Reflections of School Quality on the Housing Market: Extending the Definition of Better Schools

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This study uses a hedonic price method to estimate the effect of school quality on the housing market. Property sales records and elementary school data from Pitt County North Carolina are used to estimate the marginal effect of a given school quality unit. This study finds that higher student performance is associated with higher property values in the school district. For a one-point increase in average test scores, there is a $4,600 premium reflected in the housing market. Results also indicate that highly qualified teachers as well as the level of safety in the school are valued by households. Better access to technology and larger classes also show positive effects on property values.

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Introduction

Variations in the quality of public schools have drawn the attention of parents, policy makers, and scholars. Nearly 70 percent of inner city fourth graders are unable to read at a basic level on national reading tests (www.whitehouse.gov). Legislation such as the No Child Left Behind (NCLB) Act of 2001 strengthens federal pressure on all schools to provide higher standards of education (www.edsource.org). By June 30, 2006, all teachers must meet federal standards regarding competency and knowledge in each academic subject (*Source: North Carolina Department of Public Instructional Services (NCDPI), Human Resources/ Quality Professional Division*).

Researchers have studied the value of better education by primarily investigating its effects on the housing market. Many studies have applied hedonic methods to estimate the effect of school quality on property values, see Black (1998), and Haurin and Brasington (1996). One common finding is the consistent capitalization of student performance in the housing market. Harris (2001) found that a one-point increase in average scores increase property values by 0.2%. Deininger (1999) also found that average scores increase property values by 0.27% and noted that reading and math proficiency scores seems to be the most important quality variable. However, this may not be a belief shared by everyone.

Brasington (1999) tried a different method where he used a value-added approach in order to measure changes in school amenities over time. He studied housing transactions from the major metropolitan areas of Ohio and found that proficiency test passage rates are consistently reflected in the housing market while value-added by a school district was not. Brasington also found that value-added measures of graduation

rates, teacher experience and education levels are not consistently related to housing prices. From this he concluded that parents may not choose schooling based on academic improvement; instead they may base their choices on peer-group effects. Hayes and Taylor (1996) also used the value-added approach. However their results slightly differ from that of Brasington's in regards to the effect of expenditure spent on pupil. Hayes and Taylor found expenditure per pupil to have insignificant effects while Brasington's results showed consistent capitalization in the housing market.

Crone's (1998) study was consistent to that of Hayes and Taylor regarding the statistically insignificant effects of expenditure per pupil, while at the same time he agreed with Brasington's notion of peer group effects. Data on student performance and that of their classmates were used to investigate peer group effects. Crone finds that a pupil's achievement is strongly related to the aspirations of the other students in the school. These findings again suggest that households may not base their choice of schooling solely on test scores which was the motivating factor that compelled me to find other quality measures.

This paper differs from earlier studies in that it examines five categories that determine school quality; performance, classroom environment, safety, technology, and teacher quality while most previous studies have focused only on two or three. By identifying more relevant quality measures reflected in housing market, the definition of a better school can be more accurately stated thus helping to decrease quality variations in public schools.

Consistent with other studies, this paper find that higher scores are positively correlated with house price. Results also indicate that on average, large classes are

favored by households as well as safer schools, and the value of a highly qualified is comparable to availability of internet in classrooms.

Study Area and Data

Pitt County is located in the coastal plain of eastern North Carolina. As one of the fastest growing areas in the state, the population increased by 23.3% between 1990 and 2000. According to the 2000 Census, the County has a population of 133,798 and the largest city, Greenville, has a population of 60,476. Recently, many new houses have been built due to the population growth and Hurricane Floyd that destroyed many homes in September 1999. The total number of housing units in Pitt County is 55,116, and of those housing units, a total of 50,018 are occupied (www.co.pitt.nc.us).

The primary source of parcel data comes from the Pitt County Tax Assessor's Office. Included are sales transactions and information detailing a particular parcel sold between January 2001 and December 2004. Only parcels identified as single family residential homes and sales transactions greater than $20,000 are used in this study. Sales prices are adjusted for inflation using a Consumer Price Index to reflect December 2004 price levels. Based on the 5,622 homes sold during that period, the average selling price is $147,738 with the minimum sales price of $20,954 and maximum of $1,152,324. Housing characteristic dummy variables are created for gas-heating, central air conditioning, brick front, and hardwood flooring, and garage. About 52% of the homes have gas heating and 42% have a fireplace. More than half of the homes sold are located in Greenville and 68% of them have a garage.

Eighteen elementary schools of seven different cities in Pitt County are the primary focus of this study. Information regarding the selected schools was all obtained from the Education First NC School Report Cards website for the years 2001-2004 (http://www.ncreportcards.org/src/). A 3-year average of school quality determinants are used and is separated into five categories; performance, class size, safety, technology, and teacher quality. Performance is measured by using the annual North Carolina ABCs End-of-Course test results. Average class size is used to measure the effect of having an additional student in the class. The variable *Hazard* is used as a measure of safety. *Hazard* is described as the average number of school code violations within a year. School suspensions that are less than 10 days, and any reportable acts of crime and violence described by the NC Department of Public Instruction are summed to describe the level of safety in the school. This variable is also a proxy for peer group effects. To capture the effect of technology within the schools, the variable *percweb* is used. This variable is the percentage of classrooms within a school that have access to the internet. Turnover rates and percentage of classrooms taught with highly qualified teachers is used to proxy teacher quality. Turnover rates are described as the "percentage of teachers employed in a school last year who are no longer employed in the same school this year" (http://www.ncreportcards.org/src/). Highly qualified teachers are those who have obtained an appropriate license for the core academic subjects taught and demonstrate subject knowledge and have passed the Praxis II exams required for license. *Facqlfy* describes the percentage of classrooms taught by highly qualified teachers. Based on 18 elementary schools in the Pitt County school district, the average class size is 21 students and the average number of school code violations is about 23. 92% of the classrooms

have internet access and about 90% of all classrooms have highly qualified teachers. The mean turnover rate is about 17% with a minimum of 9% and a maximum of 34%. Table 1 defines the variables used in this study, and summary statistics are reported in table 2.

Method

This section provides a brief discussion of the hedonic price function and the estimation procedures. Let $\boldsymbol{X}$ represent a vector of structural characteristics of the house (e.g., age, square footage, and heating source), and let $\boldsymbol{Z}$ represent a vector of school quality characteristics (e.g., student performance, safety, and technology). The housing market is assumed to be in equilibrium, which requires that individuals optimize their housing choice based on the prices of alternative houses. Prices are assumed to be market clearing, given the inventory of housing choices and their characteristics. Thus, the price of any house, P, can be described as a function of the housing characteristics:

$$P = P(\boldsymbol{X}, \boldsymbol{Z})$$

Equation (1) is referred to as the hedonic price function. With additional assumptions on individual's utility function, the estimation and partial differentiation of the hedonic price function with respect to a housing attribute reveal the marginal willingness to pay for that one attribute.

In this study, the hedonic price function is modeled as follows (Model 1):

$$\begin{aligned}\ln(price_i) = {} & \beta_0 + \beta_1 tsft_i + \beta_2 age_i + \beta_3 bedrm_i + \beta_4 bathrm_i + \beta_5 gasheat_i + \beta_6 aircent_i + \\ & \beta_7 facebrick_i + \beta_8 hdwdfloor_i + \beta_9 garage_i + \beta_{10} gville_i + \beta_{11} score_i + \\ & \beta_{12} avgclass_i + \beta_{13} hazard_i + \beta_{14} percweb_i + \beta_{15} turnov_i + \beta_{16} facqlfy_i + \varepsilon_i\end{aligned}$$

where ε_i is a random error term with mean zero and variance σ_i. Dummy variables related to structural characteristics, such as *aircent, facebrick, hdwdfloor, garage* are house-specific, and *gville* is a dummy variable that proxies location. School-specific variables are *score, avgclass, hazard, percweb, turnov,* and *facqlfy*. The hedonic model is estimated by the Ordinary Least Squares estimation method. White's method (1980) is used to obtain consistent estimates of the covariance matrix and the standard errors corrected for potential heteroskedasticity.

Sonstelie and Portney (1978) noted that in heterogeneous communities, the impact to which school quality has on the value of a small home may not be the same for a large home. Hence, if the quality value of a particular school increases, there will be a greater increase in value to large homes relative to the small homes. To test this hypothesis, I have created an interaction variable, *(score*tsqf).* I have also created another interaction variable, *(score*hazard)*, to investigate the interaction between *score* and *hazard*. My hypothesis is that an increase in hazard rates will decrease the marginal effect of student performance on house prices.

The hedonic price function with interaction terms is shown as (Model 2):

$$\begin{aligned}\ln(price_i) = {} & \beta_0 + \beta_1 tsft_i + \beta_2 age_i + \beta_3 bedrm_i + \beta_4 bathrm_i + \beta_5 gasheat_i + \beta_6 aircent_i + \\ & \beta_7 facebrick_i + \beta_8 hdwdfloor_i + \beta_9 garage_i + \beta_{10} gville_i + \beta_{11} score_i + \\ & \beta_{12} avgclass_i + \beta_{13} hazard_i + \beta_{14} percweb_i + \beta_{15} turnov_i + \beta_{16} facqlfy_i + \\ & \beta_{17} score * tsqf_i + \beta_{18} score * hazard_i + \varepsilon_i\end{aligned}$$

where ε_i is a random error term with mean zero and variance σ_i.

Results

Tables 3 and 4 report the estimation results. Most coefficients have the same signs across these models and are statistically significant. The signs of the coefficients are consistent with the findings from previous empirical studies. Given the mean house price ($147,738), an additional square foot of living area results in a 0.010% or $16 increase in house price. *Age* decreases house price by 0.078% ($115.77) per additional year. For an additional bedroom, there is a 5% premium and an 18% premium for each additional bathroom. Homes with central air conditioning demand a $70,906 premium, and the dummy variable *garage* has a positive yet statistically insignificant effect on the house price. This may be due to the high frequency of garages (68%) in our sample and large variations in house prices.

Parameter estimate of the dummy variable *gville* was statistically insignificant and could not be used to evaluate the marginal effects of being located in Greenville. Many researchers and policy makers agree that the student performance variable, *score* is the most well recognized measure of school quality. From the estimation results, it is not shocking to find that this variable has a positive and significant effect on house price. The coefficient value 0.03114 translates into a $4,600 premium for a one-point increase in test scores. This variable is generally well behaved and predictable.

Avgclass is a used to proxy classroom environment characteristics. The coefficient (0.04445) for this variable is positive and significant at the 1% level. It is reasonable to assume that crowded classrooms are not good environments for learning. In order to test this assumption, another model was estimated that included a square term to emulate the diminishing effects. The coefficient on *avgclass* is -0.80483 and

avgclasssq is 0.01987. The overall marginal effect is 0.0212 so larger classes may be favored by the housing market.

Nearly all parents would agree that school safety is an important factor. I used the variable *hazard* as a school safety proxy. The results indicate that *hazard* has a negative effect on housing prices at the 1% significance level. For a unit increase in *hazard,* there is a 0.00302% ($446) decrease that is reflected in the housing market. A 1966 report from the U.S. office of Education entitled *Equality of Educational Opportunity* by James Coleman found that the influence of other students in the class were important for a student's academic performance. If the *hazard* variable is used to proxy peer-group-effects, high levels of this *hazard* variable could signal an unfavorable learning environment according to this report.

Percweb describes the accessibility of the internet in the school viewed as a technology variable. The internet plays such a huge role in our lives today that it is imperative for future generations to learn how to use this tool. It is not surprising that this variable has a positive effect and is significant at the 1% level. For an additional percentage point increase of access in classrooms, a premium of $1,097 can be attributed to house price.

Turnover rates represented by *turnov,* could be misleading according to the North Carolina Department of Public Instructional Services (NCDPI). Results show a positive relationship with house prices, but this was not found to be consistent in other specifications. One could assume that at moderate levels, the school is able to bring in new and younger teachers that can provide more insight and ideas. Thus the school is kept up-to-date with teachers. However it also reasonable to assume that familiarity with

the students and experience goes a long way in providing quality instruction. The NCDPI states that turnover rates may be high because of an early retirement incentive or that a new school in your neighborhood required a number of teacher transfers. *(Source: NCDPI, Human Resources/Quality Professional Division, Licensure Section, Annual Teacher Turnover Report, 2004*). It is inconclusive what type of impact turnover rate has on the housing market.

Facqlfy is described as the percentage of teachers who is considered "highly qualified" by the federal government. By June 30, 2006, all teachers of core academic subjects must be "highly qualified". As specified by the No Child Left Behind (NCLB) federal education act, the term "core academic subjects" means English, reading or language arts, mathematics, science, foreign languages, civics and government, economics, arts, history, and geography (*Source: NCDPI, Human Resources/Quality Professional Division, Licensure Section, Licensure & Salary Certification Files, March 2004).* The coefficient on *facqlfy* is 0.0043, which translates into a $635 for a percentage increase in highly qualified teachers.

To test Sonstelie and Portney's theory from earlier, I use the partial derivative to calculate the effect that *score* has on house price with respect to the size of the house, *tsqf.* Table 4 outlines the results. The coefficient on *(score*tsqf)* which is 2.99E-06, and -5.17E-04 is the coefficient for *(score*hazard).* Using these values, results indicate that for every percentage point increase in *score* given *tsqf* equals 624 ft^2 *(small house)*, house price increases by 3.21% or $4,741.74. At the mean size of 2,555.92 ft^2 , house price increases by 3.79% or $5,598.50. Finally, at the maximum size of 13,630 ft^2 *(very large house)*, house price increases by 7.1% or $10,487.96. This supports the theory that larger

homes yield larger premiums. A difference of $5,746.22 between the smallest house and the largest house is also observed. In the case with the *hazard* variable, results indicate that a percentage point increase in *score* given the *hazard* level equal the minimum value of 5.00 school code violations, house price increase by 4.7% ($6,942.73). At the mean, (22.97 violations), house price increase by 3.5% ($5,170.12), and finally at the max level of 56.16 violations, house price increase only by 2.07% ($3,057.76). This shows that safer schools demand higher premiums for an increase in *score* and supports the hypothesis from earlier.

Closing Remarks

The main objective of this study was to find more measures of school quality that can be reflected in the housing market. Throughout this paper, I have shown that quality measures such as school safety and class sizes have significant effects on house price. Because of data limitations, I was not able to use demographic characteristics to help explain housing price. In Pitt County, North Carolina where individuals are predominately Caucasian or African American, school information regarding racial composition may have been useful. I also lacked neighborhood characteristics, i.e. distance to city limits, median income, etc. Also, parental involvement has shown to have a positive effect on student performance. Through organizations such as the PTA, parents participate in organizing school activities, set up rallies, and raise funds to finance field trips. To proxy the parental involvement in schools, one could collect information regarding membership size in the district, frequency of meetings, number of members present at meetings, amount of funds collected to support school activities, and various

other ways to identify parental involvement. The findings of this paper are not only relevant to parents but to policy makers. Understanding the benefits of improved education can help us understand the benefits of educational reform policies.

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Table 1

Variable list

Variable	Description
House Characteristics	
adjprice	Sales price inflation-adjusted to December 2004
tsqf	Size of house (square feet)
age	Age of house at the time of sale
bedrm	Number of bedrooms
bathrm	Number of bathrooms
gasheat	Dummy variable for presence of gas heating (1 if gas heating; 0 otherwise)
aircent	Presence of central air conditioning (dummy)
facebrick	Presence of brick front (dummy)
hdwdfloor	Presence of hardwood flooring (dummy)
garage	Presence of garage (dummy)
Location	
gville	Dummy variable for house (1 if located in Greenville; 0 otherwise)
School Characteristic	
score	Combined averages of math and reading scores (ABCs)
avgclass	Average number of students in a classroom
hazard	Average number of school code violations
percweb	Percentage of classrooms with internet connection
turnov	Percentage of teachers not present this year from last year
facqlfy	Percentage of teachers that are considered "highly qualified"

Table 2

Summary of Statistics

Variable	Mean	Std Dev	Minimum	Maximum
Housing Characteristics				
adjprice	147738.11	92040.65	20954.27	1152324.56
tsqf	2556.37	1118.83	624.00	13630.00
age	18.02	21.25	1.00	172.00
bedrm	3.23	0.63	1.00	7.00
bathrm	2.18	0.70	1.00	7.00
gasheat	0.52	0.50	0.00	1.00
aircent	0.94	0.24	0.00	1.00
facebrick	0.42	0.49	0.00	1.00
hdwdfloor	0.22	0.42	0.00	1.00
garage	0.58	0.49	0.00	1.00
gville	0.55	0.50	0.00	1.00
School Characteristics				
score	85.48	4.78	73.25	91.50
avgclass	21.63	1.89	16.67	24.43
hazard	22.97	13.88	5.00	56.16
percweb	92.42	10.32	65.30	100.00
turnov	17.45	6.62	9.33	34.33
facqlfy	90.14	4.40	79.00	98.00

(N=5622)

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a. Only sales transactions greater than $20,000 and sales year from 2001 to 2004 is used in this sample.
b. Sales price is adjusted for inflation using CPI. Sales prices are as of December 2004. *Source: Bureau of Labor Statistics (www.bld.gov/cpi/home.html)*
c. A 3-year average of school characteristics is used. (Fall 2001-Spring 2004). Overall math and reading scores on the annual ABCs End-of-Grade tests for each school year with grade range 3-8 measures student performance along with safety, technology, and faculty information is used in the sample.
Source: NC School Report Cards (www.ncreportcards.org)

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Table 3

Estimation Results for Model 1

Dependent Variable: ln(adjprice)

Adj-$R^2 = 0.347$ *F-Value=187.67*

Variable	Parameter Estimate	Standard Error	T-Statistic
Intercept	5.6296	0.3945	14.270
Housing Characteristics			
tsqf	0.0001	0.000018	5.556
age	-0.00078	0.00045	-1.733
bedrm	0.05035	0.01901	2.649
bathrm	0.18039	0.02219	8.129
gasheat	0.02111	0.0135	1.564
aircent	0.47995	0.03077	15.598
facebrick	0.04143	0.01633	2.537
hdwdfloor	-0.0417	0.02033	-2.051
garage	0.01772	0.0171	1.036
gville	-0.0144	0.01591	-0.905
School Characteristics			
score	0.0311	0.00213	14.601
avgclass	0.0444	0.00597	7.437
hazard	-0.003	0.00073	-4.110
percweb	0.0074	0.00091	8.132
turnov	0.0099	0.00174	5.690
facqlfy	0.0043	0.0022	1.955

(N=5622)

Table 4

Estimation Results for Model 2

Dependent Variable: ln(adjprice)

Adj-$R^2 = 0.3496$ *F-Value=168.88*

Variable	Parameter Estimate	Standard Error	T-Statistic
Intercept	4.0882	0.7355	5.558
Housing Characteristics			
tsqf	-0.00014	0.0002	-0.700
age	-0.00059	0.00045	-1.311
bedrm	0.04744	0.019	2.497
bathrm	0.1779	0.0221	8.050
gasheat	0.02	0.0134	1.493
aircent	0.4857	0.0306	15.873
facebrick	0.0381	0.0163	2.337
hdwdfloor	-0.039	0.0202	-1.931
garage	0.0131	0.0176	0.744
gville	-0.0149	0.0158	-0.943
School Characteristics			
score	0.0421	0.0066	6.379
avgclass	0.0491	0.00619	7.932
hazard	0.041	0.00989	4.146
percweb	0.0096	0.00109	8.807
turnov	0.0104	0.00171	6.082
facqlfy	0.0073	0.0024	3.042
Interaction Term			
(score*tsqf)	0.0000029	0.0000024	1.208
(score*haz)	-0.000517	0.00011	-4.700

(N=5622)