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How Much Is a Neighborhood School Worth?[1]

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This paper presents evidence of the effect on house values of a school redistricting in Shaker Heights, Ohio in 1987. As a result of redistricting, neighborhood schools are disrupted, bus transportation is introduced, and school racial composition changes. The data include all arms-length sales of houses in Shaker Heights between 1983 and 1994. We find, using a difference-in-difference estimator, that disruption of neighborhood schools reduces house values by 9.9%, or $5738 at the mean house value. This result is robust to a variety of alternative specifications, including repeat-sales analysis and within-neighborhood analysis. © 2000 Academic Press

"A community is known by the schools it keeps."
Motto, Shaker Heights City School District

1. INTRODUCTION

How much is your local public school worth? It is well known that the quality of the local public school system is a crucial determinant of the demand for housing in a neighborhood. Any change in the perceived quality of the local public school system is likely to have an important impact on housing demand and therefore housing prices in an area.

The relation between school quality and house prices is especially salient when school district realignments are considered. One of the most

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important causes for realignment has been the ongoing attempt to racially integrate the public schools, with the well-known result of widespread busing of black and white students. Such policies have always been controversial, and there is ongoing activity in several cities aimed at continuing or undoing court-ordered or voluntary desegregation programs.

Another cause for realignment is a change in demographics, as the number of school children and their geographical distribution within a city vary over time. This paper investigates the impact on house prices of a school district realignment (including some school closures) that led to busing of some school children in a suburb characterized by neighborhood schools before the realignment.

One effect of redistricting may be that, by making it harder for parents to get involved, it harms the quality of schools. It also makes it more difficult for students to participate in after-school activities relative to the case where they can walk to and from the school. We refer to this as the "neighborhood schools effect" of redistricting. Because the neighborhood schools effect reduces the quality of the schools, it leads us to expect to find a negative relation between sales prices of houses and school redistricting.

A second effect of redistricting is to change the racial composition of the public schools. We refer to this as the "racial composition effect" of realignment. If people are racially prejudiced, they may be willing to pay less for a house in a racially integrated school district than in a segregated district. If people prefer integration, then they may be willing to pay more to live in an integrated district. Because both the racial composition and neighborhood schools effects are predicted to reduce the value of housing (in the case of segregationist preferences), it is important to distinguish between them when trying to understand the underlying reasons for a change in house values resulting from a school district realignment.

The third effect of redistricting in our sample is that bus service is introduced in areas that previously did not receive it. We call this the "transportation services effect" of busing. If the student now receives transportation while attending the same neighborhood school with the same racial composition, then presumably this service would lead to a higher value being placed on the house. (As far as we know, we are the first to estimate this effect.) However, if the school or racial composition is also changing, this effect might be difficult to identify. Our data include houses that underwent some combination of all three outcomes, and therefore allow us to identify all three effects of redistricting.[2]

[2] In other words, there are houses that remained in the same school district while the racial composition changed and bus service was not provided, houses that remained in the same school district while the racial composition changed and bus service was provided, and so on.

Researchers investigating the impact of school district realignment have found evidence that busing of students results in lower house values. Clotfelter [8] surveys the early work. Jud and Watts [17] argue that earlier estimates of the effect of racial composition are overstated because they did not adequately account for varying school district quality. Black [1] makes a similar point. Gill [12] analyzes year to year variation in the price differentials between suburban houses and city houses in an attempt to measure the timing of house price response to a court-ordered desegregation in the city. Colwell and Guntermann [9] measure the relation between house value and proximity to a school and use it to calculate the financial impact of closing a neighborhood school.

Previous research has typically focused on a large urban school district. For example, Clotfelter [7] examined Atlanta, Jud and Watts [17] studied Charlotte–Mecklenberg County, North Carolina, Gill [12] analyzed Columbus, Ohio, and Colwell and Guntermann [9] considered Lubbock, Texas. We investigate the effects of a school district realignment in a relatively wealthy and racially integrated suburb of Cleveland—Shaker Heights, Ohio—using a dataset consisting of house sales between 1983 and 1994. Our approach has several advantages over previous research. First, we examine reform in a school district widely acknowledged to be of high quality. This makes our work more applicable outside the important, but restricted, area of distressed urban school districts. Second, we are able to distinguish among the neighborhood schools, racial composition, and transportation services effect of redistricting. This enables us to be more precise about the determinants of the overall reaction of the housing market to a public school district realignment. Third, our data span several years before and after the reform, enabling us to control for unobservable heterogeneity among neighborhoods.

Our study has two limitations resulting from the nature of the data. The first limitation is that we are unable to estimate the effect of redistricting that involves schools of disparate quality, because all of the schools in Shaker Heights are of high quality.[3] The second limitation is that we have no information on the social and economic characteristics of the people residing in the houses, although we use tract-level data from the Census of Population and Housing to control for the racial composition of a neighborhood.

The paper proceeds as follows. Section 2 provides some background information on Shaker Heights and details the 1987 reform. Section 3 describes the econometric approach. Section 4 provides evidence of the

[3] We have standardized third grade reading test scores for each school for the years 1983–1989 which we use to test the robustness of our findings. See Black [1] on the importance of school quality.

effect of the reform on sales prices of houses in Shaker Heights. Section 5 contains concluding remarks.

2. SCHOOL DISTRICT REALIGNMENT IN SHAKER HEIGHTS

Shaker Heights is a city of 30,831 people (U.S. Census of Population and Housing, 1990) covering about seven square miles and located five miles east of downtown Cleveland. One of the earliest planned communities in the country, Shaker Heights was designed as a group of neighborhoods each centered around an elementary school.[4] The neighborhoods contain a housing stock ranging from relatively modest homes in the south and west, to larger houses in central Shaker, to mansions in the northern part of the city. Although the community was designed to include and does include a variety of socioeconomic groups, all students attend the same high school and all elementary schools are held to the same (high) standards.

Despite an early history of restrictive racial and religious covenants, Shaker Heights has been a leader since the 1950s in policies designed to promote and preserve racial integration.[5] Recent research [10, 11] suggests that affirmative marketing policies in Shaker Heights have resulted in greater integration of previously all-white areas and less racial change in integrated areas than would have occurred in the absence of such policies.

In the early 1980s, the school district faced both financial and racial balance problems. The total enrollment had fallen from a peak of 8079 students in 1966–1967 to 5301 by 1983–1984, a decline of 34%. This decline seems to reflect changing demographics—the end of the baby boom—rather than a systematic shift away from public schools to private schools.[6] The effect of the decrease in enrollment was that resources were strained as some schools remained near capacity and others were nearly empty. Further, the pattern of integration within the district was irregular, with some schools (especially Moreland) predominantly black and others (such as Fernway and Mercer) predominantly white.

As shown in Fig. 1, Shaker Heights borders some predominantly black neighborhoods in the city of Cleveland to its south and west. The largely black neighborhood of Moreland is in the southwest corner of Shaker Heights, as is the integrated neighborhood of Ludlow. Shaker Heights neighborhoods toward the north and east are progressively more affluent

[4] See Molyneaux and Sackman [19] or Haberman [13] for a history of Shaker Heights.

[5] See Keating [18, Chap. 6] for an overview.

[6] Using data on Shaker Heights from the U.S. Census, we find that the public school enrollment was 84% of total public and private school enrollment in 1979 and 81% in 1989. An alternative measure, enrollment reported by the Shaker Heights City School as a fraction of the population aged 5–17 reported by the Census was 89% in 1969, 89% in 1979, and 87% in 1989.

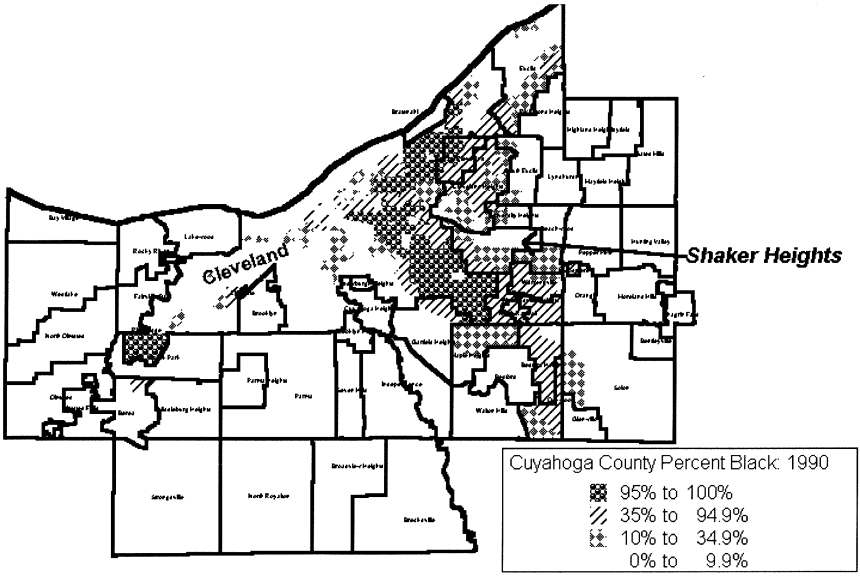

FIG. 1. Cuyahoga County percent black: 1990 by Transportation Analysis Zone 1990 Census data.

and the racial composition of the neighborhoods becomes predominantly white. The original neighborhoods—which were identified with the names of their elementary school districts—are shown in Fig. 2.[7]

In 1984, a citizen's committee advised the Shaker Heights City School District to close three schools (Moreland Elementary, Malvern Elementary, and Byron Junior High) in order to save money and promote greater racial balance. This proposal caused a great public outcry. In the end, Woodbury Junior High was closed, with all of the other schools remaining open.[8]

By 1987, enrollment in the district had fallen to 5013 and another set of reforms was proposed. This time, four elementary schools (Ludlow, Moreland, Malvern, and Sussex) were targeted for closing. The remaining five elementary schools would teach grades K–4, and Woodbury would be reopened to house all fifth and sixth graders. The plan became public in January 1987 and was approved by the school board on March 10, 1987.[9]

[7]The numbers under the neighborhood/school district names reflect the median sales price of houses in 1989, with 1 being the highest and 9 the lowest.

[8]See Sullivan [21] and Jordan [14, 15, 16].

[9]See Breckenridge [3, 4, 5].

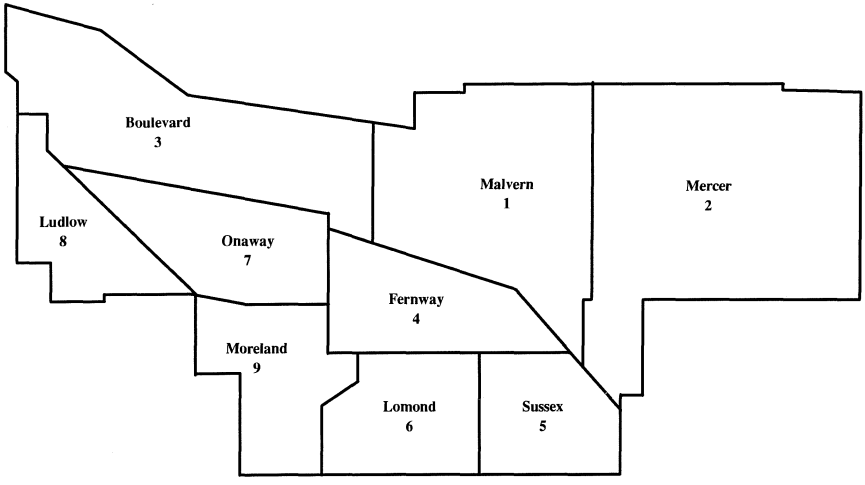

FIG. 2. Shaker Heights City School District pre-redistricting.

The reform necessitated some drastic shifts in boundaries. The new boundaries are shown in Fig. 3, with the old boundaries included to facilitate comparison.[10] There was a clear break in the 60-year adherence to the plan of neighborhood schools. The most dramatic case was that of students from the largely black neighborhood of Moreland who would be "airlifted"—in the words of one parent—from the southwest corner of the district to the Mercer school district in the northeast part of the city (a drive of about 10 minutes). Other changes were also significant: the Ludlow district was split between Boulevard and Onaway; the Sussex district and a section of Fernway were redistricted to less affluent Lomond; and the formerly compact Onaway district now meandered from the western border of the city to the affluent Malvern area in the east-central part of the city.

In general, the redistricting disrupted many previously coherent neighborhood schools. Not all schools were disrupted, however. Students in Boulevard, Mercer, and most of Fernway remained in their original district.[11] The plan also resulted in the desired racial balance in the elementary schools, as shown in Table 1. While in the 1986–1987 school

[10] The numbers in parentheses indicate the neighborhoods from which students in the elementary schools are drawn after 1987. For example, the Mercer schools now include students from the Mercer (2), Sussex (5), and Moreland (9) neighborhoods.

[11] Because the composition of the schools changed, it is possible that the "neighborhood" school is viewed differently even by those people who did not change districts. We do not have data that allow us to identify such a result, however.

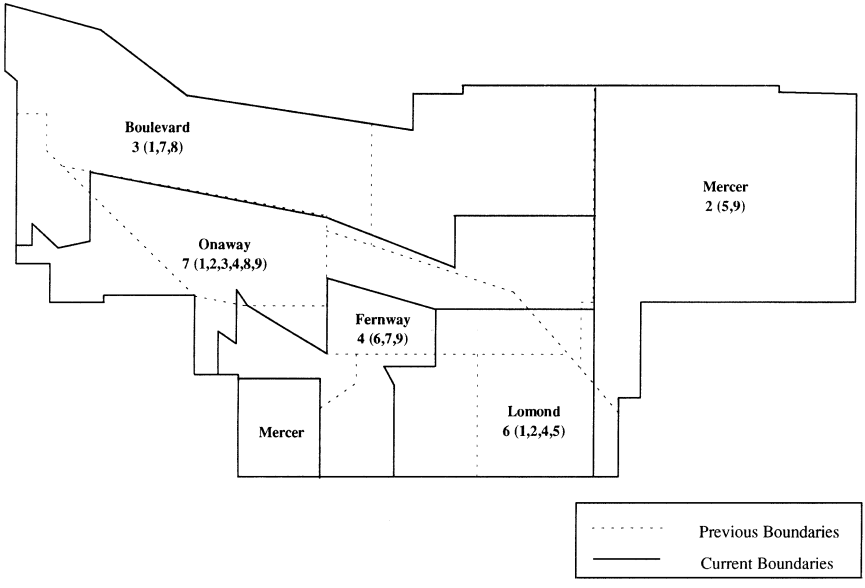

FIG. 3. Shaker Heights City School district post-redistricting.

year the percent nonwhite in the elementary schools ranged from 23% in Fernway to 87% in Moreland, the percent nonwhite in 1987–1988 was in the 42 to 51% range for all of the schools. The school district also began providing bus transportation for students who remained in their original districts but had previously walked relatively long distances. Students who lived relatively close to their schools, however, continued to walk.

In sum, this redistricting provides quasi-experimental variation to identify the different effects of the policy on the housing market. Some neighborhoods had their schools redistricted, but not all. Significant variation in racial composition of schools existed both across schools prior to redistricting and over time in the same school as a result of the redistricting. Finally, bus transportation was introduced for many students but some students continued to walk to school. And all of these changes occurred in a relatively homogeneous educational setting.

3. ESTIMATING THE EFFECTS OF REFORM

Throughout the debate on redistricting, one of the concerns expressed by residents of Shaker Heights was the impact of school closing on property values.[12] We use a unique dataset to investigate the effects. It

[12] See Jordan [16], Sullivan [21], and Breckenridge [4].

TABLE 1
School Percent Nonwhite

Year → School district ↓	1983–1984	1984–1985	1985–1986	1986–1987	1987–1988	1988–1989
Boulevard	34.5	42.0	35.7	39.6	49.8	52.8
Fernway	23.4	21.6	25.2	22.6	48.2	45.8
Lomond	55.4	56.7	54.9	57.2	42.0	43.6
Mercer	26.8	27.9	28.3	27.9	45.0	45.0
Onaway	34.3	37.1	35.1	31.7	51.4	52.4
Ludlow	53.0	54.6	62.4	65.1		
Malvern	27.7	29.2	26.1	23.6		
Moreland	79.2	84.4	84.9	86.9		
Sussex	41.0	42.1	42.9	44.6		

Year → School district ↓	1989–1990	1990–1991	1991–1992	1992–1993	1993–1994	1994–1995
Boulevard	50.5	49.7	53.5	57.0	58.3	63.0
Fernway	51.6	54.8	57.2	59.9	63.3	59.0
Lomond	41.4	44.4	46.7	45.6	52.4	54.7
Mercer	46.9	50.0	48.3	51.8	50.9	52.7
Onaway	50.0	49.6	48.7	46.3	46.1	52.7

Source: Shaker Heights City School District.
Note. Ludlow, Malvern, Moreland, and Sussex schools were closed in 1987.

includes all arms-length purchases (4463) of single-family homes in Shaker Heights for the years 1983 through 1994.[13] There are detailed physical characteristics for each house; descriptive statistics for the variables used in the analysis are found in Table 3. We control for both physical characteristics and neighborhood characteristics in order to focus on the effects of the following variables: whether the house remained in its original (neighborhood) school district or not, whether a student living in the house would ride the bus or not, and the racial composition of the school district the house is in.

We use a standard model of an intrametropolitan housing market to motivate our regression analysis [6]. Households are assumed to be mobile among a fixed set of neighborhoods, each of which has a fixed amount of land and a fixed housing stock. Because Shaker Heights is completely built out, this assumption is innocuous. Households derive utility from consuming housing (H), amenities associated with locating in a neighborhood (A),

[13] Thomas Bier at Cleveland State University has invested a great deal of time and effort in checking the accuracy of these data, and we are extremely grateful to him for providing them to us.

and a composite good (X). If it is assumed that housing is supplied inelastically, capital and X are in elastic supply from a national market, and production and utility functions are convex, then the price of housing can be written as a function of household income and amenities. If we let P_j be the price of housing in neighborhood j, then the following relation holds true: $dP_j/dA_j > 0$. It is this relationship between the house price and the local amenities that we will estimate. In particular, we will analyze the effect of changing the elementary school from a neighborhood school to another school (a reduction in A_j), and we will analyze the effect of instituting transportation service to the neighborhood school (an increase in A_j).[14]

Our approach has several advantages over previous research on the link between school reform and house values. First, we are confident that the schools in the district are of similar quality.[15] As a matter of public policy, all elementary schools are held to the same standards and receive inputs appropriate to do so. This includes, among other things, rotating teachers among the schools in the district. Further, all students attend the same high school, and the school district's overall high quality has been widely acknowledged.[16] Second, we have a detailed list of housing characteristics, reducing the effects of unobserved heterogeneity among houses.

Third, we are able to distinguish between the three effects of busing on house values introduced in the first section. The racial composition effect is identified because the racial composition does not change much in some schools, but changes substantially in others. The neighborhood schools effect is identified because some houses do not change district, while others do. The transportation services effect is identified because some houses that do not change district nevertheless benefit from the addition of bus service.

Hedonic Analysis of Pooled Data

Our main econometric approach is to estimate a hedonic price equation using individual transaction prices of houses as the dependent variable and school, neighborhood, and physical characteristics as independent vari-

[14] We also estimate the racial composition effect, although our results from Shaker Heights are unlikely to be representative because of the 40-year history of pro-integrative efforts in the city.

[15] See Jud and Watts [17] or Black [1] on the importance of this point.

[16] Whelan [22] cites such accomplishments as Shaker High being ranked among the top dozen (of 16,000 nationwide) by *Money* in 1981 and one of the top 15 by *Parade* in 1984. We include test scores as a measure of school quality for the years 1983–1989 in order to test the robustness of our conclusions.

ables. In general, hedonic models focus on markets in which a generic commodity can embody varying amounts of a vector of attributes. As a practical matter in applied studies, the price equation is typically estimated by ordinary least squares, with the supply of attributes and the tastes of consumers assumed exogenous. This is the approach taken here.

Our preferred approach is to use a difference-in-difference regression to estimate the impact of losing a neighborhood school on house value.[17] It is possible to separate the houses into two different groups: houses that do not lose their neighborhood schools as a result of redistricting and houses that do. It is also possible to separate the sales into those that happened before the redistricting and those that happened after. The idea of a difference-in-difference regression is to identify a control group and a treatment group, and compare the experience of the two groups. The control group in this case consists of houses that stay in the same school district, while the treatment group consists of houses that change districts.

To implement the difference-in-difference estimator, we create three dummy variables. The first dummy variable, *School District Change*, equals 1 if the house is in a part of Shaker Heights that lost its neighborhood school after 1987, and equals 0 otherwise. The second dummy variable, *Sale in* 1987 *or Later*, equals 1 if the house sold in 1987 or later, and 0 otherwise. The third dummy variable, and the focus of our attention, is the product of the other two dummy variables. The third variable is called *School District Change and Sale in* 1987 *or Later*. The coefficient on this variable is our estimate of the neighborhood schools effect.

In order to control for other differences among houses, we include a set of variables that summarize the physical characteristics of the house. These characteristics include the lot size, age, average room size, living area, number of plumbing fixtures, the construction grade of the house, and the current condition of the house. We also include observable characteristics of the neighborhood and school district, including whether the street has heavy traffic, the percent nonwhite in the census tract in 1980 and 1990, and the percent nonwhite in the school.

Because our sales take place over a 12-year period, there is inflation over time. We deflate the sales prices of the houses using a repeat-sales annual housing price index (shown in Table 2).

Let V represent the sales price of the house deflated by the price index, X the matrix of physical and neighborhood characteristics of the house, and Z the dummy variables indicating whether the house was sold before or after 1987 and whether the house was in a part of Shaker Heights that

[17] We are grateful to a referee for suggesting this interpretation of our work.

TABLE 2
Housing Price Index

Year	Index
1983	1.451
1984	1.539
1985	1.559
1986	1.668
1987	1.742
1988	1.844
1989	1.919
1990	2.004
1991	2.173
1992	2.099
1993	2.131
1994	2.288

Note. index calculated using repeat sales of houses in Shaker Heights. Base year is 1976 (index = 1 for 1976).

was redistricted. Then the regression that we estimate using ordinary least squares (OLS) is shown as Eq. (1). The variable we are most concerned with is α, which indicates the impact on house price of losing the neighborhood school:

$$\ln(V) = X\beta + Z\gamma + \alpha^{*}\ \textit{School District Change and Sale in } 1987 \textit{ or Later} + \varepsilon. \quad (1)$$

While our main results are obtained using the difference-in-difference estimator, we use a variety of alternative specifications to investigate the robustness of our findings. First, we estimate a pooled cross-section regression that includes dummy variables for the various neighborhoods within Shaker Heights, year dummy variables, and third grade reading test scores (a measure of school quality). This approach is similar to the difference-in-difference approach, but estimates a transportation services effect for those houses that remained within the same school district as well as a neighborhood schools effect. We create a dummy variable, *Bus & No District Change*, that equals 1 if the house receives bus service after 1987 and remains in the same district, and 0 otherwise. There is also a dummy variable, *Bus & District Change*, that equals 1 if the house receives bus service after 1987 and changes district, and 0 otherwise. The

omitted option is *No Bus & No District Change*, which covers the remaining houses in Shaker Heights.[18]

As before, let V represent the sales price of the house deflated by the price index and X the matrix of physical and neighborhood characteristics of the house. Unlike the difference-in-difference specification, we now include in Z dummy variables indicating which year the house was sold and the neighborhood in which the house is located.[19] Then the regression that we estimate using OLS is shown as Eq. (2). The variable we are most concerned with is α, which indicates the impact on house price of losing the neighborhood school. We also pay attention to the estimate of χ, the transportation services effect:

$$\ln(V) = X\beta + Z\gamma + \alpha^{*}\, Bus\ \&\ District\ Change + \chi^{*}\, Bus\ \&\ No\ District\ Change + \varepsilon. \quad (2)$$

One of the requirements for consistent estimation of a hedonic regression is that the coefficients remain constant over the entire sample. Because of the disruption to the market caused by the redistricting, we do not necessarily expect this condition to hold for the entire sample period. Therefore, we also estimate Eq. (2) splitting the sample into before and after redistricting periods (1983–1986 and 1987–1994) as well as separate regressions for each year. To anticipate, we find that the coefficients on the physical characteristics of the house do not change over the entire time period, so that the principal influence of any changes in house prices is captured by the variables that directly measure the policy innovations.[20]

Oaxaca Decomposition—Change within a Neighborhood

One criticism of the hedonic approach is that it does not sufficiently account for unobserved differences among neighborhoods. This is especially important when evaluating a policy innovation such as eliminating neighborhood schools in some places. After all, before 1987, the neighbor-

[18] It is also possible that a house could change districts, but the new school would be close enough to the house that no bus service would be required (*No Bus & District Change*). There were six observations where this occurred, which was too few to include in the analysis, so they were dropped.

[19] Because the price index varies annually, we could use the year dummies alone to control for inflation rather than deflating the sales price. Doing so would alter the variance of the dependent variable relative to the difference-in-difference approach, making comparison of R^2 across the approaches less straightforward. There is no effect on the parameter estimates or standard errors of using the deflated sales prices, so we continue to use them.

[20] We reject the hypothesis of equality at the 5% significance level for the years 1984 and 1989 as described in detail below. Reestimating the regression omitting those years does not change our conclusions with respect to the effect of redistricting on house prices.

hood and the school district were identical, making it impossible to estimate the pre-1987 variation in house prices due to the school alone.

This concern leads us to use an alternative econometric approach that uses within-neighborhood variation in school district after 1987 to identify the effect of the school district on house values. The approach is a statistical implementation of the following thought experiment: take a house in one school district and move it across the street into the other school district while keeping the house in the same neighborhood. The physical characteristics and neighborhood characteristics of the house remain the same, so that any change in the value of the house must result solely from the change in the school district.

The econometric approach we use was originally developed by Oaxaca [20] to study male–female wage differences. He decomposed the difference in the mean wage of males and the mean wage of females into a part explained by observable characteristics and a residual based on unobservable characteristics. In his work, the residual component was assumed to reflect labor market discrimination.

We apply Oaxaca's approach in the following way.[21] First, we identify neighborhoods where there are sufficient observations in both the neighborhood school and another school to estimate hedonic regressions using the observable characteristics of the house. Second, we estimate regressions for the sales in the different parts of the neighborhood. Third, we apply the coefficients from the regression in one part of the neighborhood to the mean house in the other part of the neighborhood, giving us a difference in the means due to observable differences in physical characteristics. The remaining difference we attribute to the effects of changing from the neighborhood school to another school. This gives us two alternate estimates (one using each of the two regressions within the neighborhood) of the neighborhood schools effect estimated by the *School District Change and Sale in* 1987 *or Later* variable in the difference-in-difference specification and the *Bus & District Change* variable in the pooled hedonic regression specification. We compare the implied change in the value of a house with that found using the other approaches in order to investigate the robustness of the earlier results.

Formally, let V_j and V_k represent the sales price of a house in school district j and school district k, respectively, where the houses are in the same neighborhood. Let X_j and X_k represent the observed characteristics

[21] The description of this approach is based on Bogart and Cromwell [2], who apply it to estimating the effect of school districts of different quality on house prices. Black [1] also focuses on the boundaries between school attendance districts in identifying the effect of schools on house prices.

of each house. We estimate the following regressions using OLS. Note that the same set of right-hand-side variables is used in each of the two regressions:

$$\begin{aligned} \ln(V_j) &= X_j \beta_j + \varepsilon_j \\ \ln(V_k) &= X_k \beta_k + \varepsilon_k . \end{aligned} \tag{3}$$

If we let $\mathbf{V_j}$ and $\mathbf{V_k}$ represent the geometric means of V_j and V_k, $\mathbf{X_j}$ and $\mathbf{X_k}$ the means of X_j and X_k, and $\mathbf{b_j}$ and $\mathbf{b_k}$ the estimates of β_j and β_k, then, from the properties of OLS estimation, it must be the case that $\ln(\mathbf{V_j}) = \mathbf{X_j}\,\mathbf{b_j}$ and $\ln(\mathbf{V_k}) = \mathbf{X_k}\,\mathbf{b_k}$.

Now consider the following decomposition of the difference between $\ln(\mathbf{V_j})$ and $\ln(\mathbf{V_k})$. Let $\Delta\mathbf{X}$ be defined to equal $\mathbf{X_j} - \mathbf{X_k}$ and let $\Delta\mathbf{b}$ be defined to equal $\mathbf{b_k} - \mathbf{b_j}$. Then we can write the following equation:

$$\ln(\mathbf{V_j}) - \ln(\mathbf{V_k}) = \mathbf{X_j b_j} - \mathbf{X_k b_k} = \Delta\mathbf{X b_k} - \Delta\mathbf{b X_j} = \Delta\mathbf{X b_j} - \Delta\mathbf{b X_k}. \tag{4}$$

Equation (4) shows two alternative ways of expressing the idea that the difference in the mean house value across school districts has two parts: first, a part due to differences in observable characteristics ($\Delta\mathbf{X b_k}$ or $\Delta\mathbf{X b_j}$) and, second, a residual part that we attribute to the value of a neighborhood school ($\Delta\mathbf{b X_j}$ or $\Delta\mathbf{b X_k}$).

We also apply this approach to studying the effect of instituting bus service in one part of a school district but not in the other part of a school district. In this case, the unobservable characteristic is the value of bus services rather than the benefit of having a neighborhood school. Applying the decomposition technique provides an alternate estimate of the transportation services effect of school district realignment.

Repeat-Sales Analysis

As we have already noted, a criticism of the hedonic approach is that it does not sufficiently account for unobserved physical and neighborhood characteristics. A well-known alternative to pooling the data is to estimate regressions using only those observations where the house sells more than once. We use a variation of the so-called "repeat-sales" approach to provide yet another estimate of the neighborhood schools and transportation services effects. (Our approach is a variation on that described in Yinger et al. [23].)

We focus on houses that sold twice—once before 1987 and the second time after 1987, and whose physical characteristics did not change. These houses have the same physical characteristics and are located in the same neighborhood during both sales. The only differences are that the house

might be in a different school district, bus service might have been instituted, the racial composition of the school might have changed, and the reading test scores (school quality) might have changed. Our basic regression is as follows, where i indicates the house, t indicates the year of the second sale (between 1987 and 1994), and τ indicates the year of the first sale (between 1983 and 1986):

$$\begin{aligned}\ln(Price_{it}) - \ln(Price_{i\tau}) &= \alpha_t YEAR_t - \alpha_\tau YEAR_\tau + \beta_t School\ Nonwhite\ \%_{it} \\ &\quad - \beta_\tau School\ Nonwhite\ \%_{i\tau} + \delta_{it} Reading\ Score\ \%_{it} \\ &\quad - \delta_{i\tau} Reading\ Score\ \%_{i\tau} + \phi\ Bus\ \&\ No\ District\ Change \\ &\quad + \gamma\ Bus\ \&\ District\ Change + \varepsilon_{it} - \varepsilon_{i\tau}. \qquad (5)\end{aligned}$$

Equation (5) is estimated using several alternative samples of repeat sales to check the robustness of the results. The first sample includes all repeat sales where the first sale occurred between 1983 and 1986 and the second sale between 1987 and 1994. The second sample is the same as the first with the exception that sales that occurred in 1987 are omitted. (Because reading scores are available only for the years 1983 to 1989, they are not included in these first two regressions.) The third sample only includes second sales that occurred between 1987 and 1989, in order to investigate whether school quality as measured by test scores affects the results. The fourth sample is the same as the third sample except that sales that occurred in 1987 are excluded from the analysis.

The coefficients on the variables *Bus & No District Change* and *Bus & District Change* provide estimates of the transportation services effect and neighborhood schools effect, respectively. The coefficients on *School Nonwhite %* give a set of annual estimates of the racial composition effect. Finally, the coefficients on *Reading Score %* yield a set of estimates of the effect of school quality on house prices.

4. THE EFFECTS OF REFORM: EVIDENCE FROM HOUSE PRICES

The results of estimating the difference-in-difference specification are reported in Table 4. Hedonic regression results using a pooled cross-section are reported in Table 5. Tables 6 through 8 report summaries of the findings for the Oaxaca decomposition and the repeat-sales regression approaches. The main findings with respect to the effects of the redistricting are discussed below, as is the test for the assumption that data from several years can be pooled together to analyze the housing market.

TABLE 3
Summary Statistics

Variable (continuous)	Mean	Standard deviation
ln (house price/index)	10.970	0.466
Average room size/100	2.867	0.611
ln (living area)	7.742	0.287
ln (age of house)	3.944	0.293
Plumbing fixtures	10.241	2.771
ln (lot size)	8.977	0.354
Third grade reading test scores	62.627	6.157
% Nonwhite in school	0.468	0.116
% Nonwhite in tract 1980	0.268	0.218
% Nonwhite in tract 1990	0.338	0.239

Variable (0 − 1)	Observations = 1
Bad or fair condition	752
Good condition	1805
Excellent condition	368
Construction grade AA or A +	543
Construction grade A	256
Construction grade B +	2262
Construction grade B or C or D	1014
Lomond	1007
Ludlow	65
Malvern	45
Moreland	301
Sussex	660
Fernway	701
Mercer	1065
Onaway	423
Boulevard	196
Year of sale 1983	348
Year of sale 1984	370
Year of sale 1985	386
Year of sale 1986	444
Year of sale 1987	396
Year of sale 1988	379
Year of sale 1989	347
Year of sale 1990	340
Year of sale 1991	330
Year of sale 1992	341
Year of sale 1993	382
Year of sale 1994	400
School district change *and* sale in 1987 or later	1012
Bus & district change	1012
Bus & no district change	509
Heavy traffic	232

Note. 4463 total observations except for third grade reading test scores, for which there are 2670 total observations.

TABLE 4
Regression Results—Difference-in-Difference Estimator

Variable	Coefficient (standard error)
School district change	0.050 (0.016)
Sale in 1987 or later	0.062 (0.013)
School district change *and* sale in 1987 or later	−0.104 (0.019)
% Nonwhite in school	−0.051 (0.044)
ln (lot size)	0.223 (0.018)
ln (living area)	0.317 (0.026)
Construction grade AA or A +	0.193 (0.016)
Construction grade A	0.097 (0.019)
Construction grade B or C or D	0.026 (0.010)
ln (age of house)	−0.079 (0.017)
Bad or fair condition	−0.083 (0.012)
Excellent condition	0.089 (0.018)
Average room size	0.080 (0.009)
Plumbing fixtures	0.017 (0.002)
Heavy traffic	−0.220 (0.020)
% Nonwhite in tract 1980	1.329 (0.271)
% Nonwhite in tract 1990	−1.758 (0.257)
Intercept	6.632(0.228)
Adjusted R^2	0.65
Observations	4463
Dependent variable mean	10.97

Note. Estimated impact of redistricting is the coefficient of "school district *and* sale in 1987 or later." Omitted dummy variables are normal condition and construction grade B + . Dependent variable is the log of house price deflated by the housing price index (see Table 2).

Neighborhood Schools Effect

Our preferred approach to estimating the neighborhood schools effect is to use the difference-in-difference regression reported in Table 4. The neighborhood schools effect is represented by the coefficient on the variable *School District Change and Sale in* 1987 *or Later*. This variable is negative and statistically significant, indicating that the loss of a neighborhood school reduces house value, all else being equal. The magnitude of the effect is substantial, with an estimated reduction in the house price of 9.9% (calculated as $1 - e^{-0.104}$, where -0.104 is the coefficient on the variable). Evaluating this at the mean house value of $58,090, this implies redistricting reduced the value of the average house by $5738. The remainder of this subsection investigates how robust this finding is to alternative regression specifications.

In the pooled cross-section hedonic regression, the neighborhood schools effect is captured by the variable *Bus & District Change*. This variable is

TABLE 5
Regression Results—1983–1994, 1983–1989

Year → Variable ↓	1983–1994	1983–1989 (without test scores)	1983–1989 (with test scores)
Bus & district change	−0.072 (0.014)	−0.064 (0.021)	−0.064 (0.021)
Bus & no district change	0.026 (0.018)	0.039 (0.026)	0.040 (0.026)
% Nonwhite in school	0.245 (0.048)	0.117 (0.064)	0.055 (0.069)
Third grade reading test scores	—	—	−0.003 (0.001)
ln (lot size)	0.284 (0.019)	0.251 (0.023)	0.252 (0.023)
ln (living area)	0.299 (0.025)	0.321 (0.033)	0.321 (0.033)
Construction grade AA or A +	0.195 (0.015)	0.193 (0.020)	0.191 (0.020)
Construction grade A	0.103 (0.018)	0.119 (0.023)	0.119 (0.023)
Construction grade B or C or D	0.004 (0.010)	0.002 (0.013)	0.002 (0.013)
ln (age of house)	−0.050 (0.018)	−0.057 (0.022)	−0.056 (0.022)
Bad or fair condition	−0.062 (0.012)	−0.063 (0.015)	−0.063 (0.015)
Excellent condition	0.086 (0.018)	0.098 (0.023)	0.098 (0.023)
Average room size	0.052 (0.009)	0.038 (0.012)	0.038 (0.012)
Plumbing fixtures	0.012 (0.002)	0.011 (0.003)	0.011 (0.003)
Heavy traffic	−0.216 (0.019)	−0.200 (0.024)	−0.201 (0.024)
% Nonwhite in tract 1980	4.893 (0.444)	4.982 (0.570)	5.002 (0.570)
% Nonwhite in tract 1990	−4.939 (0.419)	−5.009 (0.538)	−5.031 (0.538)
Ludlow	0.009 (0.041)	0.068 (0.051)	0.096 (0.052)
Malvern	−0.107 (0.052)	−0.066 (0.069)	−0.069 (0.069)
Moreland	−0.174 (0.032)	−0.081 (0.043)	−0.084 (0.043)
Sussex	0.278 (0.025)	0.308 (0.031)	0.292 (0.032)
Fernway	0.257 (0.023)	0.278 (0.029)	0.271 (0.030)
Lomond	0.128 (0.024)	0.170 (0.032)	0.161 (0.032)
Mercer	0.015 (0.033)	0.059 (0.042)	0.043 (0.043)
Onaway	0.070 (0.026)	0.108 (0.034)	0.107 (0.034)
Intercept	6.157 (0.232)	6.371 (0.293)	6.614 (0.308)
Adjusted R^2	0.69	0.67	0.67
Observations	4463	2670	2670
Dependent variable mean	10.97	10.97	10.97

Note. Standard errors in parentheses. Regressions also included year dummies that are not reported. Omitted dummy variables are normal condition, construction grade B + , and Boulevard. Dependent variable is the log of house price deflated by the housing price index (see Table 2). Reading scores available for 1983–1989 only.

negative and statistically significant, as reported in the first column of Table 5. The loss of the neighborhood school is predicted to reduce the value of the house by about 6.9%, or $4060 at the mean house price.

The result is robust to including reading test scores as a measure of school quality. The second and third columns of Table 5 present the results of estimating the pooled cross-section hedonic regression for the years 1983–1989, when the school test scores are available. The second column includes the same variables as the first column, only for the

TABLE 6
Within Neighborhood Estimates of Neighborhood Schools Effect, Lomond Neighborhood (1987–1994)

Difference in mean house value	$6,545
Percent of difference due to district change	52.9%–59.1%
Effect of district change on mean house value (decrease)	$3462–$3868
Dummy variable estimate of effect of district change	$3779
Number of observations (662 total sales)	476—same district 186—change district

Note. Percent of difference due to district change equals 100% minus the percent explained by differences in observable characteristics. Included characteristics are *heavy traffic*, *ln*(*frontage*), *ln*(*living area*), *ln*(*lot size*), *ln*(*age of house*), *average room size*, *plumbing fixtures*, *attached garage*, *finished attic*, *construction grade AA/A +* , *construction grade A*, *construction grade B or C or D*, *bad or fair condition*, *excellent condition*, and a set of year dummies. Regressions estimated using data from 1987 to 1994. Complete regression results available on request.

smaller set of years. The third column adds the reading test scores to the list of variables. The point estimate of the neighborhood effect coefficient is slightly smaller than for the period 1983–1994, but the estimated reduction of mean house values is $3621, only slightly less than found using the entire sample.

In order to further investigate how robust are results are, we focus especially on the possibility that neighborhood characteristics are not completely accounted for by the hedonic approach. We begin by estimat-

TABLE 7
Within Neighborhood Estimates of Transportation Services Effect, Mercer Neighborhood (1987–1994)

Difference in mean house value	$11,437
Percent of difference due to bus service	52.6%–59.7%
Effect of bus service on mean house value (increase)	$6013–$6825
Dummy variable estimate of effect of district change	$5010
Number of observations (703 total sales)	473—do not get bus service 230—get bus service

Note. Percent of difference due to district change equals 100 minus the percent explained by differences in observable characteristics. Included characteristics are *heavy traffic*, *ln*(*frontage*), *ln*(*living area*), *ln*(*lot size*), *ln*(*age of house*), *average room size*, *plumbing fixtures*, *attached garage*, *finished attic*, *construction grade AA/A +* , *construction grade A*, *construction grade B or C or D*, *bad or fair condition*, *excellent condition*, and a set of year dummies. Regressions estimated using data from 1987 to 1994. Complete regression results available on request.

TABLE 8
Neighborhood Schools Effect and Transportation Services Effect, Repeat Sales Only

Sample	Observations	Neighborhood schools effect at mean value	Transportation services effect at mean value
1983–1994 (including 1987)	634	−$7593	$16,024
1983–1994 (excluding 1987)	539	−$7003	$16,562
1983–1989 (including 1987)	290	−$7377	$9745
1983–1989 (excluding 1987)	195	−$7396	$11,534

Note. Only repeat sales where the first sale was before 1987 and the second sale was in 1987 or after are includes in the analysis. All regressions include the percent nonwhite in the school; regressions for 1983–1989 also include third grade reading test scores.

ing the effect of disrupting the neighborhood school using the Oaxaca decomposition described earlier.

We analyze the Lomond neighborhood, where there were enough observations of both houses that changed districts and houses that remained in the Lomond schools to make estimation feasible. The results of using this approach are summarized in Table 6. The difference in the (geometric) mean value of houses that remained in the Lomond school district and those that were transferred to another district is $6545. Between 40.9% and 47.1% of the difference is explained by observable physical and neighborhood characteristics.[22] Thus, the difference in value attributable to the change in school district is between 52.9% and 59.1% of $6545, or between $3462 and $3868. This number is only slightly smaller than that found using the entire city over the period 1983–1994.[23]

Another check of robustness is also reported in Table 6. A hedonic regression as in Table 5 was performed using data on the Lomond neighborhood only. A dummy variable was included to indicate whether the school district changed after 1987. Evaluating the effect of this variable at the mean house value, the estimated effect of changing schools was found to be $3779. This number is within the range estimated using the decomposition technique (it does not have to be—see Bogart and Cromwell

[22] Recall that there are two different regressions used, so that two different estimates are obtained. In the terms of the thought experiment described earlier, this is like saying you can move the house in either direction across the district boundary.

[23] We also estimated the regressions omitting the 1987 observations. We found an estimated neighborhood schools effect of between $2307 and $3384, or not very different from the results including 1987.

[2] and the results in the next section) and again is quite similar to the result found using the entire sample.

The final robustness check was to use a sample of only those houses that sold twice, once before and once after the redistricting. This approach allows us to focus on changes in the observable neighborhood characteristics by holding the physical characteristics and geographical location of the house constant. We estimated four variations of this approach, and the results are reported in Table 8.

The first regression included all repeat sales from 1983–1994 where the first sale was before 1987 and the second sale in 1987 or after. The observable characteristics that (could) change were the percent nonwhite in the school and the school district itself. Evaluating the coefficient on *Bus & District Change* at the mean value of the houses in the sample implied a reduction in house value of $7593. This is larger than the change found using the other methods, suggesting that neighborhood effects were not perfectly controlled, even in the within-neighborhood estimation procedure.

The second regression included all repeat sales from 1983–1994 where the first sale occurred before 1987 and the second sale after 1987 (so sales in 1987 were excluded). The results were quite similar to those found including 1987, with an estimated effect at the mean of −$7003.

The third regression included repeat sales from 1983–1989 that straddle 1987. This specification allowed us to include data on third grade reading test scores as a measure of school quality. There was little impact on the estimated effect of losing a neighborhood school, however. The estimated effect at the mean was −$7377, almost identical to the effect found using the entire period and not accounting for test scores.

The fourth and final regression again used 1983–1989 but excluded 1987 sales. The result was again similar, with an estimated effect of −$7396 at the mean.

Transportation Services Effect

The transportation services effect is captured in the pooled cross-section hedonic regression by the variable *Bus & No District Change*. This variable identifies those houses for which the school remained the same but which were now eligible to receive bus service to and from the school. The regression coefficient using the entire sample is reported in the first column of Table 5. The estimated impact of instituting bus service, all else being equal, is to increase the mean house value by about 2.6%, or $1502 at the mean house value.

As with the neighborhood schools effect, we undertook a variety of tests on the robustness of our result. The first test was to include reading test scores and restrict the time period to 1983–1989. The result of this

specification is found in the second column of Table 5, an estimated impact on the mean house value of $2370.

The results of estimating within-neighborhood regressions are found in Table 7. Between 52.6% and 59.7% of the $11,437 difference in the mean value of houses in the two parts of the Mercer neighborhood is attributed to the institution of bus services. Thus, instituting bus service is estimated to increase the value of the average house by between $6013 and $6825. This number is larger than that found using the hedonic approach reported in Table 5, which suggests that the neighborhood controls were not accounting for all unobserved characteristics. (The mean house value in Mercer is larger than the mean for Shaker Heights as a whole, which would tend to increase the point estimate.) This explanation is reinforced by the results of estimating a hedonic regression on the Mercer neighborhood including a dummy variable indicating whether or not bus services were provided to the house. The effect of this variable at the mean was to increase house prices by $5010, intermediate between the results including the entire city and the results using the two different parts of the Mercer neighborhood.[24]

As was the case with the neighborhood schools effect, repeat-sales analysis (reported in Table 8) yields estimated effects of the policy interventions that are large relative to the results obtained via the other regression methods. When the entire period from 1983–1994 is included, the impact of providing bus service is estimated to be between $16024 and $16562 at the mean, depending on whether 1987 is included or excluded from the analysis. Restricting the sample period to 1983–1989 and including reading test scores reduces the estimated impact substantially, to a range of $9745 to $11,334 depending on whether 1987 is included or excluded. Coupled with the decomposition results, these results suggest that unobserved heterogeneity among neighborhoods is important. However, the main conclusions of the hedonic analysis are robust to these alternative specifications.

Tests of Pooling Assumptions

Because we are pooling observations from a period of over a decade, it is possible that the coefficients on the physical characteristics of the houses could have changed during that time. If that were the case, then it would be inappropriate to pool observations from the various years. We tested the hypothesis that the coefficients on the physical characteristics of the house (including whether the street had heavy traffic) remained the same for the entire time period by estimating separate regressions for

[24] Regressions omitting 1987 were also estimated, and the transportation services effect was found to be between $4578 and $5865.

TABLE 9
Hypothesis Test: Coefficients on Physical Characteristics Equal across Years

Years	F statistic (degrees of freedom)	P Value
1983–1986	1.661 (11,1522)	0.08
1987–1994	0.854 (11,2883)	0.59
1983–1989	0.449 (11,2638)	0.93
1983	0.860 (11,325)	0.58
1984	*2.588 (11,347)*	*0.004*
1985	0.829 (11,363)	0.61
1986	1.288 (11,421)	0.23
1987	1.716 (11,371)	0.07
1988	0.852 (11,354)	0.59
1989	*3.011 (11,322)*	*0.001*
1990	0.763 (11,315)	0.68
1991	1.338 (11,305)	0.20
1992	1.265 (11,316)	0.24
1993	0.608 (11,357)	0.82
1994	0.810 (11,375)	0.63

Note. The test is whether the coefficients on the following list of variables are equal to those estimated using the entire sample 1983–1994: *ln*(*lot size*), *ln*(*living area*), *construction grade AA or A +* , *construction grade A*, *construction grade B or C or D*, *ln*(*age of house*), *bad or fair condition*, *excellent condition*, *average room size*, *plumbing fixtures*, *heavy traffic*. The higher the P value, the less probable it is that the null hypothesis of equality of the coefficients can be rejected. Years for which the null hypothesis of pooling is rejected at the 5% significance level are shown in *italics*.

1983–1986, 1987–1994, 1983–1989, and for each of the years 1983 through 1994. We then performed an F test on the hypothesis that the coefficients were the same as those estimated using the entire set of sales between 1983 and 1994.

The results of these tests are presented in Table 9. In most of the cases, we fail to reject the hypothesis that the coefficients are equal, which means that our approach of pooling the various years is appropriate. There are some exceptions, though. The null hypothesis of pooling is strongly rejected for the years 1984 and 1989. In 1984, as described earlier, there was significant uncertainty about the school district, so the inequality of the coefficients is easy to understand. There is not as clear an explanation for 1989.

We also reject the null hypothesis at the 10% significance level for the period 1983–1986 and the year 1987. The 1983–1986 result is explained by the 1984 result, while 1987 was again a year of tremendous upheaval—the focus of this paper—and thus a year where the housing market might be expected to systematically differ. In order to investigate the robustness of our results, we reestimated our regressions omitting the years 1984, 1987,

and 1989. There were no qualitative changes in the results as a result. (Complete regression results are available upon request.) Recall that we also estimated the within-neighborhood regressions and the repeat-sales regressions both including and excluding sales during 1987, with minimal effect on the findings.

Racial Composition Effect

The coefficient on the variable *School Nonwhite %* in the various regressions is a measure of the racial composition effect. In our main (difference-in-difference) specification, the coefficient is negative, which is consistent with racial prejudice against nonwhite students. The coefficient is not statistically significantly different from zero, though, so one cannot draw too strong an inference from the point estimate.

The positive and statistically significant coefficient on the variable *School Nonwhite %* in the pooled cross-section hedonic regression (reported in the first column of Table 5) is difficult to explain, even given the 40-year pro-integrative history of Shaker Heights. At face value, this result implies that households are willing to pay more for a house in a school district with a higher fraction of nonwhite students, all else being equal.

The results in the second and third column of Table 5 provide some explanation of this otherwise anomalous finding. When the time period studied is changed from 1983–1994 to 1983–1989, the coefficient on *School Nonwhite %* is somewhat smaller, but still larger than its standard error. When third grade reading test scores are included, the coefficient on *School Nonwhite %* drops substantially, and in fact is less than its standard error. This suggests that the coefficients in the first and second columns are picking up some sort of unobserved heterogeneity in schools and neighborhoods, rather than a racial composition effect per se.[25]

This interpretation is reinforced by the results of the repeat-sales analysis. The coefficients on *School Nonwhite %* in the repeat-sales analysis are never statistically significant, with some being negative and some positive in no particular pattern. (Complete regression results are available upon request.) These results suggest that unobserved neighborhood heterogeneity is not completely accounted for by the various dummy variables in the hedonic regression.

[25]The simple correlation between *School Nonwhite %* and *Third Grade Reading Test Score* is −0.33. When both variables are included in the analysis, they have opposite signs, as we would expect. However, the signs are in the "wrong" direction: test scores have a negative coefficient, while percent nonwhite has positive coefficient. Our interpretation is that these variables are proxying for unobserved heterogeneity among schools and neighborhoods.

School Quality and House Prices

In a study that is closely related to this one, Black [1] focuses on the value of houses that are close to attendance district boundaries and uses test scores as a measure of school quality. She finds that a 5% increase in test scores increases house prices by about 2.5%, all else being equal. Our hedonic regression including reading test scores comes up with the surprising result that test scores are negatively related to house values. We explain this finding in three ways. First, the test scores do not vary systematically among the schools. (The year-to-year correlations are relatively low.) Second, the test scores are mainly serving as a proxy for unobservable heterogeneity among schools and neighborhoods. This interpretation is strengthened by the results of the repeat-sales analysis, in which the coefficients on reading scores are positive (with one exception) and usually statistically significant. Third, there is not a great deal of difference in the quality of the schools. Recall that all of the students in the various elementary schools attend the same high school, and that public policy in the school district is aimed at ensuring a consistent high level of academic quality.

One final test of these results was to include third grade math test scores in the regressions. Whether they were entered separately or jointly with the reading scores, including the math scores did not change the qualitative results reported here. (Complete regression results are available upon request.)

5. CONCLUDING REMARKS

This paper has presented evidence on a familiar question, the relation between local public schools and house prices. Our main result is that disrupting neighborhood schools reduces house values by 9.9%, all else being equal. We were also able to measure the value of providing transportation services, something that has not (to our knowledge) been done before. Instituting transportation services increases house values by 2.6%, all else being equal. Our findings are robust to alternative econometric specifications that focus on the unobservable heterogeneity across neighborhoods.

The neighborhood schools effect is about $570 per year at a 10% discount rate. To put this number in perspective, consider that the mean school property tax rate for this period was about 60 mills, applied to an assessed value of 35% of market value. At the mean house price of about $58,000, this implies an annual property tax bill for schools of about $1200. This neighborhood schools effect has an equivalent impact on house values of a fully capitalized 47.5% increase in property taxes. This is a substantial number, and one that indicates the importance of the way in which public schools are provided as well as how they are financed.

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