THE EFFECT OF SCHOOL QUALITY ON RESIDENTIAL SALES PRICE

The Effect of School Quality on Residential Sales Price

by

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Abstract

This study seeks to find the extent to which various measures of public school quality are capitalized into house prices after the No Child Left Behind Act (2001). School quality input and outputs, proficiency test scores, value-added, school district rating, efficiency, and performance index, are tested using regression analysis, with a spatial error model, on individual sales in Cuyahoga County, Ohio for 2000 and 2005. Results show that while all school quality measures tested have some explanatory power, school district ratings and performance index, which are comprehensive measures of school quality, are the most appropriate measures and are readily capitalized into housing prices.

Key words:

Hedonic regression, school quality, spatial error model, Housing markets, capitalization

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Introduction

The decision of where to live is made based on households' taste and preferences for the quality of public services and amenities (Tiebout, 1956). Housing prices vary with the quality of a bundle of public services provided by a jurisdiction since better public service creates demand and willingness to pay, which are capitalized into housing prices. School quality is considered one of the most influential factors on housing prices in the United States. Empirical studies have shown that there is a positive relationship between school quality and housing prices, particularly school outcome measures (i.e., state standardized math test scores). In recent peer-reviewed research focusing on the relationship between school quality and housing prices (Hayes and Taylor 1996; Downes and Zabel 2002; Haurin and Brasington 2006), the value-added variable (of output over a previous time period) has also been used as a measure of school quality, although the empirical results are not consistent. More recently, comprehensive measures of school quality (school ratings and performance index)[1] introduced by the No Child Left Behind Act (NCLB 2001) have been tested empirically (Figlio and Lucas 2004).

It is still debatable, however, which school quality variables are the appropriate measures of school quality and have the most influence on housing price, although there is consensus that they do have a positive relationship with respect to

[1] In Ohio the school rating is called "School District Designation" and is calculated based on a composite performance index. School district designations are state-generated school district ratings in a five-category format.

housing prices. The purpose of this research is to find the specific measure of school quality that is appropriate in the housing market as a proxy for school quality, and how much this measure of school quality is capitalized. This paper considers several alternative measures of school quality, including the state-generated performance index (a comprehensive weighted measure based on both test scores and non-testable elements including graduation and attendance rates), student proficiency test scores, value-added, and school district designation. These are tested utilizing a cross-sectional housing sales database over two time periods in Cuyahoga County, Ohio, the central county of the Cleveland Metropolitan area.

A classical OLS model has usually been used to find the measure of school quality and to measure the extent of capitalization of school quality on housing prices. However, the estimates generated by the OLS model would be biased if housing prices are spatially correlated. There is reason to believe that housing prices are spatially correlated since neighborhoods in a community enjoy the same quality of public goods and services (Basu and Thibodeau 1998).

This paper will first present the literature on school quality, which includes expenditure per pupil, test scores, value-added, and information on accountability. The sources of housing and neighborhood characteristics data and school quality are discussed in the next section. The following section addresses the variables, research questions and model specifications. The analysis of the results and conclusions are discussed in the final section of this study.

Literature Review

A substantial number of researchers (Hayes and Taylor 1996; Downes and Zabel 2002; Haurin and Brasington 2006) have attempted to answer the question of what the most appropriate measure of school quality is, and how much households are willing to pay for these attributes. Among these researchers, some scholars empirically tested expenditure-per-pupil as the measure of public service quality, while others posited test scores and other scholastic output measures are a good proxy for school quality. Measurements of school quality are neither simple nor adequately quantified (Hanushek 1986). The lack of consensus among the researchers indicates that no definitive conclusion can be made as to which school quality factors influence on individuals' decisions about where to buy a house.

The seminal paper that first introduced the concepts of school quality and capitalization of school quality on housing price dates back to Oates' paper (1969). Oates hypothesized that consumers who expect a high quality of public services reside in communities with high-quality public service programs. Expenditure per pupil was used as the measure of the quality of public service. Using aggregated median house values in New Jersey, Oates used the least-squares regression and found that property values have a significantly negative relationship with property tax, and that property values are positively correlated with expenditure per pupil in the public schools.

However, Rosen and Fullerton (1977) were skeptical of using the expenditure per pupil variable as the measure of school quality. They argue that the statistical results are more consistent with the theoretical predictions when output measures are

included in the analysis than when expenditure levels are used exclusively. They tested this hypothesis and replicated Oates's study, using students' achievement test scores as a measure of public output. They found that the coefficient of the expenditure per pupil variable was not consistent in the 1960 and 1970 results, while the achievement test scores were statistically significant and positive in both models. They conclude that achievement test scores are well capitalized on housing prices and improve the statistical equation considerably.

Jud and Watts (1981) included school quality and racial composition in the model to examine the effect of both variables in housing prices in the city of Charlotte, Mecklenburg County, NC. The achievement test scores of the third grade reading level were used as the index of school quality, which had a positive effect and increase in housing prices by 5.2 percent in the full sample and 6.2 percent in the non-inner-city sample. The effect of racial composition had a negative effect on housing prices but was statistically not significant when the school quality variable is included (race was statistically significant when the school quality variable was excluded from the model). This inconsistency leads Jud's study (1985) to further examine the relationship between school quality and housing values by separating the effect of school quality from the effect of students' racial composition. Jud contends that average reading scores are associated with an increase in housing prices of 1.6 percent in Los Angeles and 2.7 percent in San Francisco, regardless of student racial composition and socioeconomic background.

Further empirical studies have confirmed that test scores are preferred to the school input measure of expenditure per pupil as a reliable measure of school quality in housing studies. Using test scores, expenditure per pupil, and value-added, Downes and Zabel (2002) found that proficiency test scores are a good measure of school quality. They used the American Housing Survey (AHS) housing sales data and neighborhood characteristics in Chicago from 1987 to 1991 to address the relationship between neighborhood characteristics and performance of the students. They concluded that neighborhood characteristics were correlated with reading scores and are capitalized into housing prices, while the value-added and expenditures variables are not major determinants of housing price.

Motivated by several educational and economic research articles, the value-added method (year-on-year improvement in output) was considered the most theoretically appropriate measure and has gained popularity. Because test scores are reflected in parents' demographics, neighborhood quality, and innate student intelligence, the value-added method measures improvements of academic achievement from a baseline level (Brasington 1999).

Hayes and Taylor (1996) tested whether the marginal school effects (the change in year-to-year school performance results) as a measure of school quality had influence on housing prices sold in 1987 in Dallas, Texas. Their "marginal effect" is the increase in student achievement and is decomposed into a school effect and peer effect. They found that parents pay a housing price premium of 0.26 percent for the

marginal effect of the school on student performance, but there is no significant premium for expenditure per pupil or test scores.

Brasington (1999) utilized similar methods and variables as Hayes and Taylor (1996), but his study differs because he had more measures of school quality variables, had a larger sample (27,440 houses in 128 communities) and different units of study, and controlled for spatial autocorrelation. To measure school quality, 37 explanatory variables of school quality (expenditure per pupil, teachers' academic degrees, salary, experience, student-to-teacher ratio, students' graduation rates, attendance rate, and value) were used in the six largest metropolitan areas of Ohio. Although the finding shows that test scores are positively correlated with housing prices in four models and negatively in two, he concludes that proficiency test scores are better capitalized in the housing market than value-added. The author also asserts that the value-added approach is not appropriate for measuring school quality in housing prices because it is largely unobservable, is not valued in the housing market, and is less important to parents than school outcomes.

After No Child Left Behind (NCLB), Figlio and Lucas (2004) focused on school ratings -- school quality information provided by each state education department to parents-- and tested whether parents value this information, and if so, how much this information is capitalized. Figlio and Lucas examined the impact of publicly available information in housing prices and letter grades of school districts in Florida. The state-assigned school letter grades, ranging from A to F, provide a comprehensive measure of school quality beyond test scores. The grades earned by a district form a

corresponding geographic zone. For example, the difference in the capitalization of school quality into housing prices an "A" zone and a "B" zone is approximately 8 percent. Their conclusion shows that new information through the school report cards plays an important role in the housing market. This research will attempt to corroborate this in Ohio.

Another concern is that school quality is correlated with neighborhood effects. Black (1999) attempted to isolate the impact of public school quality outcomes from other neighborhood characteristics. Black employed a boundary fixed effect, which assumes that neighborhood characteristics (shopping, etc.) are similar across municipal or other district borders. This approach further isolates the effect on housing price due to school quality through a comparison of housing prices on one side of the street affiliated with a specific school, to prices on the other side of the same street affiliated with a different school. Black examined how much parents and other homebuyers place value on schools with higher test scores in the suburban area around Boston, Massachusetts, controlling for property tax and school spending. Test scores of a fourth-grade statewide assessment were used as a proxy for school quality. The findings are consistent with previous work without the boundary fixed effect; however, with the boundary fixed effect, the coefficient of test scores is reduced by 50 percent.

However, the boundary fixed-effect method has been criticized because school quality information is given at the school district level (Clapp, Nanda, and Ross 2005), and because the boundary approach parameter estimates are biased and have the

incorrect sign (Brasington and Haurin 2006). Brasington and Haurin also apply a spatial autoregressive model that measures the spatial dependence between housing sale prices that are close to one another. They used three school quality variables: expenditure per pupil, proficiency test scores, and value-added, and found that expenditure per pupil and proficiency test scores increase housing prices by 0.49 and 7.1 percent, respectively.

The coefficients of the measure of school quality may be biased due to spatial autocorrelation and vary according to the methodology. The technique of boundary fixed effect might be the appropriate method to disentangle school measures from neighborhood characteristics when the study area is small and relatively homogeneous. However, the boundary-fixed effect is not an appropriate or precise technique in a study that examines a large geographical boundary because of spatial dependence and heterogeneity.

To conclude, the literature can be organized into several categories, including input factors such as expenditures, output factors including test scores and school district performance index and "report cards," value-added where schools increase output levels over a previous period, demographics and other parent-related factors, and efficiency (e.g., the ratio of school quality output to property taxes paid for school services). Exhibit 1 summarizes the extant literature.

Insert Exhibit 1 here

Study Area and Data Collection

The study area for this research is Cuyahoga County, Ohio, whose main city is city of Cleveland contains 31 school districts. This study, however, focuses on 30 districts, omitting the central city Cleveland School District because of its unusual size, dominant position, declining enrollment, fiscal stress, and other atypical qualities. There are approximately 1.4 million people and 617,000 housing units in Cuyahoga County, of which the City of Cleveland represents about one third (U.S. Census 2000).

Data for housing sales prices were obtained from Cuyahoga County Auditor records and are available for all residential transactions. The county data set includes variables related to structural characteristics of the house, including but not limited to: lot size, age of house, number of bathrooms, and living total size. Average housing sales prices were $148,676 in 2000 and $176,048 in 2005, respectively.

The initial data set contained about 30,000 housing sale transactions in 2005. The data cleaning process led to the deletion of all records that had missing data for the following variables: sale price, parcel number, building square footage, number of rooms, lot square footage, properties with missing style and construction type specification, and age of the property. Data for the City of Cleveland were also deleted. Records clearly outside of a reasonable range (outliers) were also deleted. Only houses sold for between $65,000 and $700,000 were retained for the analysis. Residential square footage in the study ranged from 500 to 6,000 square feet. Properties with less than three rooms and those with more than 15 rooms were removed, as were properties with lot square footage lower than 1,000 square feet and

larger than 100,000 square feet (about 2.3 acres). Parcels with lot frontage lower than 20 and higher than 200 feet were excluded from consideration. Finally, foreclosed properties were also excluded from the data set. After deleting these sales, 12,462 suburban residential sale observations were available for analysis. A similar process was also undertaken for the 2000 sales year, which had 11,146 valid sales, but for the sake of brevity the process is not further addressed here.

School Quality Variables

School quality information, aggregated at the school district level, was added to the real estate data set. At the most basic level, 29 school district dummy variables (plus Parma, the reference category and the largest school district outside of the city of Cleveland) are used to capture the differences among each school district without delineating which school-related factors affect value.

Five broad measures of school quality are examined. These include input factors (teacher characteristics and overall expenditures per pupil); output factors (percent of students at and above proficiency levels, performance index, and school district "report card" designations); value-added of year-to-year progress in output; efficiency of output to tax rates; and parent and peer characteristics, largely controlled for in neighborhood characteristics. All these were used to find the most appropriate measure of school quality in the housing markets. All of these measures of school quality are publicly available to various degrees (through the Ohio

Department of Education), and may be accessible to parents via the world wide web, newspapers, realtor data bases, general reputation, or word of mouth.

Although the value-added variable is hard to measure and unobservable, the value-added variable is defined as the point estimates of the mean gains for each grade-subject combination (Ohio Department of Education).

The performance index variable is a comprehensive measure calculated on how well each student does on all tested subjects in grades 3-8 and the 10th grade graduation test. The variable of school district "report card" designations is categorized in a five-point ranking: excellent being the best, followed by effective, continuous improvement, academic watch, and finally by academic emergency, the lowest category. The category of academic emergency is excluded because no school district falls in the County fell into this category. A total of 42 percent (13 school districts out of 31 in Cuyahoga County) were rated excellent as per the state report card in 2005.

Using thematic maps, housing prices and measures of school quality in Cuyahoga County provide an interesting spatial visualization of the data, shown in Exhibit 2.

Insert Exhibit 2 about here

Housing prices appear to be well matched visually to school district "report card" designation and performance index. The map for value-added, however, shows

different patterns between the west and east sides of the city. The "apparently well performing" school districts in the east side, including Beachwood, Solon, and Orange, gained less value-added than the west side school districts, Westlake, Strongsville, and Rocky River, potentially because of their higher baseline starting values.

Additional data were obtained from the U.S. Census at the block group level for control variables such as neighborhood characteristics, including the percentage of white population, percentage of high school students, percentage of private school students, education attainment of population above 24 years, and median household income. The detailed descriptions of these and all variables are presented in Exhibit 3a. Other relevant school measures, teacher's experience, salary, attendance rate, and graduation rate, were used as control variables and are also included. Exhibit 3b contains a list of the school district dummy variable names.

Insert Exhibit 3a and 3b here

<u>Model Specifications</u>

This research addresses which variables are the best measures of school quality after NCLB, and to what extent these variables are capitalized into housing price. Housing prices are a function of the house's physical and local neighborhood characteristics, and school quality:

$$HP = f(S, N, SQ) \qquad (1)$$

where S is a vector of physical housing characteristics, N is a vector representing neighborhood characteristics, and SQ stands for school quality factors.

A hedonic model was used to test the hypothesis that school quality is positively related to housing prices. With school quality variables or school district dummy variables as independent variables in 2000 and 2005, the model's reduced form is:

$$Ln(P) = \beta o + \beta_1 S + \beta_2 N + \beta_3 SQ + \varepsilon \qquad (2)$$

Where,

P	**=**	**Sales price of the house, in a log functional form**
S	**=**	**Vector for structural characteristics of the house**
N	**=**	**Vector that consists of neighborhood characteristics**
SQ	**=**	**School quality vector, including school district dummy variables, input factors (teacher and expenditure per pupil), output factors (PI, proficiency test scores, school district report card), value added, and school expenditure efficiency**
ε	**=**	**Error term**

School quality variables in the model are input factors (teachers' average salary and experience, and expenditure per pupil), output factors (the percentage of student at or above proficiency level for 4th math test, performance index, and school district designation), value-added, and efficiency. The efficiency variable is obtained by calculating the ratio of a school output measure (performance index) and the expenses of the school (the effective tax rate).

The research hypothesis are that comprehensive school measures, such as school district "report card" designation and performance index are preferred to partial information such as test proficiency scores and expenditure per pupil.

This research also utilizes spatial modeling, because housing prices are affected by those of the neighborhood, which causes spatial autocorrelation problems. The "Lagrange Multiplier (LM test)"[2] test was used to test spatial autocorrelation on this data set. The spatial error model is utilized and is described as follows:

$$\mathbf{H} = \mathbf{X}\beta + \varepsilon, \ \varepsilon = \lambda \mathbf{Wu} + \mathbf{u}, \ \mathbf{E}(\varepsilon\, \varepsilon') \neq \mathbf{0} \qquad \textbf{(3)}$$

Where λ (Lambda) is a spatial autoregressive error parameter and W is is the weighted matrix. This study uses the spatial error model instead of a spatial lag model, which is more appropriate for situation where a certain phenomenon or action at a given location is thought to affect property at other locations (Anselin 2003).

Regression Diagnostics

Diagnostic results detect whether model is properly specified or not. In order to test for multicollinearity[3], the Jarque-Bera test was used to test the normality based

[2] According to Anselin (1998), spatial dependence and heterogeneity is structural instability in the form of non-constant error variances or model coefficients. . . . Spatial autocorrelation is through the specification of a spatial stochastic process. Spatial stochastic processes are categorized as spatial autoregressive (SAR) and spatial moving average (SMA) processes. The LM equation is: $\frac{n-k}{m}\frac{R^2}{1-R^2}$

[3] This research approach elects to delete variables that had a multicollinearity problem. Thus, the percentage of percentage of African American, number of rooms and bedrooms, lot depth and width, were discarded from some models.

on the OLS residuals. The value of Jarque-Bera statistic is 9,508.33 with 2 degrees of freedom, which is statistically significant so we can not reject the null hypothesis that the residuals are normally distributed.

The Lagrange Multiplier (LM) test indicates the OLS model has a spatial autocorrelation problem. The probability of the spatial error model is significant: the value of LM is 226.07.

Empirical Findings

The initial model was prepared using dummy variables for each school district to show the difference in housing prices between 2000 and 2005. This was done in order to isolate school districts' values (with a dummy variable) to detect a pure market effect for school district without saying which school quality factors were associated with capitalization into property value. We ran the model with all 29 school districts' dummy variables, leaving out Parma, Ohio, the largest district and one of typical (Effective) quality, as the reference category. The hedonic model for 2000 was used as the baseline. Exhibit 4a shows the results from both 2000 and 2005, controlling for structural, housing, and neighborhood characteristics.

The model adjusted R^2 is highly satisfactory: Independent variables included in the model explain 82.8 percent of variation in the dependent variable in the 2000 model and 79.6 percent in the 2005 model, respectively. The sign of the coefficients are as expected for the structural variables and are consistent with theory and with findings of previous research in Cuyahoga County.

The coefficients for the physical and neighborhood variables performed well. All had the same signs and significance in 2000 and 2005 with the exception of the fall sales season and location of private schools within a one-mile radius of each sale. The proximity to private schools in 2005 was insignificant compared to 2000, where it had a positive sign. This may indicate that the presence of private schools as a competitive factor to public schools may outweigh any amenity value.

As shown in Exhibit 4b, there are 16 school districts that had an increase in the value of the school district dummy variable, expressed in percent, between 2000 and 2005, compared with the reference category.[4] Three districts have a decrease in coefficient, and 10 districts have no substantial change (a one-percent change in a significant coefficient). This curious overall trend toward a larger coefficient (or in many cases a gravitation toward zero in a 2000 coefficient that was negative) may indicate an increase in the importance of school district values in the marketplace. Part of this could be attributable to the removal of uncertainty about school district quality.[5]

Insert Exhibit 4b here

[4] See Exhibit 4. The plus (+) sign represents increase in the school district dummy for housing price, and the (-) sign shows decline in housing prices, of greater than one percentage point. If either the dummy (2000 or 2005) is not statistically significant, this is counted as zero.

[5] Results for school district dummy variables under both the classic OLS and spatial models were very similar and provided the same coefficient signs: Only the sign of the Strongsville school district is different.

The analysis now moves toward the core research question of which school quality factors are capitalized into market value. Using the spatial error model to control for spatial autocorrelation, six alternative models are set forth to examine different measures of school quality. Exhibit 5 shows the empirical results. The first model has only school quality input factors (no output factors at all), including annual pupil expenditure, teacher salary, and teacher experience. All signs for the input factors are statistically significant at 99%, with corresponding t-stats in the 3-5 range. The overall model R^2 is the lowest of the six models at 78.67. However, all six model R^2 statistics are quite close.

The first model's log-likelihood is 2,382.76. Results show that average expenditure per pupil is positively correlated with housing price, and is statistically significant. With respect to the interpretation of the magnitude of the effects of this variable on housing sales price, this research followed the methodology set forth by Black (1999), which standardizes the marginal effects by using standard deviation as the unit of analysis. This is necessary in the current case because most variables have different scales. For pupil expenditure, a one standard deviation increase in expenditure per pupil raises housing price by $1,527, controlling for housing characteristics and neighborhood characteristics. The estimate of teacher's salary is also significant and positively associated with house price, and its effects are capitalized by 4.8 percent ($8,415). Teacher experience is generally positive, but one model (6) shows a negative sign. The magnitude of this variable is very small; one standard deviation increase in teachers' experience raises housing prices by only $3.50.

The second model uses a single non-aggregated output measure: 4th grade math proficiency rate. The adjusted R^2 indicates 78.82 and the log-likelihood is 2,434. It indicates that the proficiency percentage of 4th grade math test in Cuyahoga County is positively correlated to housing prices and is statistically significant. The coefficient is 0.003, and this reflects that the willingness to pay for 4th grade math score for each additional percentage pass rate in the test score equates to a school quality in Cuyahoga County is $5,973 at average housing price of $176,048.

In contrast, the value-added variable analyzed in the third model has a positive coefficient value of 0.0016 but is only statistically significant at near the 90 percent confidence interval (the t statistic is 1.66). In another words, the value-added variable affects housing price positively by approximately 0.5 percent, or $788. The value-added variable has the least significance, and the second lowest R^2 and log likelihood among the six models.

As shown in the visual map display in Exhibit 2, the value-added variable appears not to relate as closely to housing prices as do the other measures of school quality. A comparison of the east-side and west-side cities indicates that relatively poor-performing school districts appear to gain more value-added than do cities with a higher initial level of student competence. Higher ranked school districts on the east side are stable in value-added characteristics compared with the school districts on the west side, which have the potential to improve in school quality as shown in the map. The statistical results show that the value-added variable is an adequate proxy for school quality but may vary according to location.

Moving on to the school district report card (a comprehensive output measure mandated by the NCLB Act of 2001), housing prices in school districts designated as Excellent increased more than those in Effective school districts (the reference category) by 4.8 percent. Also, housing prices in school districts designated as Continuous Improvement and Academic Watch are lower than those in school districts designated as Effective by 5.5 percent and 11.0 percent, respectively. Hence, readily available public information, in the form of school district designations, is consistent with expectations and is capitalized in housing prices in suburban Cuyahoga County. The model R^2 and log likelihood were tied for the highest of the six models. Homebuyers appear to be willing to pay more for houses with higher school district designation, and this is capitalized into housing prices. This might be because the school district designation is simple and easy to recognize to residents and homebuyers. Also, it is noteworthy that the difference between the designation categories is in roughly five percent bands, and it can be stated that the intervals between the categories is approximately equivalent.

Moving on to model 5, the performance index variable, another comprehensive output measure, is also positively correlated with housing prices. The R^2 of 78.93 is also tied with school district designation for the highest among six models. The coefficient is 0.0059 (*p* < .01) and increase housing prices by $9,667. Similar to the school district designation variable, the performance index is publicly available information for residents and nonresidents alike. Unlike 4th math proficiency

percentage, which is a partial measure of school quality, the performance index is a comprehensive measure of school quality and matched to the housing prices.

Finally, model 6 includes the efficiency variable and tests whether households value the efficiency ratio of school output/property tax. Theory indicates that the effective property tax rate is negatively related to housing prices, while the measure of school quality has a positive impact on housing prices. The ratio of school outcome and effective property tax rate reflects the trade off-of negative and positive effects, and the coefficient of the efficiency variable is statistically significant and positive at approximately 0.15. The adjusted R^2 is 78.77 and the log-likelihood is 2,418, respectively, but this is in the middle of the pack in a closely contested field of school quality factors. Efficiency is capitalized into housing prices by 5 percent, or $9,228. It can be inferred that school quality output has a stronger effect on housing price than the equivalent increase in effective property taxes paid.

Insert Exhibit 5 here

Conclusions

This research has analyzed the role of public school quality as an influential variable in housing price. Empirical studies have shown that the various measures of school quality have a substantial impact on housing prices, but it is still debatable which measure of school quality is most appropriate. The purpose of this research has been to identify and compare appropriate measures of school quality that influence the housing market after the No Child Left Behind Act (2001). Both OLS and a spatial error models were used to analyze about 12,000 housing sales per year in

2000 and 2005 in suburban Cuyahoga County, Ohio. The R^2 of the models were approximately 80 percent. Several measures of school quality that home buyers value include: school input factors, output factors, value-added, comprehensive performance measures, and efficiency factors. Six models were utilized with input factors (teachers' average salary and experience and expenditure per pupil), output factors (4th grade math proficiency rate, school district designations, and performance index), value-added, and efficiency.

There was a curious overall trend toward a larger or more positive school district coefficient from 2000 to 2005. This may indicate an increase in the importance of school district values, and part of this could be attributable to the removal of uncertainty about school district quality, and increased awareness of school services in general.

The variation of input variables such as expenditure per pupil, teacher salary, and teacher's experience are adequate measures of school quality but do not perform as highly as output variables such as proficiency test scores, school district report card ratings, and a comprehensive school performance index. The expenditure per pupil in lower ranked school districts is similar to that in higher ranked school districts. In other words, less wealthy school districts are less efficient in terms of input and output, and tax burdens are greater to taxpayers in poor school districts, although poor districts have lower test scores. This is partly exacerbated by rapidly declining enrollments in the central city (not tested in this research) and some adjoining inner-ring suburbs. In one model this sign was negative. In general, however, our findings

are consistent with Oates (1969) who finds a positive relationship between school inputs and property values.

Although all six models show that the school quality variables used in this paper are positively related to housing prices, the empirical results indicate that the state school district report card and comprehensive performance index are (by a narrow margin) the most appropriate measures of school quality by two measures: the degree to which they are capitalized into the housing market, and by the explanatory power of the statistical models. These aggregated measures are also the simplest and easiest to access and understand: From the myriad of analytical tools and data, the school district results are boiled down to one designation or number. The school district rating result supports the work of Figlio and Lucas (2004), who also found a positive relationship between school district ratings and school quality. The passage rate of the 4th grade math test was also a good measure, as was the efficiency ratio of school output/tax price, similar to the findings set forth by Black (1999). The value added measure was also significant, but only at a 90 percent level of confidence. These findings are complementary to the findings of Brasington (1999) and Brasington and Haurin (2006) concerning the difficulty of market capitalization of the value added concept in the public school context.

With respect to the magnitude of the capitalization of the effects on housing price, results showed that the most influential variables were performance index, efficiency, teacher salary, and 4th grade math pass rate, with a one standard deviation change in these variables generating a 3-5 percent change in house price. The least

influential variables were pupil expenditure, value added, and teacher experience, which all had a capitalization rate of less than one percent. While not strictly comparable with the other variables in this study, the categorical variables (school district report card designations) were also quite influential, with poor performing districts capitalized at a discounted value of 11 percent, with the highest performing districts trading at about 5 percent above the reference category of Effective educational services.

After the No Child Left Behind Act (2001), the performance index and school district rating replaced proficiency test scores as most the appropriate measure of school quality in the housing market. Residents are sensitive to public information and consider it when purchasing houses, and respond more readily to comprehensive measures of school quality, not just partial test scores. We conclude that this information is capitalized into housing prices and that school district awareness appears to be increasing since NCLB was established in 2001.

References

Anselin, L., *Spatial Dependence In Linear Regression Models With An Introduction To Spatial Econometrics,* Handbook of Applied Economic Statistics, New York: Marcel Dekker. 1998.

Anselin, L., Spatial Externalities, Spatial Multipliers, And Spatial Econometrics, *International Regional Science Review*, 2003, 26 (2), 153-166.

Basu, S. & T. G. Thibodeau, Analysis of spatial autocorrelation in house prices, *Journal of Real Estate Finance and Economics,* 1998, 17(1), 61-85

Bayer, P., F. Ferreura, & R. McMillan. *Tiebout Sorting, Social Multipliers And The Demand For School Quality.* NBER working paper, 2005, No.10871.

Black, S., Do Better School Matter? Parental Valuation Of Elementary Education. *The Quarterly Journal of Economics,* 1999, 114(2), 577-599.

Bogart, W. & B. Crowell. How Much More Is A Good School District Worth? *National Tax Journal.* 1997, 50(2), 215-232.

Brasington, D., Which Measures Of School Quality Does The Housing Market Value? *Journal of Real Estate Research,* 1999, 18 (3), 395-413.

Brasington, D., School Quality And The Flight To Private Schools: To What Extent Are Public And Private School Substitutes*? Department of Economics, Louisiana State U-University working paper.* 2004

Brasington, D. & D. Haurin. Education Outcomes And House Values: A Test Of The Value Added Approach. *Journal of Regional Science,* 2006, 46(2), 245-268.

Case, B. & J.M. Quigley, The Dynamic Of Real Estate Price. *The Review of Economics and Statistics,* 1991, 73 (1), 50-58.

Clapp, J. M., A. Nanda, & S. L. Ross, Test-Scores And Demographics: What Premiums Do They Attract In Property Values? A Panel Data Analysis, Working paper, University of Connecticut. 2005

Downes, T.& J. E. Zabel, The Impact Of School Characteristics On House Prices: Chicago 1987-1991. *Journal of Urban Economics,* 2002, 52.

Ding, C., R.A. Simons, and E. Baku, The Effect Of Residential Investment On Nearby Property Values: Evidence From Cleveland, Ohio. *Journal of Real Estate Research,* 2000, 19 (1/2), 23-48.

Figlio, D. & M.E. Lucas, What's In A Grade? School Report Cards And The Housing Market, *American Economic Review,* 2004, 94(3), 591-604.

Haining, R., Diagnostics For Regression Modeling In Spatial Econometrics. *Journal of Regional Science,* 1994, 34 (3), 325-341.

Hayes, K. & L.Taylor, Neighborhood School Characteristics: What Signals Quality To Homebuyers? *Federal Reserve Bank of Dallas Economic Review, Fourth quarter*. 1996, 2-9.

Hanushek, E., The Economics Of Schooling: Production And Efficiency In Public Schools. *Journal of Economic Literature,* 1986, 2 (3), 1141-1177.

Jud, D. & J. Watts, Schools And Housing Values, *Land Economics,* 1981, 57(3), 459-470.

Jud, D., A Further Note On Schools And Housing Values, *AREUEA Journal*, 1985, 13(4), 452-462.

Oates, W., The Effect Of Property Taxes And Local Public Spending On Property Values; An Empirical Study Of Tax Capitalization And The Tiebout Hypothesis. *The Journal of Political Economy,* 1969, 77 (6), 957-971.

Ohio Department of Education, Local Report Card School Year 2005 District Level Data. Columbus, Ohio. 2005

Pollakowski, H., The Effects Of Property Taxes And Local Public Spending On Property Values: A Comment And Further Results. *The Journal of Political Economy,* 1973, 81(4), 994-1003.

Ryan, J. E., *The Perverse Incentives Of The No Child Left Behind Act*. New York University Law Review, 2004.

Rosen, S., Hedonic Price And Implicit Markets: Product Differentiation In Pure Competition. *The Journal of Political Economy,* 1974, 82(1), 34-55.

Rosen, H. & D. Fullerton, A Note On Local Tax Rates, Public Benefit Levels, And Property Values. *The Journal of Political Economy,* 1977, 85(2), 433-440.

Seiler, M.J., M. T. Bond, & V. L. Seiler, The Impact Of World Class Great Lakes Water Views On Residential Property Values. *The Appraisal Journal*, 2001, 69(3), 287-295.

Simons, R.A., and A. El. Jaouhari. The Effect Of Freight Railroad Track Activity On Residential Property Values In Cuyahoga County, Ohio. *The Appraisal Journal,* 2004, 72(3), 223-233.

Simons, R. A., W. Bowen and A. Sementelli, The Price and Liquidity Effects of UST leaks from Gas Stations on Residential and Commercial Property Values. *The Appraisal Journal,* 1999, 67(2), 186-194.

Simons, R. A., R. Quercia and I. Maric, The Value Impact of Neighborhood Transition on Residential Sales Price. *Journal of Real Estate Research,* 1997, 15(2), 147-162.

Simons, R.A., W. Bowen and A. Sementelli, The Effect of Underground Storage Tanks on Residential Property Values*.* *Journal of Real Estate Research,* 1997,14(1/2), 29-42.

Wang, F. T. and P.M. Zorn, Estimating House Price Growth With Repeat Sales Data: What's The Aim Of The Game? *Journal of Housing Economics,* 1997, 6(2), 93-118.

Exhibit 1. Summary of Previous Literature

Author	Year	Measure of school quality	Remarks and findings
Oates	1969	Expenditure per pupil	Positive relationship between school quality and expenditure per pupil
Rosen and Fullerton	1977	4th grade test scores	Outcome variables are better measure of school quality
Jud and Watts	1981	3rd grade reading test scores	Separating the effect of school quality from racial composition in housing values
Hayes and Taylor	1996	Marginal (performance) effect, expenditure per pupil and test scores	Positive relationship between school quality and marginal school performance results over time
Brasington	1999	Value-added, expenditure per pupil, and test scores	Proficiency test scores are better measure than the marginal performance effect
Black	1999	4th math test scores	Boundary-fixed effect avoids omitted variable bias
Downs and Zable	2002	Value-added and proficiency test scores	Proficiency test scores are better measure than the marginal effect
Figlio and Lucas	2004	School district ratings	School ratings were used as measure of school quality: found positive relationship with housing prices
Brasington and Haurin	2006	Value-added and proficiency test scores	Adopting spatial lag model to correct for spatial autocorrelation

Exhibit 2 Housing Prices and Measures Of School Quality, 2005

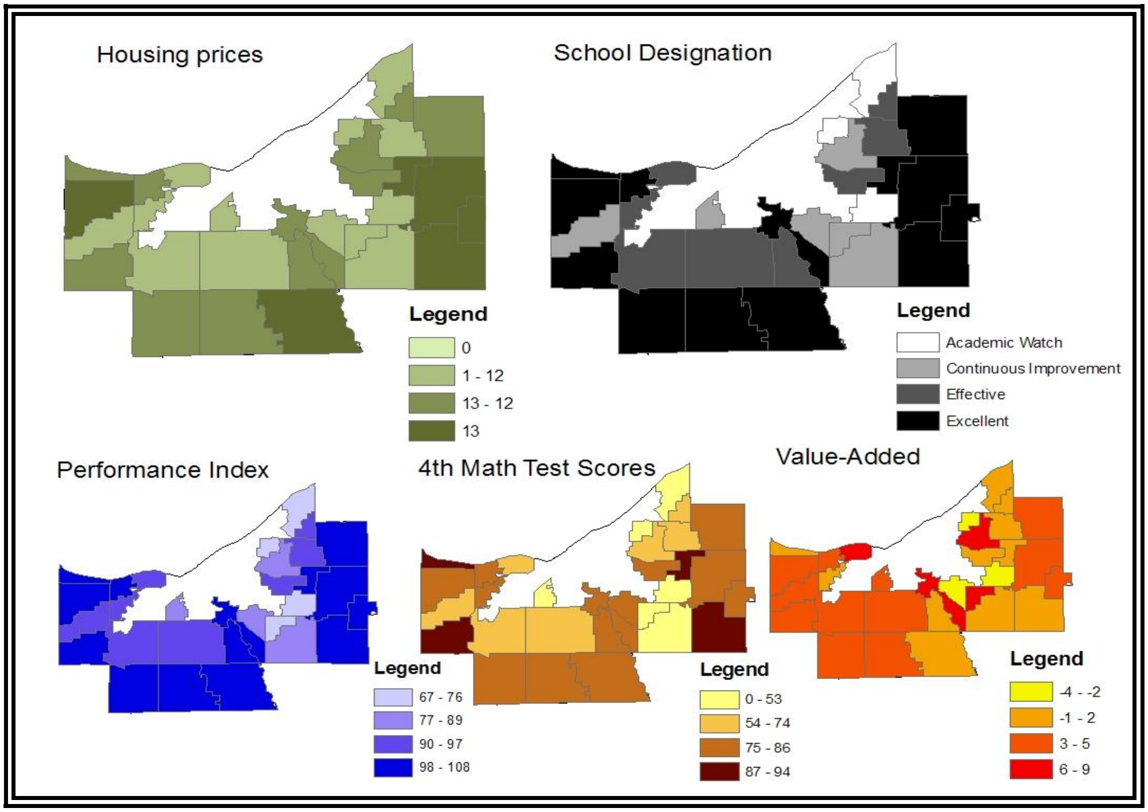

Exhibit 3a: Variable Definition, Means, and Standard Deviation, 2005

Variables	Description	Mean	Standard Deviation
Log_HP	Log of housing price	11.98	0.437
BASESQFT	Basement square footage	864.95	482.75
BEDROOMS	Number of bedrooms	3.26	0.817
BATHS	Number of bathrooms	1.42	0.616
FIREPL	Number of fireplaces	0.53	0.607
GARSIZE	Garage size in square feet	416.26	154.02
L_FRONT	Lot of frontage in feet	65.90	62.12
LOG_LOT	Log of lot size in square feet	9.17	0.693
LOG_LIVOT	Log of living area square footage	7.39	0.374
AGE	Age of property in years	52.65	23.31
D_SPRING	Dummy for sales in the spring sales season	0.24	0.429
D_SUMMER	Dummy for sales in the summer season	0.34	0.474
D_FALL	Dummy for sales in the fall season	0.25	0.436
D_WINTER	Dummy for sales in the winter season	0.16	0.366
D_SINGLE	Dummy for single family dwelling	0.95	0.227
P_WHITE	Percentage of white population in a block group	84.01	23.00
P_PUBLIC	Percentage of public students in a block group	14.69	5.389
P_PRIVATE	Percentage of private students in a block group	4.22	3.244
P_HIGH	Percentage of adult high school degree attainment in block group	28.36	11.34
P_BACHELOR	Percentage of adult bachelor degree attainment in block group	20.07	9.33
LOG_INCOME	Log of median income in block group	10.86	0.35
PROPERTY TAX	Effective property tax rate in each school district (Mills)	71	12
EXPENDITUR	Expenditure per pupil	10,924.94	1,886.56
SALARY_1	Teacher's average annual salary	55,569.65	4,779.69
T_EXPERIENCE	Teacher's experience in years	13.94	2.00
4THMATH_1	4th math (percentage of students at and above proficiency)	70.65	13.05
VALUE_ADDE	Value-added variable (difference between previous year and current year)	2.87	2.87
D_EXCELLEN	Dummy variable of excellent school district designation	0.28	0.45
D_EFFECTIV	Dummy variable of effective school district designation	0.39	0.488
D_CI	Dummy variable of continuous improvement school district	0.24	0.43
D_AC	Dummy variable of academic watch school district	0.09	0.28
PI	Performance index (a comprehensive school quality measure)	93.02	9.26
EFFICIENCY	The ratio of performance index to effective tax rate	1.34	0.36

LAMBDA	**Spatial autoregressive coefficient in the spatial error model**	**NA**	**NA**

Exhibit 3b: Variables' Definition, Means, and Standard Deviation

Variables	Description	Mean	Std. Dev.
D_SD_BV	Dummy variable for Bay Village School District	0.03	0.16
D_SD_BEA	Dummy variable for Beachwood School District	0.01	0.09
D_SD_BEDF	Dummy variable for Bedford School District	0.03	0.17
D_SD_BEREA	Dummy variable for Berea School District	0.06	0.23
D_SD_BRE_B	Dummy variable for Brecksville-Broadview Heights School District	0.02	0.15
D_SD_BROOK	Dummy variable for Brooklyn School District	0.01	0.11
D_SD_CHAR	Dummy variable for Chagrin Falls District	0.01	0.09
D_SD_CH	Dummy variable for Cleveland Heights-University Heights School District	0.09	0.28
D_SD_CUYAH	Dummy variable for Cuyahoga Heights School District	0.00	0.06
D_SD_ECLE	Dummy variable for East Cleveland School District	0.02	0.14
D_SD_EUCLI	Dummy variable for Euclid School District	0.06	0.24
D_SD_FAIRP	Dummy variable for Fairview park School District	0.02	0.15
D_SD_GARH	Dummy variable for Garfield Heights School District	0.04	0.19
D_SD_INDEP	Dummy variable for Independence School District	0.01	0.08
D_SD_LAKEW	Dummy variable for Lakewood School District	0.05	0.23
D_SD_MAYPL	Dummy variable for Maple Heights School District	0.04	0.19
D_SD_MAYFI	Dummy variable for Mayfield School District	0.03	0.18
D_SD_NOROM	Dummy variable for North Olmsted School District	0.03	0.18
D_SD_NORRO	Dummy variable for North Royalton School District	0.03	0.16
D_SD_OMFA	Dummy variable for Olmsted Falls School District	0.02	0.14
D_SD_ORA	Dummy variable for Orange School District	0.01	0.12
D_SD_RICHM	Dummy variable for Richmond Heights School District	0.01	0.12
D_SD_ROCRI	Dummy variable for Rocky River School District	0.02	0.15
D_SD_SHAKH	Dummy variable for Shaker Heights School District	0.04	0.19
D_SD_SOLON	Dummy variable for Solon School District	0.02	
D_SD_SOUEU	Dummy variable for South Euclid-Lyndhurst School District	0.07	0.25
D_SD_STRON	Dummy variable for Strongsville School District	0.05	0.23
D_SD_WARR	Dummy variable for Warrensville Heights School District	0.01	0.09
D_SD_WESTL	Dummy variable for Westlake School District	0.03	0.16

Exhibit 4a: Results of Structural and Neighborhood Characteristics for 2000 and 2005 Models

	2000 Beta t-value		2005 Beta t-value
CONSTANT	7.6082 *** (73.00)		7.2155*** (68.57)
BASESQFT	0.0001*** (18.86)		0.0001*** (19.44)
BEDROOMS	0.0164*** (6.04)		0.0784*** (18.02)
BATHS	0.0620*** (15.44)		0.0065** (2.20)
FIREPL	0.0380*** (11.54)		0.0327*** (9.02)
GARSIZE	0.0001*** (10.05)		0.0001*** (8.60)
L_FRONT	0.0006*** (5.70)		0.0005*** (4.56)
LOG_LOT	0.0487*** (9.37)		0.0486*** (9.46)
LOG_LIVOT	0.3890*** (46.44)		0.4625*** (51.64)
AGE	-0.0028*** (-23.01)		-0.0024*** (-19.83)
D_SPRING	-0.0172*** (-4.19)		-0.0176*** (-3.83)
D_FALL	-0.0004 (-0.08)		-0.0118*** (-2.60)
D_WINTER	-0.0374*** (-7.95)		-0.0417*** (-7.94)
D_SINGLE	0.1723*** (18.31)		0.2143*** (22.31)
P_WHITE	0.0018*** (8.87)		0.0021*** (11.64)
P_PUBLIC	-0.0029*** (-5.36)		-0.0023*** (-4.84)
P_PRIVATE	0.0024*** (2.83)		0.0002 (0.20)
P_HIGH	-0.0033*** (-7.95)		-0.0041*** (-10.91)
P_BACHELOR	0.0016*** (3.26)		0.0015*** (3.32)
LOG_INCOME	0.0455*** (5.56)		0.0413*** (5.15)

Note: Numbers in parentheses are t-values.

*** = $\alpha \geq .10$**

**** = $\alpha \geq .05$**

***** = $\alpha \geq .01$**

Exhibit 4b: Results of School District Dummies for 2000 and 2005 Models

Sorted by 2005 report card	2000 Beta t-value		2005 Beta t-value	Price changes between 2000 and 2005
D_SD_BV	0.0717*** (3.97)		0.0930*** (5.74)	+
D_SD_BEA	0.2141*** (8.44)		0.2178*** (9.49)	NC
D_SD_BEDF	-0.0748*** (-4.33)		-0.0070 (-0.49)	+
D_SD_BEREA	0.0194 (1.52)		0.0267** (2.48)	NC
D_SD_BRE_B	0.0791*** (4.01)		0.0612*** (3.68)	-
D_SD_BROOK	0.0307 (1.24)		0.0511*** (2.61)	+
D_SD_CHAR	0.3889*** (13.22)		0.3988*** (14.61)	NC
D_SD_CH	-0.0165 (-1.04)		0.0182 (1.31)	NC
D_SD_CUYAH	0.0280 (0.73)		0.1586*** (4.76)	+
D_SD_ECLE	-0.1161*** (-4.22)		-0.0695*** (-3.14)	+
D_SD_EUCLI	-0.1230*** (-9.63)		-0.0708*** (-6.49)	+
D_SD_FAIRP	0.0347** (2.03)		0.0287* (1.90)	NC
D_SD_GARH	-0.1145*** (-7.66)		-0.0858*** (-7.10)	+
D_SD_INDEP	0.1452*** (4.87)		0.1979*** (7.31)	+
D_SD_LAKEW	0.0765*** (5.30)		0.0725*** (5.75)	NC
D_SD_MAPL	-0.1037*** (-6.24)		-0.0259* (-1.86)	+
D_SD_MAYFI	0.0950*** (6.04)		0.1414*** (11.04)	+
D_SD_NOROM	-0.0094 (-0.61)		-0.0270** (-2.05)	-
D_SD_NORRO	0.0045 (0.23)		0.0460*** (3.11)	+
D_SD_OMFA	-0.0262 (-1.12)		0.0118 (0.69)	NC
D_SD_ORA	0.1743*** (6.57)		0.1982*** (8.10)	+
D_SD_RICHM	-0.0295 (-1.12)		0.0036 (0.17)	NC
D_SD_ROCRI	0.2440*** (13.82)		0.2534*** (16.27)	NC
D_SD_SHAKH	0.1936*** (10.03)		0.1596*** (9.49)	-
D_SD_SOLON	0.1054*** (5.22)		0.1749*** (10.06)	+
D_SD_SOUEU	-0.0503*** (-3.77)		-0.0363*** (-3.31)	+
D_SD_STRON	-0.0187 (-1.26)		-0.0108 (-0.85)	NC
D_SD_WARR	-0.0673** (-1.99)		0.0084 (0.31)	+
D_SD_WESTL	0.0675*** (3.71)		0.0914*** (6.11)	+
LAMBDA	0.3818*** (28.98)		0.1998*** (14.39)	NA
R Squared	82.8		79.6	
Log-Likelihood	3954.57		2720.41	
DF	11097		12413	

Note: Numbers in parentheses are t-values.

* = $\alpha \geq .10$

** = $\alpha \geq .05$

*** = $\alpha \geq .01$

Exhibit 5a: Estimation of the Spatial Error Models

Variable	INPUT (Model 1)	4^{th} MATH PROFICIENCY TEST (Model 2)	VALUE_ADDED (Model 3)	SCHOOL DESIGNATION (Model 4)	PERFORMANCE INDEX (Model 5)	EFFICIENCY (Model 6)
CONSTANT	6.79919 *** (63.34)	6.81580 *** (63.87)	6.79870*** (63.34)	7.07650*** (65.26)	6.58195*** (61.41)	6.8265***(63.91)
BASESQFT	0.00009*** (20.07)	0.00009*** (20.70)	0.00009*** (20.04)	0.00009*** (20.85)	0.00009*** (21.38)	0.0001***(20.41)
BEDROOMS	0.0056* (1.85)	0.00654** (2.19)	0.00545* (1.82)	0.00674** (2.26)	0.00674** (2.27)	0.0066**(2.20)
BATHS	0.076*** (17.10)	0.07528*** (17.07)	0.07591*** (17.14)	0.07651*** (17.39)	0.07690*** (17.48)	0.0787***(17.83)
FIREPL	0.034** (9.18)	0.03224*** (8.83)	0.03321*** (9.04)	0.03295*** (9.04)	0.03217*** (8.84)	0.0349***(9.54)
GARSIZE	0.00013*** (9.23)	0.00013*** (9.00)	0.00013*** (9.15)	0.00013*** (8.93)	0.00012*** (8.72)	0.0001***(8.97)
L_FRONT	0.0006** (5.28)	0.00057*** (4.96)	0.00062*** (5.33)	0.00056*** (4.88)	0.00056*** (4.86)	0.0006***(4.96)
LOG_LOT	0.053** (10.50)	0.04674*** (9.33)	0.05297*** (10.58)	0.04307*** (8.58)	0.04082*** (8.12)	0.0429***(8.42)
LOG_LIVOT	0.454*** (50.24)	0.45394*** (50.38)	0.45451*** (50.26)	0.45715*** (50.87)	0.45807*** (50.98)	0.4601***(51.02)
AGE	-0.0022*** (-20.34)	-0.00210*** (-19.05)	-0.00224*** (-20.38)	-0.00193*** (-17.25)	-0.0019*** (-16.99)	-0.0019***(-16.46)
D_SPRING	-0.017** (-3.71)	-0.01734*** (-3.72)	-0.01738*** (-3.72)	-0.01680*** (-3.61)	-0.01704*** (-3.66)	-0.0176***(-3.78)
D_FALL	-0.009** (-1.99)	-0.00965** (-2.09)	-0.00920*** (-1.99)	-0.00988** (-2.15)	-0.00967** (-2.10)	-0.0107**(-2.32)
D_WINTER	-0.04038*** (-7.56)	-0.04046*** (-7.59)	-0.04036*** (-7.55)	-0.04049*** (-7.62)	-0.04045*** (-7.61)	-0.0410***(-7.69)
D_SINGLE	0.21199*** (21.56)	0.21474*** (21.93)	0.21218*** (21.58)	0.21421*** (21.94)	0.21562*** (22.08)	0.2127***(21.70)
P_WHITE	0.00297** (22.63)	0.00239*** (16.81)	0.00295*** (22.35)	0.00219*** (15.50)	0.00186*** (12.19)	0.0022***(15.11)
P_PUBLIC	-0.00135** (-2.80)	-0.00236*** (-4.84)	-0.00129*** (-2.66)	-0.00241*** (-5.00)	-0.00274*** (-5.65)	-0.0018***(-3.72)
P_PRIVATE	-0.00362*** (-4.67)	-0.00246*** (-3.17)	-0.00360*** (-4.65)	-0.00143* (-1.83)	-0.00108*** (-1.37)	-0.0029***(-3.79)
P_HIGH	-0.00477*** (-12.42)	-0.00439*** (-11.48)	-0.00477*** (-12.42)	-0.00436*** (-11.46)	-0.0041*** (-10.65)	-0.0053***(-13.98)
P_BACHELOR	0.00348*** (7.79)	0.00297*** (6.67)	0.00347*** (7.76)	0.00236*** (5.22)	0.00252*** (5.69)	0.0036***(8.09)
LOG_INCOME	0.02937*** (3.66)	0.02923*** (3.66)	0.02900*** (3.61)	0.03017*** (3.78)	0.02948*** (3.72)	0.0347***(4.33)
EXPENDITUR	0.0000046*** (6.75)	0.0000048*** (7.03)	0.0000045*** (6.62)	0.0000042*** (5.95)	0.0000041*** (6.07)	0.000008***(4.80)
SALARY_1	0.00001*** (4.02)	0.00001*** (6.34)	0.00001*** (3.21)	0.00001*** (7.63)	0.00001*** (7.26)	0.000005***(6.88)
T_EXPERIENCE	0.00001*** (12.44)	0.00001*** (8.10)	0.00001*** (12.38)	0.0000046*** (5.72)	0.00001*** (7.17)	-0.0040***(-2.83)
LAMBDA	0.29942*** (0.01323)	0.28804*** (21.61)	0.29999*** (22.68)	0.27902*** (20.81)	0.27670*** (20.61)	0.2875***(21.56)

Exhibit 5b: Estimation of the Spatial Error Model

Variable	INPUT (Model 1)	4^{th} MATH TEST (Model 2)	VALUE_ADDED (Model 3)	SCHOOL DESIGNATION (Model 4)	PERFORMANCE INDEX (Model 5)	EFFICIENCY (Model 6)
4^{TH} MATH_1		0.0026*** (10.19)				
Value-added			0.00156* (1.66)			
D_EXCELLEN				0.04846*** (6.04)		
D_EFFECTIVE				REFERENCE CATEGORY		
D_CONT IMPR				-0.05532*** (-7.60)		
D_ACAD WATCH				-0.11046*** (-10.52)		
PI					0.00593*** (13.65)	
EFFICIENCY						0.1456***(10.79)
R squared	78.67 %	78.82	78.68	78.93	78.93	78.77
Log Likelihood	2382.76	2434.11	2384.13	2473.40	2473.61	2418.03
DF	12438	12437	12437	12435	12437	12437

Note: Numbers in the parentheses are t-values. The dependent variable is log of housing price in 2005.

* = $\alpha \geq .10$
** = $\alpha \geq .05$
*** = $\alpha \geq .01$