Hartford home buyers were sensitive to both test scores and school racial composition, the latter had nearly seven times more influence during the post-2001 period.

Although the Internet is praised for offering more academic quality indicators—such as test scores—for making "smarter" school choices, we cannot ignore the fact that many parents are using this resource to look more closely—with racial biases—at their children's future classmates.

Conclusion

What are the broader implications of the growing body of literature that shows, in general, a measurable relationship between public school characteristics and private home sales prices? Interestingly, while academic researchers often bemoan their lack of influence on general audiences, that is not necessarily the case here. Dozens of news stories have appeared on the relationship between public school quality and private housing markets. The CEOs of school rating and home price Web sites have publicly demonstrated correlations between school performance and housing appreciation, while journalists have reported on home hunters in California using Excel spreadsheets with test score and home price indexes drawn directly from state databases (Gardner 2005; Max 2004). In fact, the National Association of Realtors produced a *Public Education Toolkit* to translate research findings by economists Sandra Black, Thomas Kane, and David Brasington for its real estate agents and to document what the organization refers to as the "direct link between good neighborhood schools and good neighborhood real estate markets" (Everett et al. 2005, 3).

But for advocates of educational equity these findings are much more troubling. First, it serves as evidence of yet another form of unjust privilege as access to more desirable public schools is viewed more like a commodity—rather than a democratic right—to be readily bought and sold within the private housing market. While this linkage between public schools and private homes is not new, researchers have developed better tools with which to measure and demonstrate its existence and perhaps growing influence. Second, the race-based findings also question the wisdom of extending government-sponsored school choice to urban families through public charter and magnet schools or private school vouchers. Many of these choice programs are politically justified on the logic that lower-income urban families deserve the same degree of school choice that middle-class home buyers currently enjoy through the suburban housing market. As one Hartford news columnist, criticizing the lack of public and private school choice in the state, explained: "Of course, if you have the money, Connecticut has 'school choice.' It's called a suburb" (Cohen 2005). But if further studies continue to show that suburban home buyers are motivated more by racial preferences than by higher test scores, then it may call into question the underlying premise for expanding school choice.

Notes

We appreciate comments we received on earlier drafts from Sandra Black, Jeffrey Cohen, Ed McKenna, Salvatore Saporito, Rachael Barlow, our audiences in West Hartford and at the American Educational Research Association in 2007, and three anonymous reviewers. This project would not have been possible without data provided by the Town of West Hartford and ArcGIS support from David Tatem, instructional technologist at Trinity College. Other Trinity students who worked on an earlier phase of this project were Ryan Butler, Molly Stumbras, and Ben Willig. Financial support was provided by a one-year grant from the Faculty Research Committee and an Urban-Global Senior Project Grant, both at Trinity College.

1. In this study, all academic year data are stated by the end of the school year (i.e., 1995–96 is reported as 1996) to make it more consistent with calendar year data.

2. A minor redistricting in fall 2000 affected approximately 50 students across three elementary schools (Aiken, Bugbee, and Whiting Lane). Also, in 2005 a new middle school was opened, though it used randomized lottery admissions rather than a neighborhood attendance area, so boundaries for all schools remained intact.

3. Only 3 percent (162 out of 4,734 total) of elementary students left a neighborhood school to attend a West Hartford intradistrict magnet program, according to the 2004–5 Strategic School Profile. In that same year, an additional 1 percent (52 elementary students) left to attend an interdistrict magnet school in Hartford as part of the *Sheff vs. O'Neill* metropolitan desegregation remedy, according to 2004–5 data from the Capitol Region Education Council.

4. The second generation CMT (offered each fall, from 1993–94 to 1999–2000) and the third generation CMT (offered every fall, from 2000–3001 to 2004–5) were relatively comparable, but the fourth generation CMT (offered every spring, beginning in 2005–6) marked a significant departure from past practice.

5. Although a brief news story about West Hartford scores might appear in various editions, a graphic featuring individual school results appeared only in the local edition of the *Hartford Courant* on December 23, 1996, B3 (5E West Hartford/Farmington Valley local news edition); December 23, 1997, B3 (5E local news edition); January 6, 1999, B1 (7 Hartford North final edition).

6. According to the Internet archive, http://www.archive.org, the original Web site for the Connecticut Department of Education, http://www.state.ct.us/sde, was launched in May 1996, with Strategic School Profiles added as a new feature most likely in late 1997.

7. While our original sample of 11 elementary schools formed 28 common boundary areas (or neighborhoods), we omitted two of these due to their extremely small geography, which eliminated 27 home sales from our total sample.

8. These data were obtained from the Town of West Hartford property records database. Only "qualified" sales, a legally recognized sale between two parties, were included.

9. Both the number of bathrooms and the number of bathrooms squared are included as independent variables to capture the nonlinear (quadratic) relationship between the number of bathrooms and house price, which has been identified in prior studies.

10. School-level data were obtained from the Connecticut Department of Education, Data and Research Web site, http://www.csde.state.ct.us/public/cedar/index.htm. Our test score variable was calculated from the average percentage of students meeting goal across three separate tests, and it should not be confused with a different variable in the state

database: the percentage of students meeting goal on all three tests. Using the percentage of students meeting goal (rather than raw scores) allows us to blend data drawn from the second and third generations of the CMT.

11. Since housing characteristics may be correlated with each other, including them as independent variables may result in multicollinearity and insignificant coefficient estimates. In this study, as in previous studies, with the exception of the number of bedrooms, the coefficients on the housing characteristics are statistically significant. The coefficient on the number of bedrooms is not biased; therefore, it was included in the model.

12. See Kane et al. (2005, n. 10), which distinguishes between the 2 percent housing increase per 1 school-level standard deviation in test scores versus their more widely reported finding of a 10 percent housing increase per 1 student-level standard deviation in test scores. Bayer et al. (2007), Black (1999), and our study all report findings in school-level format.

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