WORKING PAPERS
RESEARCH DEPARTMENT

WORKING PAPER NO. 06-15

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August 2006

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The views expressed here are those of the author and do not necessarily represent those of the Federal Reserve Bank of Philadelphia or the Federal Reserve System. Jason Novak provided excellent research assistance on this project. Any errors are mine alone. This paper is available free of charge at www.philadelphiafed.org/econ/wps/index.html.

Abstract

The expansion of state-mandated tests in the 1990s and the testing requirements of the No Child Left Behind Act have supplied researchers with an abundance of data on test scores that can be used as measures of school quality. This paper uses the state-mandated test scores for 5th grade and 11th grade in Montgomery County, Pennsylvania, to examine three issues about the capitalization of school quality into house prices: (1) At what level do prospective home buyers evaluate the quality of local public education—at the district level or the level of the neighborhood school? (2) After accounting for student achievement as reflected in test scores, are other aspects of the local public school system, such as class size or expenditures, capitalized into the value of a house? (3) Are the positive results we get for the capitalization of school quality into house prices due simply to the correlation between high test scores and other desirable neighborhood characteristics? The results of our investigation suggest that to home buyers some test-score averages are significantly better indicators of the quality of the local public school system than others. In particular, home buyers seem to evaluate the quality of public education at the district level rather than at the level of the local school. Class size at the high-school level has some independent effect on house prices, but not class size at the elementary school level. And once we account for student achievement, expenditures per pupil have no further effect on house prices. Finally, restricting our sample to similar neighborhoods along school district boundaries confirms our earlier results for high school test scores but not for elementary school scores.

Capitalization of the Quality of Local Public Schools:
What Do Home Buyers Value?

In his 1956 article, Charles Tiebout first published his theory that consumers (home buyers) shop among local communities for the combination of local public goods and taxes that best satisfies their preferences. One implication of this theory is that, other things equal, houses in a community that offers a higher quality of public goods for the same level of taxes will command higher prices. Empirical tests of this implication of the Tiebout model have focused primarily on the capitalized value of local public education. Much of the early research centered on the proper measure of school quality and the appropriate functional form of the hedonic equation used to estimate the effect of school quality on house prices. More recent research has emphasized the need to control for the housing and neighborhood characteristics that are correlated with common measures of school quality such as test scores. And some papers have broadened the scope of the research to include not only the direct effect of school quality on house prices but also the indirect effect due to differences in neighborhood demographics that result from Tiebout sorting. The remainder of this paper is divided into five sections. Section I presents a brief survey of the literature on the capitalization of the quality of the local public schools into house prices. Section II sketches the basic hedonic model with public goods and discusses the difficulty of isolating the effect of school quality. Section III describes the data used in the empirical estimations. Section IV presents the estimating equations and results. Section V summarizes the basic conclusions.

I. Literature on the Capitalization of School Quality

In an early examination of the implications of the Tiebout model, Wallace Oates (1969 and 1973) used per pupil spending as the measure of the quality of local public education.[1] He found that, after controlling for effective property tax rates, median house values were higher in school districts with higher per pupil expenditures.[2] Rosen and Fullerton (1977) criticized the

[1] Oates appealed explicitly to Tiebout, but two years earlier Ridker and Henning (1967) published an article focused on air quality and house prices in which they also attempted to account for the effect of perceived differences in school quality on house prices.
[2] King (1977) estimated alternative specifications of the Oates model substituting the property tax payment for the tax rate and obtained the same qualitative results for per pupil expenditures.

use of expenditures by Oates on the grounds that expenditures on inputs are not a measure of the output of a public good. Rosen and Fullerton replicated Oates' study using test scores as the measure of school quality in the same New Jersey school districts examined by Oates. They obtained the same qualitative results; higher test scores were associated with higher house prices. Rather than using test scores, some early studies looked at the effect on house prices of a school district's *reputation* obtained from surveys or from homeowners' own estimates (Ridker and Henning, 1967; Linneman, 1980). The logic of this approach is that it is the *perceived* quality of local schools that determines the value of a house to a potential buyer. The focus of these papers was not the capitalization of school quality, and the results were often counterintuitive. They indicated that houses in neighborhoods where the schools had a "below average" or "poor" reputation commanded a higher price. These results could reflect a lack of control for other housing and neighborhood characteristics or simply a poor measure of reputation. In any case, test scores rather than survey measures of schools' reputations have increasingly come to be used as the standard measure of quality. In the 1980s and 1990s a number of states began requiring standardized tests. And the No Child Left Behind Act of 2001 requires that students in grades three through eight take statewide standardized tests every year. Since the results of these required tests are widely publicized, one might assume that a school's reputation is largely based on the results of the tests. Thus, the distinction between reputation and a quantitative measure of student performance like test scores may be largely academic at this point. Most recent studies have used average scores from state-mandated tests or pass rates for the tests as the measure of quality.[3]

Test scores, however, are not a pure measure of school quality. Other factors, such as the student's native ability and family background can affect achievement on standardized tests. Theoretically, if test scores are the measure of student achievement, it is only the marginal effect of the school on those scores that should be credited as the school's output or value added (Hanushek, 1986; Hayes and Taylor, 1996). Economists, therefore, have taken efforts to control for personal and family characteristics of the student body when estimating the effect of test scores on house values. Controlling for native ability presents a special challenge. Ideally it requires some pre-school or early-school benchmark for individual students against which to

[3] See Haurin and Brasington, 1996; Hayes and Taylor, 1996; Downes and Zabel, 1997; Black, 1999; Brasington, 1999 and 2000; Bradbury, Mayer, and Case, 2001; Weimer and Wolkoff, 2001; and Dills, 2001.

measure the school's contribution to the student's achievement (Summers and Wolfe, 1977; Hanushek and Taylor, 1990). A few studies use the change in test scores between different grades in a school as an indicator of a school's value added (Sonstelie and Portney, 1980; Reinhard, 1981; Downes and Zabel, 1997). But to the extent that students change schools or school districts between the time of the first and second test, these two sets of scores may not refer to the same cohort of students.[4]

At least two recent studies have decomposed cross-sectional differences in test scores into contributions by the schools, the influence of peers, and, in one case, the parental background of the students. Hayes and Taylor (1996) used prior test scores and student characteristics to decompose average test scores for elementary schools in the Dallas district into school effects and peer effects. Their measure of the peer group's contribution had no significant effect on house prices.[5] On the other hand, their measure of the school's contribution (the school's value added) had a positive and significant effect on house prices in northern Dallas but not in southern Dallas. However, they obtained the same qualitative results by just using the average test scores rather than a value-added measure. Brasington and Haurin (2005) decompose test results in 123 Ohio school districts into a parental contribution, a school contribution, and a peer group contribution. They find only weak support for any effect on house prices from their measure of the school's contribution to the pass rates on proficiency tests. Moreover, without any decomposition, the pass rates themselves had a highly significant effect on house prices. The authors suggest that the value-added measure may show little effect on house prices because a school's value added is difficult to ascertain for both the researcher and the home buyer. Prospective home buyers may simply consider overall test scores the best indicator of school quality.

There has been some renewed interest in Wallace Oates' early conclusion that per pupil expenditures are reflected in house prices. Several recent studies have included per pupil expenditures along with test scores in their estimating equations. Per pupil spending has a positive and significant effect on house prices over and above the effect of test scores in models

[4] See Kane and Staiger (2002b) for a discussion of the variation in the change in test scores that is due to random factors or to a change in the group of students being tested. Brasington (1999) uses differences in fourth, ninth, and twelfth grade test scores *in a given year* to measure value added at the school district level. This measure admittedly does not reflect improvement in the same cohort of students.

estimated by Downes and Zabel (1997), Black (1999), and Brasington (1999).[6] Hilber and Mayer (2002) found that increases in per pupil expenditures are reflected in increases in house prices in densely populated communities, i.e., in communities in which housing supply is relatively inelastic.

Other recent articles have revived the notion that it is a school's or a district's reputation that is reflected in house values. Because they did not have any quantitative measure of school quality, Bogart and Cromwell (1997) used a dummy variable for generally perceived poor school districts in their hedonic estimates of house prices in three samples of otherwise similar neighborhoods in the Cleveland area. The coefficients on these dummy variables for poor districts were all negative and significant. Figlio and Lucas (2004) use Florida's grading system as well as test scores to examine whether a school's reputation affects house prices over and above the effect of average test scores. Besides the average test scores, a school's grade depends on other factors, such as the improvement in scores, absentee rates, and suspension rates. The authors find that the letter grades given to schools by the state do affect housing prices over and above average test scores, although the effect has diminished over time. These results suggest that home buyers evaluate the quality of local public schools on more than test scores.

A major concern of several recent studies has been how to control for neighborhood characteristics that are correlated with school test scores and also raise house prices. Bogart and Cromwell (1997) limited their sample to statistical planning areas in given municipalities that spanned two separate school districts. The use of planning areas was intended to control for the quality of other public services. Black (1999) limited her sample to houses close to the boundaries of elementary school attendance zones within school districts, and she pioneered the use of boundary fixed effects to control for neighborhood characteristics. Boundary fixed effects have now become a common control for neighborhood characteristics in hedonic estimates of the effect of school quality on house prices (Bayer, Ferreira, and McMillan, 2003 and 2004; Kane, Staiger, and Reigg, 2005).

While the use of boundary fixed effects addresses the issue of the contemporaneous correlation of other desirable neighborhood characteristics and the quality of public schools, it

[5] Even though Hayes and Taylor found no significant effect on house prices from their measure of the peer group's contribution to student achievement, differences in the quality of the peer group in a school should theoretically be capitalized in house prices.

does not address the issue of the long-run effects on neighborhood demographics due to Tiebout sorting. Bayer, Ferreira, and McMillan (2003 and 2004) have developed a general equilibrium model in which other desirable neighborhood characteristics are affected by the quality of public schools through Tiebout sorting. They find that, when we take into account Tiebout sorting, the full effect on house prices of differences in school quality is two to four times as great as the direct effect. The hedonic model in this paper does not attempt to capture the *indirect* effects of school quality on house prices due to Tiebout sorting; it is in the tradition of earlier studies that use control variables to keep neighborhood characteristics constant.

II. The Basic Hedonic Model with Public Goods

The theoretical foundations for estimating the implicit (hedonic) price of the structural, neighborhood, and public-goods characteristics of a given property were developed by Sherwin Rosen (1974). The bundle of goods combined in any two houses may be heterogeneous, but there is an assumed common price structure for the embodied characteristics or attributes. Since houses are associated with location, the quantity and quality of each of the public goods in that location are among the attributes contained in the housing bundle. The housing bundle itself can be defined as z where

$$z = (z_1, z_2, \ldots z_n)$$

and each of the elements of the vector z represents the quantity of a given attribute of the housing bundle. The market price of a house, P(z), will be a function of the vector z. And the implicit price function of any characteristic z_i is represented by

$$\frac{\partial P(z)}{\partial z_i} = p_{z_i}(z_i, z_{-i}) \quad (1)$$

where z_{-i} is the vector of all the characteristics except z_i. This implicit price function for attribute z_i will be determined by households maximizing their utility subject to their budget constraint and housing producers maximizing their profits.

The utility function of the household can be represented by

$$U = u(z, x; \theta) \quad (2)$$

[6] Hayes and Taylor (1996) found no significant effect of per pupil spending on house prices when test scores were entered in their equations.

where x represents the composite non-housing good and θ represents the household's preferences for the non-housing good and housing characteristics. If we normalize prices by the price of the non-housing good, then the budget constraint for each household will be

$$y = x + P(z) \quad (3)$$

where y equals household income.

In any given period, suppliers of housing include both developers and owners of existing homes. They maximize their profit π (z) where

$$\pi(z) = P(z) - C(z_s;\ \hat{z}_s, \bar{z}_d, \bar{z}_p) \quad (4)$$

C(z) is the cost of providing a house with attributes z.

I have distinguished the elements z by subscripts s, d, and p. The structural or site characteristics of a property, such as the size of the lot or the age of the structure, are subscripted s. The socio-demographic characteristics of the neighborhood are subscripted by d. The public characteristics, such as proximity to shopping or employment, neighborhood safety, air quality, school quality, municipal services, and local tax rates, are subscripted p. In this notation, the school district property tax rate is a public characteristic that carries a negative price, and the net value of the local public education system is a combination of the quality of the schools and the taxes imposed to provide that quality.[7] For the individual home buyer the tradeoff is not between per pupil expenditures and test scores but between school property taxes and test scores. Therefore, any study that attempts to measure the effect of school quality on house prices across districts must account for differential property tax rates.

The important feature of the socio-demographic and public characteristics of a neighborhood is that they are not determined by individual housing suppliers; hence the notation $\bar{z}_d$ and $\bar{z}_p$ in the profit function. The characteristics of a neighborhood can change over time and perhaps in response to the quality of local public education, but to the housing supplier they are exogenous.[8]

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[7] Since it is not possible to determine the cost of raising test scores by any given amount, one cannot determine from most econometric studies what combination of tax rates and school expenditures would maximize house values. Hanushek's review of econometric studies (1986) suggests that there is no proven relationship between school inputs or spending levels and student achievement. Brueckner (1979) estimates the effects of per pupil expenditures on house prices without controlling for taxes. He argues that under some fairly strong assumptions his results indicate that local public education is over-provided in his sample of northeastern New Jersey communities. The communities could raise housing values by lowering both their tax rates and expenditures on education.

[8] Developers of new tracts may have some control over public characteristics such as open space and traffic patterns. However, once provided, these characteristics are provided to all the houses in the development, and they become fixed characteristics for the purchasers of the newly built houses. Some new public characteristics, like the opening

Those structural and site characteristics of a house that were present in the previous period are designated $\hat{z}_s$. These are singled out because they constrain the set of characteristics that a supplier can offer in the current period. For example, in fully developed neighborhoods, the lot size of a dwelling *generally* cannot be changed, although lots are sometimes subdivided. Central air can be added to a house that has radiator heat, but only at a higher cost than in houses that already have heating ducts. Thus the cost of providing any combination of characteristics z_s in the current period depends on the combination in the previous period $\hat{z}_s$.[9] Finally, the cost to the supplier of providing any set of public and non-public characteristics z in a given period will depend on what the supplier has to pay for the combination that existed in the previous period $\hat{P}(\hat{z})$. Thus the type of house provided in a given neighborhood will depend on the neighborhood's history and the character of the original housing. We will account for this by including in our estimating equations the age of the house and distance from the central business district (CBD).

III. The Data

In the U.S., it is the quality and not the quantity of public education that distinguishes one school district or neighborhood school from another. The law guarantees students in most states a public education through their high school years, but the quality of that education can vary from district to district and from school to school. We use data from Montgomery County, Pennsylvania, a suburban county in the Philadelphia metro area, to estimate the effect of differences in school quality on house prices.

We have combined data from four major sources to estimate the effect of elementary and secondary school quality on house prices in Montgomery County. Data on the sale prices of houses and housing characteristics come from the Montgomery County assessor's file. This file includes the latest sale price and the previous sale price as well as certain structural characteristics for each house in the county. The data on schools and school districts come from the Pennsylvania System of School Assessment (PSSA) database. Data on school district and municipal property tax rates and on crime rates come from the Pennsylvania Department of

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of a shopping center or office park nearby, may change the housing bundle and therefore the market value of the house without any action on the part of the property owner.

[9] For a developer of new homes there may be few non-public characteristics from the previous period except lot size.

Community and Economic Development. Neighborhood characteristics, such as median household income or percent elderly in the census block group, are taken from the 2000 census files.

Data on Housing Units. Our source for the market prices of houses and their major characteristics is the Montgomery County assessor's file. We selected home sales that took place between January and July 2000. We dropped from our sample any home that was sold for less than $25,000 to eliminate any transactions that were not arms-length. This resulted in a loss of only 32 observations. There were 3150 home sales remaining in the 21 school districts in Montgomery County over this seven-month period with sufficient data in the assessor's files and our other data sources to use for this study.[10] We confine our sample to sales over a seven-month period for several reasons. We do not have to convert sale prices in different periods to constant dollars. We do not have to account for changes over time in the elementary school attendance zones. And the same information about property tax rates and test scores through the 1998-99 school year would have been available to all prospective home buyers.

The assessor's records also include a number of the characteristics of the property that are important determinants of house price. Perhaps the most important distinction among the properties is whether the house is attached or detached. This distinction was no longer available after 1996 from the assessor's office, but for units built before 1996 we obtained the information from the 1996 file by matching addresses. For units built after that time, the variable for attached and detached was determined by lot size. Post-1996 units with a lot size of 0.129 acre or less were coded attached. In the 1996 assessor's file only 5 percent of detached homes had lot sizes that small, and 81 percent of the attached houses had lot sizes of 0.129 acre or less.

There are a number of property characteristics in the assessor's file that are represented by continuous variables. These include the age of the structure, lot size, square feet of living space, number of bedrooms, and the number of full bathrooms. Other characteristics are reported in binary form (yes/no). These include the presence of a basement, central air conditioning, a fireplace, and a garage. The presence of one or more of these features often reflects overall quality differentials in otherwise similar houses, so the estimated coefficients should not

[10] There are officially 22 school districts in Montgomery County. But the Bryn Athyn School District has no schools of its own; the district pays for its public school students to attend schools in other districts. The Boyertown School District is partially in Montgomery County and partially in Berks County. Houses in that school district are not in our database.

necessarily be interpreted as the added value from the characteristic itself. For about one-third of our observations the number of baths was missing. Because this is such an important structural characteristic, the number of baths for these houses was imputed using the age of the house, the square feet of living space, the number of bedrooms, and the dummy variables for whether the house was attached and whether it had a basement, central air, or a fireplace.

Data on Schools. The PSSA database contains information at the district level and the school level on average scores and the distribution of scores for the PSSA math and reading tests for fifth, eighth, and eleventh grades.[11] In separate regressions we use both the fifth and eleventh grade math and reading scores and the sum of the two scores as measures of the quality of the local elementary school and the high school. We also use district-wide averages for these fifth and eleventh grade scores in a parallel set of regressions.[12] The PSSA database begins with the 1995-96 school year, but we did not use the test scores from that year because differences in scores in the first year of testing could reflect the inexperience of the school staffs in preparing the students and administering the tests. We averaged the mean test scores for the 1996-97, 1997-98, and 1998-99 school years to minimize the effect of year-to-year variation in scores that may not reflect differences in school quality.[13] Kane and Staiger (2001) estimate that for an elementary school of average size in North Carolina almost 40 percent of the variance in reading test scores among schools is due to sampling variation and other non-persistent sources of variation.[14] Sampling variation occurs because abilities vary among the cohorts of children in the same school who take the test for a given grade level in different years. Other non-persistent sources of variation can include widespread illness in the school on the day of the test or

[11] The distribution is given by the percentage of students in each school or district that scored in each quartile of the state distribution.

[12] Only one of the 21 school districts in our Montgomery County sample has more than one high school—Lower Merion. Therefore, the eleventh grade scores are the same for the district and the school averages in every other district. In the 1999-2000 school year 48 of the 442 eleventh graders in the Norristown District attended two other schools besides Norristown High School. Since we do not know where these students lived, we assigned all houses in the district to Norristown High. In the Spring-Ford school district all fifth grade students were assigned to the Spring-Ford intermediate school beginning in the 1999-2000 school year. Since our price data on home sales are from the year 2000 we used district-wide fifth grade test scores for the Spring-Ford District.

[13] Since our data on house sales were for the first seven months of 2000, we did not use the test scores after the 1998-99 school year. Potential home buyers in the first seven months of 2000 would not have had the information on test scores from the 1999-2000 school year, but the scores from 1998-99 would have been available. School administrators get the test scores from the preceding academic year in September or October, and the scores are widely publicized and available on the State Department of Education website by the end of November.

[14] The average size of the elementary schools is 60 students per grade. The percent of the variance in math scores due to sampling variation and other non-persistent sources of variation is smaller than in the case of reading scores.

classroom distractions such as nearby construction activity. These sources of variation argue for some averaging of test scores across years to obtain a stable measure of school quality.

Our data set includes other variables at the school and the district level that could be classified as measures of inputs into the education process. These include expenditures per pupil at the district level and class size at the school level. We have already noted the objections to per pupil expenditures as a measure of school quality, and there is no consensus on the effect of class size on student achievement (Hanushek, 1986). But the data allow us to test whether these input measures affect house prices independently of any effect they have on student achievement as measured by test scores. Data on per pupil expenditures are not available for some school districts so regressions that include this variable are estimated with 2846 observations. Offsetting the value added by the local public schools as measured by student achievement and other characteristics of the schools is the cost to the individual homeowner of the local public education system. The primary cost to the homeowner is the property tax levied by the school district. We have data on property tax rates by school district from the Pennsylvania Department of Community and Economic Development. Differentials in these tax rates should be reflected in house prices. It is, of course, the difference in effective tax rates and not statutory tax rates that is reflected in house prices. But all properties in Montgomery County were reassessed in 1997 with the new assessments applied in 1998. Since we use property tax rates for 1999, we assume that differences in the statutory rates were very close to differences in effective tax rates so soon after the new countywide assessments were applied.

Data on Municipalities. The Montgomery County files include a municipality code for every structure, and the Pennsylvania Department of Community and Economic Development publishes data on municipalities that include property tax rates and the number of violent crimes by year. We use the municipal property tax rate for 1999. For our measure of the crime rate we use the average number of violent crimes per 1000 residents for the years 1997, 1998, and 1999. The crime rate is not available for nine of the 56 municipalities in our dataset. For these municipalities we enter dummy variables in those regressions in which the municipal crime rates appear. This affects 132 of our 3150 observations.

Data on Neighborhood Characteristics. Using GIS software we geocoded all the properties in our sample by census block group, and data from the 2000 census were used to capture neighborhood characteristics. We have data on the following characteristics of population and housing in the census block group—percent age 65 and over, percent nonwhite, percent with a graduate degree, median household income, and the percent of houses that are owner-occupied. From the Delaware Valley Regional Planning Commission we have data on the driving distance from the census tract to the central business district in Philadelphia. This provides some measure of the accessibility to the central city.[15]

The definitions, means, and standard deviations of the variables used in the regression analysis in part IV are reported in Table 1.

IV. The Estimating Equations and Results

Several early studies of the effect of school quality on house prices used a linear hedonic model with the median value of houses by census tract or municipality as the dependent variable.[16] Most recent studies, however, have used a semi-log model with the log of individual house price as the dependent variable.[17] And a few studies have used a difference in difference approach, estimating the effect of changes or first differences in the explanatory variables on the change in house prices.[18] Linneman (1980) explicitly raised the issue of the proper functional form of the hedonic model. He suggests a Box-Cox transformation of the dependent variable (house price = V), that is, $\frac{V^{\lambda}-1}{\lambda}$, where lambda and the coefficients on the independent variables are estimated by maximum likelihood. When lambda equals one the functional form will be linear, and as lambda approaches zero the function approaches the semi-log form in which the dependent variable is the log of house value.[19] When lambda equals zero the Box-Cox estimation uses the natural log of house price as the dependent variable.

We estimated the basic equations reported in Table 3 with both a semi-log model and a Box-Cox transformation of the dependent variable. We report only the semi-log results throughout the paper because the results from the Box-Cox model are not qualitatively different

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[15] These estimates of the mean driving distance to Center City Philadelphia were made in 1990; more recent estimates are not available.

[16] Ridker and Henning (1967), Oates (1969 and 1973), Rosen and Fullerton (1977), King (1977), and Reinhard (1981).

[17] Haurin and Brasington (1996), Hayes and Taylor (1996), Downes and Zabel (1997), Bogart and Cromwell (1997), Goodman and Thibodeau (1998), Black (1999), Brasington (1999 and 2000), and Weimer and Wolkoff (2001).

[18] Bradbury, Mayer, and Case (2001), Dills (2001), and Hilber and Mayer (2002).

[19] The Box-Cox transformation can be performed on the continuous independent variables as well as on the dependent variable. Halvorsen and Pollakowski (1981) and Cropper, Deck, and McConnell (1988) also argue for some form of a Box-Cox estimation. See also the evaluation of the Box-Cox transformation in Sheppard (1999).

and they are not as easy to interpret as the semi-log results. In all our Box-Cox models, the estimated lambda was approximately 0.06, which is very close to the semi-log specification in any case.

The basic estimating equation is

$$V_{ijkqn} = \alpha + X_i\beta_x + S_j\beta_s + D_k\beta_d + \mathrm{M_q}\beta_\mathrm{m} + \mathrm{C_n}\beta_c + \varepsilon_\mathrm{ijkqn}$$

where

V_{ijkqn} = The natural log of the price of property with structural characteristics i in elementary or high school attendance zone j, in school district k, in municipality q, and in census block group n.

X_i = The structural characteristics of property i.

S_j = Average test scores for the relevant class and class size for school j.[20]

D_k = School district property taxes, expenditures per pupil, and district-wide average test scores.

M_q = Municipal property taxes and the incidence of violent crime in the municipality.

C_n = Census block-group variables that describe the demographic characteristics of the neighborhood and a location variable.

The need to adequately account for the non-school public goods, differing municipal tax rates (M_m), and different neighborhood characteristics (C_n) has prompted some researchers to narrow their sample to small neighborhoods. For example, Bogart and Cromwell (1997) select houses in the same "statistical planning area" in a single municipality that sold over an 18-year period. They have three samples of houses in three statistical planning areas, each of which is served by two school districts.[21] They represent the difference in school quality by a dummy variable for the "poor school district" in each sample. They find a negative and significant effect of "poor quality" in all three samples after controlling for housing characteristics. Since Bogart and Cromwell use dummy variables for school quality, they cannot identify the characteristics of the "better school district" that result in higher house prices.[22] Sandra Black (1999) uses a different data selection process to control for neighborhood characteristics. She selects homes

[20] Except for the Lower Merion School District, the geographic area of the high school attendance zone and the school district are coterminous. The Lower Merion School District has two high schools. Thus, in the Lower Merion District, houses were also separated into the two high school attendance zones.
[21] The statistical planning areas range in size from three to six census tracts.
[22] Since they do not include a school tax variable in their regressions, Bogart and Cromwell's estimated coefficient captures the combined effect of differential taxes and school quality.

sold within approximately one-third of a mile of the intra-district boundaries of elementary school attendance areas and uses a dummy for *each* boundary in her regressions. The dummy is meant to control for neighborhood characteristics. The assumption is that neighborhood characteristics are continuous at the boundary and only school quality is discontinuous. Black estimates positive and significant coefficients for the average fourth grade test scores for her sample. Her procedure, however, only allows her to measure the effect of intra-district differences in test scores and only at the elementary level. Bayer, Ferreira, and McMillan (2003 and 2004) follow Black's procedure and use a subset of houses within a quarter mile of school district boundaries and boundary dummies to control for neighborhood effects.[23] We will test our results by limiting our sample to houses within one-half mile of school district boundaries and using boundary dummies to control for neighborhood characteristics.

We use the basic hedonic regression model described above and our data from Montgomery County to address three questions:

(1) Which measure of public school quality has the most significant effect on house prices – individual school scores or district-wide scores?

(2) Do inputs into the education process (class size or per pupil expenditures) affect house prices after accounting for student achievement?

(3) Does the measured effect of student achievement on house prices diminish when neighborhoods are defined more narrowly and boundary dummies are used to capture neighborhood effects?

In order to better interpret the coefficients on test scores, we measure them in standard deviations across schools in Montgomery County (Tables 2a and 2b). The variation in math scores at both grade levels is higher than the variation in reading scores. This is true at both the individual school level (Table 2a) and at the district level (Table 2b). The correlations of average reading and math scores for fifth and eleventh grades in Montgomery County are presented in the lower panels of Tables 2a and 2b. Reading and math scores for the same grade level are highly correlated (approximately 0.90), so it is impossible to determine by regression analysis which test score at the same grade level is the better signal of school quality. The correlations of test scores across grade levels for the same subject are considerably lower (from

[23] Since their sample is from California post-proposition 13, the authors assume that property tax rates are the same across school districts.

0.67 to 0.78), and it is possible to identify for each subject at which grade level the score has the most significant effect on house prices.

In our first set of regressions (Table 3) we test each of the average test scores and the sum of the scores for individual schools as predictors of house prices controlling for a standard set of property taxes, structural characteristics, and neighborhood characteristics. For all our regressions we report robust standard errors. The estimated coefficients on the control variables all have the expected sign, and they are significant at least at the 10 percent level. The coefficients on the variables of interest, the average test scores, are positive and significant at the 1 percent level for all the scores except eleventh grade reading. A one-standard-deviation increase in these scores raises house prices between 1.7 percent and 2.4 percent, depending on which score we use. The eleventh grade reading score (Table 3, column 5) is the weakest indicator of house prices in our sample. While the coefficient is positive, its significance level is just shy of the commonly accepted 10 percent threshold ($p = .103$). The results of Pennsylvania's eleventh grade reading test are a less reliable measure of student achievement and school quality than the results of the other tests. All standardized tests are not created equal when it comes to measuring achievement.

In Table 4 we repeat the regressions in Table 3 using district-wide averages rather than the average scores for the individual schools. The estimated coefficients for the average district scores are all higher than for the average individual school scores. And except for eleventh grade reading the standard errors on the coefficients are consistently lower. At the district level, the coefficient on the average eleventh grade reading score is significant at the 10 percent level, but it remains a weak indicator of school quality.

In the regressions reported in Table 5 we attempt to determine whether fifth or eleventh grade test scores are better predictors of house prices. At the individual school level, eleventh grade math scores are better predictors of house prices than fifth grade math scores. For all other scores at either the individual school level or the district level (math, reading, and the sum of the two scores), the fifth grade scores are better predictors of house prices than the eleventh grade scores. Later we will test the robustness of this result using different controls for neighborhood characteristics.

The results in Tables 3 through 5 also suggest that district-wide averages of fifth grade scores are better predictors of house prices than averages at the individual school level. The regressions reported in Table 6 test this hypothesis. Both school-level and district-level scores are included in each of these regressions. In each case (math, reading, and the sum of the two), the coefficient on the district-level score is positive and significant at the 1 percent level and the coefficient on the score at the individual school level is essentially zero. Thus, *intra-district* differences in elementary school scores do not affect house prices in our sample.[24] This differs from Sandra Black's result. She found that intra-district differences in test scores had positive and significant effects on house prices.[25]

The regressions reported in Tables 7 and 8 address the issue of whether other characteristics of the school or the district affect the perceived quality of local public education as reflected in house prices. We look at class size and expenditures per pupil. These two factors can undoubtedly influence student achievement and test scores; the issue is whether they are *independent* indicators of school quality and house prices after accounting for student achievement. We estimate the independent effect of class size at the level of the individual school because our data on class size is at the school level. The evidence for the effect of class size is presented in Table 7. Class size at the elementary school level has no significant effect on house prices after accounting for student achievement (Table 7, columns 1 to 3), and there is little change in the coefficients on the test scores from our original regressions (Table 3). At the high school level, however, a higher percentage of classes with 24 or more students does have a negative effect on house prices, and the effect is significant at the 5 percent level (Table 7, columns 4 to 6). This result runs counter to the common perception that parents are most concerned about class size in the elementary school. Class size seems to have an independent effect on house prices only at the high school level.

For per pupil expenditures we have data only at the district level. Therefore we estimate the independent effect of school expenditures on house prices using average test scores for the district. The coefficients on expenditures have the expected sign in the regressions in Table 8, but none is statistically significant. The inclusion of per pupil expenditures does, however, raise the estimated coefficients on the test scores relative to the estimates in Table 4, and the

[24] A similar test is not possible for high school scores because in our sample only one district, Lower Merion, has more than one high school.

[25] She effectively controlled for any inter-district differences in school quality by using dummies for intra-district elementary school boundaries. A dummy variable for each district can be calculated from a linear combination of a subset of the boundary dummies.

coefficient on the eleventh grade reading score is now much more significant. One can argue that including per pupil expenditures in the hedonic equation renders the coefficient on test scores a measure of efficiency. That is, the coefficient reflects the effect on house prices of a rise in test scores when per pupil expenditures are held constant. We suggest that this may offer an explanation for the increase in the size of the coefficients on test scores in the regressions in Table 8. Home buyers may be interested not only in higher student achievement but also in bringing it about more efficiently. This conclusion remains tentative, however, given the fact that the expenditure variable is never significant.

Our final goal is to test whether limiting our sample to neighborhoods on school district boundaries and using boundary dummies to proxy for neighborhood characteristics diminishes the effect of test scores on house prices. We choose a subset of houses in our sample within one-half mile of each school district boundary. We exclude those boundaries defined by the Schuylkill River or any of the limited access highways in Montgomery County (I-76, I-286, I-486, and PA-309). We assign a dummy variable to each remaining boundary between two districts. If the Schuylkill River or one of the limited access highways intersects a district boundary, each section of the boundary is assigned a different dummy variable.

In Tables 9 and 10 we compare the coefficients on the test scores using the full sample and the full set of neighborhood characteristics with the coefficients using the limited sample and boundary dummies to control for neighborhood characteristics. To examine whether the differences in the coefficients are due simply to the change in the sample, we reestimate the original regression with the detailed neighborhood characteristics using the smaller sample. The results for the elementary school test scores are given in Table 9. The estimates using the full sample and the full set of neighborhood variables show a positive and significant relationship between elementary school scores and house prices (columns 1, 4, and 7). These results are identical to the regression results reported in Table 4. The estimates using the limited sample and district boundary dummies show no significant relationship between elementary school scores and house prices (columns 2, 5, and 8). But this result is partially due to the smaller sample size. The estimation with the full set of neighborhood characteristics using the smaller boundary sample also does not produce a significant coefficient on the fifth grade math or reading scores or the sum of the two (columns 3, 6, and 9).

The results are more positive for the high school test scores (Table 10). Higher test scores for the eleventh grade have a positive and significant effect on house prices in both the full sample and the smaller sample of houses using boundary dummies (columns 1, 2, 4, 5, 7 and 8). The standard errors are larger for the smaller sample, but the point estimates are also larger. Moreover, the eleventh grade reading score becomes more significant in the model with school district boundary dummies. If we assume that boundary dummies are a better control for neighborhood characteristics than the set of detailed characteristics in our original equation, we would raise our estimate of the effect of high school scores on house prices. These results of the model with boundary dummies suggest that the most reliable indicators of the quality of public schools are district-wide high school scores. When we apply the model with the full set of neighborhood characteristics to the smaller sample, however, we do not get significant results for the eleventh grade scores.

V. Conclusions

The requirement of annual testing in the No Child Left Behind Act has led to increased interest in the relationship between scores on standardized tests as a measure of school quality and house prices. This paper has used the test scores from the Pennsylvania System of School Assessment (PSSA) in Montgomery County to examine that relationship. Several conclusions can be drawn from that examination. In our baseline regressions (Tables 3 and 4) the weakest link between test scores and housing prices is the link between high school reading scores and house prices. We have suggested that the PSSA eleventh grade reading test may not be a particularly reliable gauge of student achievement or school quality. When we add other school characteristics or other controls for neighborhood characteristics, however, the link between eleventh grade reading scores and house prices becomes much stronger. Among other characteristics of individual schools and school districts, class size matters at the high school level but not at the elementary school level. Per pupil expenditures, however, do not affect house prices over and above their effect on student achievement.

Prospective home buyers appear to value school quality primarily at the district level. In the regressions using our full sample of 3150 observations, *intra-district* differences in elementary school scores are not a significant determinant of house prices once we control for district-wide averages. When we restrict our sample and use school district boundary dummies to control for neighborhood characteristics, we find that district-wide high school scores significantly affect house prices, but elementary school scores do not. Although these results are tentative because of the smaller sample size of houses on district boundaries, they support our earlier conclusion about the primary importance of the school district. In effect, prospective home buyers base their offers on differences across school districts rather than across school attendance zones in the same district.

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Table 1
Variables, Definitions, Means, and Standard Deviations
N=3150

VARIABLE	DEFINITION	MEAN	STD. DEV.
HOUSING CHARACTERISTICS			
HP	Sale price of the house	184.95	122.45
LN(HP)	Log of sale price of the house	11.97	0.54
AGE	Age of the house in 2000	40.83	25.20
LTSIZE	Size of the lot in acres	0.32	0.60
LVSQFT	Square feet of living space (00s)	19.16	8.21
BDRM	Number of bedrooms	3.35	0.82
BATH	Number of full baths	2.09	0.63
ATTCHD	= 1 if attached dwelling, = 0 otherwise	0.29	NR
BSMT	= 1 if house has a basement; = 0 otherwise	0.90	NR
AIR	= 1 of house has central air; = 0 otherwise	0.53	NR
FIREPL	= 1 if house has a fireplace; = 0 otherwise	0.56	NR
GAR	= 1 if house has a garage; = 0 otherwise	0.66	NR
SCHOOL AND SCHOOL DISTRICT VARIABLES			
MATH5	Average 5th grade math score 1996-97, 1997-98, and 1998-99 for the local school	1391.48	57.62
MATH5_DIST	Average 5th grade math score 1996-97, 1997-98, and 1998-99 for the district	1390.03	51.81
READ5	Average 5th grade reading score 1996-97, 1997-98, and 1998-99 for the local school	1379.08	51.36
READ5_DIST	Average 5th grade reading score 1996-97, 1997-98, and 1998-99 for the district	1377.68	45.84
SUM5	Average of the sum of the 5th grade math and reading scores 1996-97, 1997-98, and 1998-99 for the local school	2770.55	106.60
SUM5_DIST	Average of the sum of the 5th grade math and reading scores 1996-97, 1997-98, and 1998-99 for the district	2767.71	96.27
MATH11	Average 11th grade math score 1996-97, 1997-98, 1998-99 for the local high school	1385.23	64.77
MATH11_DIST	Average 11th grade math score 1996-97, 1997-98, 1998-99 for the district	1385.23	64.73
READ11	Average 11th grade reading score 1996-97, 1997-98, and 1998-99 for the local high school	1368.28	46.96
READ11_DIST	Average 11th grade reading score 1996-97, 1997-98, and 1998-99 for the district	1368.58	47.23
SUM11	Average of the sum of the 11th grade math and reading scores 1996-97, 1997-98, and 1998-99 for the local high school	2753.51	108.72

SUM11_DIST	Average of the sum of the 11th grade math and reading scores 1996-97, 1997-98, and 1998-99 for the district	2753.81	109.12
ESCS24+	Percent of elementary school classes with 24 or more pupils (average 1996-97, 1997-98, 1998-99)	40.01	24.34
HSCS24+	Percent of high school classes with 24 or more pupils (average 1996-97, 1997-98, 1998-99)	42.45	11.79
EXPUPIL	School district expenditures per pupil (average 1996-97, 1997-98, 1998-99) ($000)	8.98	1.42
SDPTAX	School district Property tax rate 1999 (mills of assessed value)	15.67	3.01
MUNICIPALITY VARIABLES			
MUNPTAX	Municipal property tax rate 1999 (mills of assessed value)	2.06	1.19
CRIMERATE	Number of violent crimes per thousand residents (average 1997, 1998, 1999)	1.96	2.41
CENSUS BLOCK GROUP AND LOCATION VARIABLES			
65+	Proportion of population age 65 and over	0.15	0.07
NONWT	Proportion of population non-white	0.13	0.12
OWN	Proportion of houses owner-occupied	0.78	0.18
GRAD	Proportion of population 25+ with a graduate degree	0.17	0.12
MED INC	Median household income 1999 ($000)	70.60	26.09
DISTCBD	Highway distance to Philadelphia CBD (miles)	18.69	7.94

NR = Not Relevant

Table 2a Means, Standard Deviations, and Correlations Reading and Math Test Scores Across Schools Grades 5 and 11				
Means and Standard Deviations				
	Math5	Read5	Math11	Read11
Mean Score	1387.47	1373.88	1385.91	1366.82
Standard Deviation	61.70	58.24	64.82	45.14
Correlations				
Scores	Math5	Read5	Math11	Read11
Math5	1			
Read5	0.92 N=73	1		
Math11	0.73 N=73	0.74 N=73	1	
Read11	0.73 N=73	0.67 N=73	0.89 N=22	1

Table 2b Means, Standard Deviations, and Correlations Reading and Math Test Scores Across Districts Grades 5 and 11				
Means and Standard Deviations				
	Math5	Read5	Math11	Read11
Mean Score	1380.00	1374.44	1381.43	1364.60
Standard Deviation	45.86	41.01	62.77	44.96
Correlations				
Scores	Math5	Read5	Math11	Read11
Math5	1			
Read5	0.90 N=21	1		
Math11	0.75 N=21	0.82 N=21	1	
Read11	0.78 N=21	0.78 N=21	0.89 N=21	1

TABLE 3
EFFECT ON HOUSE PRICES OF 5TH AND 11TH GRADE TEST SCORES
(LOCAL SCHOOL LEVEL)

DEPENDENT VARIABLE = Ln(House Price)						
	Math 5	**Read 5**	**Sum 5**	**Math 11**	**Read 11**	**Sum11**
SCHOOL TEST SCORES						
MATH5	0.0169					
	(0.0059)***					
READ5		0.0238				
		(0.0065)***				
SUM5			0.0209			
			(0.0062)***			
MATH11				0.0225		
				(0.0064)***		
READ11					0.0100	
					(0.0062)	
SUM11						0.0183
						(0.0064)***
PROPERTY TAX RATES						
SDPTAX	-0.0134	-0.0129	-0.0131	-0.0126	-0.0138	-0.0132
	(0.0019)***	(0.0020)***	(0.0020)***	(0.0020)***	(0.0019)***	(0.0019)***
MUNPTAX	-0.0113	-0.0117	-0.0119	-0.0105	-0.0091	-0.0104
	(0.0062)*	(0.0062)*	(0.0062)*	(0.0060)*	(0.0061)	(0.0061)*
STRUCTURAL CHARACTERISTICS						
ATTCHD	-0.1746	-0.1754	-0.1750	-0.1736	-0.1738	-0.1736
	(0.0117)***	(0.0117)***	(0.0117)***	(0.0117)***	(0.0117)***	(0.0117)***
AGE	-0.0027	-0.0027	-0.0027	-0.0028	-0.0027	-0.0028
	(0.0003)***	(0.0003)***	(0.0003)***	(0.0003)***	(0.0003)***	(0.0003)***
LTSIZE	0.0596	0.0598	0.0598	0.0574	0.0579	0.0575
	(0.0252)**	(0.0252)**	(0.0252)**	(0.0252)**	(0.0253)**	(0.0253)**
LTSIZE (squared)	-0.0096	-0.0097	-0.0097	-0.0094	-0.0095	-0.0094
	(0.0043)**	(0.0043)**	(0.0043)**	(0.0043)**	(0.0043)**	(0.0043)**

	Math 5	Read 5	Sum 5	Math 11	Read 11	Sum11
LVSQFT	0.0368	0.0368	0.0368	0.0367	0.0369	0.0368
	(0.0040)***	(0.0040)***	(0.0040)***	(0.0040)***	(0.0040)***	(0.0040)***
LVSQFT (squared)	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002
	(0.0001)***	(0.0001)***	(0.0001)***	(0.0001)***	(0.0001)***	(0.0001)***
BDRM	0.0186	0.0187	0.0187	0.0184	0.0182	0.0183
	(0.0094)**	(0.0094)**	(0.0094)**	(0.0093)**	(0.0094)*	(0.0094)*
BATH	0.0465	0.0459	0.0463	0.0452	0.0458	0.0455
	(0.0145)***	(0.0145)***	(0.0145)***	(0.0145)***	(0.0146)***	(0.0145)***
BSMT	0.1051	0.1045	0.1048	0.1019	0.1048	0.1033
	(0.0153)***	(0.0153)***	(0.0153)***	(0.0152)***	(0.0154)***	(0.0153)***
AIR	0.0433	0.0429	0.0430	0.0437	0.0438	0.0436
	(0.0125)***	(0.0125)***	(0.0125)***	(0.0125)***	(0.0125)***	(0.0125)***
FIREPL	0.0580	0.0576	0.0577	0.0606	0.0599	0.0605
	(0.0104)***	(0.0103)***	(0.0104)***	(0.0103)***	(0.0103)***	(0.0103)***
GAR	0.1261	0.1249	0.1255	0.1257	0.1271	0.1264
	(0.0118)***	(0.0118)***	(0.0118)***	(0.0118)***	(0.0118)***	(0.0118)***
NEIGHBORHOOD CHARACTERISTICS						
CRIMERATE	-0.0149	-0.0138	-0.0140	-0.0134	-0.0165	-0.0143
	(0.0033)***	(0.0033)***	(0.0033)***	(0.0034)***	(0.0034)***	(0.0034)***
65+	0.3995	0.4036	0.4034	0.3893	0.3836	0.3885
	(0.0757)***	(0.0755)***	(0.0756)***	(0.0751)***	(0.0750)***	(0.0750)***
NONWT	-0.4016	-0.4012	-0.4010	-0.4225	-0.4109	-0.4178
	(0.0490)***	(0.0488)***	(0.0489)***	(0.0496)***	(0.0492)***	(0.0495)***
OWN	0.5448	0.5552	0.5499	0.5118	0.5238	0.5140
	(0.2030)***	(0.2032)***	(0.2030)***	(0.2031)**	(0.2042)**	(0.2034)**
OWN (squared)	-0.5332	-0.5441	-0.5385	-0.5099	-0.5186	-0.5122
	(0.1442)***	(0.1443)***	(0.1441)***	(0.1441)***	(0.1448)***	(0.1443)***
GRAD	0.5493	0.5235	0.5377	0.5309	0.5469	0.5376
	(0.0745)***	(0.0744)***	(0.0744)***	(0.0747)***	(0.0746)***	(0.0746)***
MED INC	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020
	(0.0005)***	(0.0005)***	(0.0005)***	(0.0005)***	(0.0005)***	(0.0005)***

	Math 5	Read 5	Sum 5	Math 11	Read 11	Sum11
DISTCBD	-0.0082	-0.0084	-0.0083	-0.0080	-0.0078	-0.0078
	(0.0010)***	(0.0010)***	(0.0010)***	(0.0010)***	(0.0010)***	(0.0010)***
CONSTANT	10.8362	10.6515	10.7214	10.7447	10.9198	10.7535
	(0.1632)***	(0.1838)***	(0.1770)***	(0.1653)***	(0.2102)***	(0.1892)***
Observations	3150	3150	3150	3150	3150	3150
R-squared	0.80	0.80	0.80	0.80	0.80	0.80
Robust standard errors in parentheses						
* significant at 10%; ** significant at 5%; *** significant at 1%						
Note: Dummies are included for those municipalities for which the crime rate is not available.						

TABLE 4 EFFECT ON HOUSE PRICES OF 5TH AND 11TH GRADE TEST SCORES (DISTRICT LEVEL)						
DEPENDENT VARIABLE = Ln(House Price)						
	Math 5	**Read 5**	**Sum 5**	**Math 11**	**Read11**	**Sum 11**
SCHOOL TEST SCORES						
MATH5_DIST	0.0199					
	(0.0050)***					
READ5_DIST		0.0308				
		(0.0051)***				
SUM5_DIST			0.0251			
			(0.0050)***			
MATH11_DIST				0.0212		
				(0.0062)***		
READ11_DIST					0.0116	
					(0.0062)*	
SUM11_DIST						0.0182
						(0.0062)***
PROPERTY TAX RATES	YES	YES	YES	YES	YES	YES
STRUCTURAL CHARACTERISTICS	YES	YES	YES	YES	YES	YES
NEIGHBORHOOD CHARACTERISTICS	YES	YES	YES	YES	YES	YES
Observations	3150	3150	3150	3150	3150	3150
R-squared	0.80	0.80	0.80	0.80	0.80	0.80
Robust standard errors in parentheses * significant at 10%; ** significant at 5%; *** significant at 1%						

TABLE 5
COMPARISON OF EFFECTS ON HOUSE PRICES OF TEST SCORES ACROSS GRADES

	SCHOOL LEVEL			**DISTRICT LEVEL**		
DEPENDENT VARIABLE = Ln(House Price)						
	Math	**Read**	**Sum**	**Math**	**Read**	**Sum**
MATH5	0.0086					
	(0.0066)					
MATH11	0.0180					
	(0.0072)**					
READ5		0.0242				
		(0.0074)***				
READ11		-0.0008				
		(0.0069)				
SUM5			0.0158			
			(0.0074)**			
SUM11			0.0097			
			(0.0075)			
MATH5_DISTRICT				0.0151		
				(0.0075)**		
MATH11_DISTRICT				0.0080		
				(0.0092)		
READ5_DISTRICT					0.0456	
					(0.0070)***	
READ11_DISTRICT					-0.0244	
					(0.0085)***	
SUM5_DISTRICT						0.0344
						(0.0082)***
SUM11_DISTRICT						-0.0141
						(0.0103)

PROPERTY TAX RATES	YES	YES	YES	YES	YES	YES
STRUCTURAL CHARACTERISTICS	YES	YES	YES	YES	YES	YES
NEIGHBORHOOD CHARACTERISTICS	YES	YES	YES	YES	YES	YES
Observations	3150	3150	3150	3150	3150	3150
R-squared	0.80	0.80	0.80	0.80	0.80	0.80
Robust standard errors in parentheses						
* significant at 10%; ** significant at 5%; *** significant at 1%						

Table 6
Comparison of Effect on House Prices of 5th Grade Scores at School Level and District Level

DEPENDENT VARIABLE = Ln(House Price)			
	Math	**Reading**	**Sum**
SCHOOL QUALITY MEASURES			
MATH5_SCHOOL	-0.0019		
	(0.0090)		
MATH5_DISTRICT	0.0212		
	(0.0077)***		
READ5_ SCHOOL		-0.0032	
		(0.0093)	
READ5_DISTRICT		0.0327	
		(0.0073)***	
SUM5_ SCHOOL			-0.0029
			(0.0094)
SUM5_DISTRICT			0.0269
			(0.0076)***
PROPERTY TAX RATES	YES	YES	YES
STRUCTURAL CHARACTERISTICS	YES	YES	YES
NEIGHBORHOOD CHARACTERISTICS	YES	YES	YES
Observations	3150	3150	3150
R-squared	0.80	0.80	0.80
Robust standard errors in parentheses			
* significant at 10%; ** significant at 5%; *** significant at 1%			

TABLE 7
EFFECT OF CLASS SIZE ON HOUSE PRICES

DEPENDENT VARIABLE = Ln(House Price)						
	Math5	**Read5**	**Sum5**	**Math11**	**Read11**	**Sum11**
SCHOOL TEST SCORES						
MATH5	0.0160					
	(0.0060)***					
READ5		0.0230				
		(0.0066)***				
SUM5			0.0201			
			(0.0064)***			
MATH11				0.0260		
				(0.0067)***		
READ11					0.0173	
					(0.0069)**	
SUM11						0.0239
						(0.0069)***
CLASS SIZE						
ESCS24+	-0.0001	-0.0002	-0.0001			
	(0.0002)	(0.0002)	(0.0002)			
HSCS24+				-0.0011	-0.0012	-0.0013
				(0.0005)**	(0.0005)**	(0.0005)***
PROPERTY TAX RATES	YES	YES	YES	YES	YES	YES
STRUCTURAL CHARACTERISTICS	YES	YES	YES	YES	YES	YES
NEIGHBORHOOD CHARACTERISTICS	YES	YES	YES	YES	YES	YES
Observations	3150	3150	3150	3150	3150	3150
R-squared	0.80	0.80	0.80	0.80	0.80	0.80
Robust standard errors in parentheses * significant at 10%; ** significant at 5%; *** significant at 1%						

Table 8 Effect Of School District Expenditures On House Prices						
DEPENDENT VARIABLE = Ln(House Price)						
	Math5	**Read5**	**Sum5**	**Math11**	**Read11**	**Sum11**
SCHOOL TEST SCORES						
MATH5_DIST	0.0474					
	(0.0068)***					
READ5_DIST		0.0416				
		(0.0058)***				
SUM5_DIST			0.0442			
			(0.0062)***			
MATH11_DIST				0.0324		
				(0.0074)***		
READ11_DIST					0.0324	
					(0.0083)***	
HSD_SUM_STD						0.0346
						(0.0079)***
PER PUPIL EXPENDITURES						
EXPUPIL	0.0050	0.0065	0.0059	0.0066	0.0030	0.0056
	(0.0064)	(0.0065)	(0.0065)	(0.0067)	(0.0064)	(0.0066)
PROPERTY TAX RATES	YES	YES	YES	YES	YES	YES
STRUCTURAL CHARACTERISTICS	YES	YES	YES	YES	YES	YES
NEIGHBORHOOD CHARACTERISTICS	YES	YES	YES	YES	YES	YES
Observations	2846	2846	2846	2846	2846	2846
R-squared	0.80	0.80	0.80	0.80	0.80	0.80
Robust standard errors in parentheses						
* significant at 10%; ** significant at 5%; *** significant at 1%						

Table 9
Fifth Grade District Scores
Full Sample with Neighborhood Variables and
District Boundary Areas with Boundary Dummies

	MATH			**READING**			**SUM**		
DEPENDENT VARIABLE = Ln(House Price)									
	Full Sample/ Neighborhood Characteristics	**Boundary Sample/ Boundary Dummies**	**Boundary Sample/ Neighborhood Characteristics**	**Full Sample/ Neighborhood Characteristics**	**Boundary Sample/ Boundary Dummies**	**Boundary Sample/ Neighborhood Characteristics**	**Full Sample/ Neighborhood Characteristics**	**Boundary Sample/ Boundary Dummies**	**Boundary Sample/ Neighborhood Characteristics**
MATH5_DIST	0.01994	0.01223	0.00448						
	(0.00500)***	(0.00961)	(0.00920)						
READ5_DIST				0.03078	0.01611	0.00750			
				(0.00513)***	(0.01131)	(0.01036)			
SUM5_DIST							0.02511	0.01408	0.00586
							(0.00503)***	(0.01033)	(0.00973)
PROPERTY TAX RATES	YES	YES	YES	YES	YES	YES	YES	YES	YES
STRUCTURAL CHARACTERISTICS	YES	YES	YES	YES	YES	YES	YES	YES	YES
NEIGHBORHOOD CHARACTERISTICS	YES	NO	YES	YES	NO	YES	YES	NO	YES
BOUNDARY DUMMIES	NO	YES	NO	NO	YES	NO	NO	YES	NO
Observations	3150	874	874	3150	874	874	3150	874	874
R-squared	0.80	0.78	0.75	0.80	0.78	0.75	0.80	0.78	0.75
Robust standard errors in parentheses									
* significant at 10%; ** significant at 5%; *** significant at 1%									

Table 10
Eleventh Grade District Scores
Full Sample with Neighborhood Variables and
District Boundary Areas with Boundary Dummies

	MATH			**READING**			**SUM**		
DEPENDENT VARIABLE = Ln(House Price)									
	Full Sample/ Neighborhood Characteristics	**Boundary Sample/ Boundary Dummies**	**Boundary Sample/ Neighborhood Characteristics**	**Full Sample/ Neighborhood Characteristics**	**Boundary Sample/ Boundary Dummies**	**Boundary Sample/ Neighborhood Characteristics**	**Full Sample/ Neighborhood Characteristics**	**Boundary Sample/ Boundary Dummies**	**Boundary Sample/ Neighborhood Characteristics**
DISTRICT TEST SCORES									
MATH11_DIST	0.02117	0.02662	0.01251						
	(0.00616)***	(0.01451)*	(0.01050)						
READ11_DIST				0.01160	0.02777	0.00659			
				(0.00620)*	(0.01373)**	(0.01057)			
SUM11_DIST							0.01816	0.02853	0.01055
							(0.00624)***	(0.01431)**	(0.01057)
PROPERTY TAX RATES	YES	YES	YES	YES	YES	YES	YES	YES	YES
STRUCTURAL CHARACTERISTICS	YES	YES	YES	YES	YES	YES	YES	YES	YES
NEIGHBORHOOD CHARACTERISTICS	YES	NO	YES	YES	NO	YES	YES	NO	YES
BOUNDARY DUMMIES	NO	YES	NO	NO	YES	NO	NO	YES	NO
Observations	3150	874	874	3150	874	874	3150	874	874
R-squared	0.80	0.78	0.75	0.80	0.78	0.75	0.80	0.78	0.75
Robust standard errors in parentheses									
* significant at 10%; ** significant at 5%; *** significant at 1%									