DEPARTMENT OF ECONOMICS WORKING PAPER SERIES

The Demand for Educational Quality: Comparing Estimates from a Median Voter Model with those from an Almost Ideal Demand System

David Brasington
Louisiana State University

Donald R. Haurin
Ohio State University

Working Paper 2005-16
http://www.bus.lsu.edu/economics/papers/pap05_16.pdf

Department of Economics
Louisiana State University
Baton Rouge, LA 70803-6306
http://www.bus.lsu.edu/economics/

The Demand for Educational Quality: Comparing Estimates from a Median Voter Model with those from an Almost Ideal Demand System

David Brasington
Department of Economics
Louisiana State University
Baton Rouge, LA 70808
Email: dbrasin@lsu.edu

Donald R. Haurin
Departments of Economics and Finance
Ohio State University
431 Arps Hall
1945 N. High Street
Columbus, OH 43210
Email: Haurin.2@osu.edu

October 13, 2005

Keywords: Demand for school quality, Median voter, AIDS model, School choice

JEL Classifications: D12, H31, H73, I2

ABSTRACT

Communities differ in both the bundle of amenities offered to residents and the implicit price of these amenities. Thus, households are faced with a choice of which bundle to select when they select their residence. This choice implies households make tradeoffs among the amenities; that is, the amenities are substitutes or complements. We focus on estimating the demand for public school quality. After generating the implicit prices of community amenities from a hedonic house price equation, we use the median voter model and the AIDS model framework for estimating price and income elasticities of demand. The two models yield very similar estimates. The own price elasticity of demand for schooling is about -0.6 with an income elasticity of demand of 0.5. Public safety and school quality are substitutes as are the community's income level and school quality.

1. INTRODUCTION

Estimating the demand for education is an important topic in economics. Primary and secondary education is an investment by parents in their children, and highly-educated children enter the labor force with higher human capital. A number of studies have investigated the determinants of the demand for schooling (Rubinfeld 1977; Jud and Watts 1981; Brasington 2000). Surveying the literature, Reiter and Weichenrieder (1997) report that estimates of price elasticities of demand for school quality generally range from –0.20 to –0.40. Bergstrom et al. (1982: 1199) report a range of -0.25 to -0.50. Previous studies generally find taxes negatively related and income levels positively related to the demand for public schooling. Cross-elasticities of the demand for school quality with other community attributes have not been reported.

Our study furthers the empirical investigation of the demand for education in two ways. Typically, the demand for public school quality is estimated using the median voter approach, this approach requiring only readily available aggregated data. However, empirical application of this model requires a number of assumptions that are rarely fulfilled. An alternative is to use a micro level data set to estimate the demand for education. One micro level approach to estimate the demand for public school quality is to use the hedonic house price model (Rosen 1974). This approach is feasible because public school quality is generally found to be an important determinant of the variation in house prices among communities (Haurin and Brasington 1996; Downes and Zabel 2002; Figlio and Lucas 2004; Brasington and Haurin forthcoming). While micro level house price transaction information is readily available, housing transaction data sets do not include information about household income, a critical variable. Thus, there are few hedonic

model analyses of the demand for educational quality.[1] We solve this data availability problem by using a different approach than employs the Almost Ideal Demand System (AIDS).

After estimating the demand for education using the median voter and AIDS approaches, we compare the results and find that they yield very similar conclusions. We can therefore say with added confidence that the price elasticity of demand for public schooling is about -0.5, the tax elasticity of demand is smaller, about -0.2, and the income elasticity of demand is 0.60. We find what appear to be the first estimates of the cross price elasticities of demand between public school quality and other neighborhood attributes. Specifically, we find that school quality and living in high-income neighborhoods are substitutes, with a cross price elasticity of about 0.2. Public safety and school quality are weak substitutes, with a cross price elasticity of 0.1. The only neighborhood attribute with an estimated cross price elasticity that is inconsistent across AIDS and median voter models is racial composition.

2. THE MEDIAN VOTER APPROACH

A common approach to estimating the demand for a local public good or service such as the quality of public schools is the median voter model, whose empirical origins trace back to Bergstrom and Goodman (1973). Using this method, the demand for quality schooling is assumed to be a function of the implicit price of schooling and a vector of characteristics of the median voter.[2] Data measuring the aggregate characteristics of households in a community are readily available. Goldstein and Pauly (1981) criticized the median voter approach, suggesting that because of imperfect Tiebout sorting (1956), the

median voter should not be chosen based solely on income, and thus we estimate two versions of the model. The first is the traditional median voter approach and the second includes additional variables suggested by Rubinfeld, Shapiro, and Roberts (RSR 1987) that mitigate Goldstein and Pauly's "Tiebout bias". The median voter model to be estimated takes the following form:

$$1)\ \log s_k = \gamma_1 \log (y_k) + \gamma_2 \log (\tau_k) + \sum_{i=1}^{n} \gamma_{3ik} \log (p_{ik}) + \gamma_4 (z_k) + \varepsilon_1$$

where s is school quality in the k-th community, y is median income, τ is the tax price, $p_{i=s}$ is the own price of school quality, the other p_i are other goods' prices, and z is a matrix of controls suggested by RSR (1987) to mitigate Tiebout bias.[3] In our analysis of substitutes and complements of school quality, we focus on community-level attributes such as community income and racial compositon. That is, recognizing that public school quality is selected by the choice of community, we focus on the tradeoffs a household makes among community attributes. In general, a household has the choice of many types and sizes of houses within a community and thus it need not face tradeoffs between school quality and house characteristics.

3. THE AIDS MODEL

Deaton and Muellbauer (1980) are credited with constructing the Almost Ideal Demand System (AIDS). This model is derived from the consumer cost function corresponding to price-independent, generalized logarithmic consumer preferences. It converts individual household budget equations into aggregate budget shares that correspond to the decisions of a representative household, and it provides a first-order

approximation to any demand system. Deaton and Muellbauer claim (1980: 315) that the parameter estimates from their model correspond to the weighted average of the parameter estimates of individual households.

In our study, we assume that consumers maximize utility by choosing a house in a particular community and a composite of other goods. The model assumes weak separability, this being equivalent to consumers maximizing utility derived from housing with a housing budget constraint and utility derived from other goods with its separate budget constraint. Thus, consumers maximize housing utility by choosing the "components" of housing. One of these components is the quality of public schooling, this dictated by the choice of residential neighborhood. Using the hedonic price model, we derive implicit prices of housing attributes including those of the community such as school quality. It is then possible to calculate the share of housing expenditures that public schooling consumes, this needed in the AIDS formulation.

More formally, if housing and other goods are separable,

2) $U = f [V_H (q_1, q_2,...q_n), V_X (q_{n+1}, q_{n+2},...q_z)]$

where U is household utility, V_H is household subutility associated with housing, V_X is household subutility associated with other goods, q_1 to q_n are components of housing, and q_{n+1} to q_z are components of other goods. Consumers maximize housing subutility subject to a housing budget constraint. The Marshallian subgroup demand for the i-th component of housing is:

3) $q_i = g_{Hi} (e_H, p_1, p_2,...p_n)$ $i = 1,2,...n$

where e_H is the expenditure on housing and the p_i are the prices of the components of housing. Expenditures on housing are observed and we estimate the implicit prices of

housing's components using a hedonic house price model. The form of the house price hedonic is:

4) $\ln e_{Hjk} = \beta\Lambda_{jk} + \delta\Phi_k + \varepsilon_{jk}$,

where the j-th household's expenditure on housing is $e_{Hjk,}$ k represents the community selected by the household, Λ is a vector of house and lot characteristics, Φ represents community characteristics, and ε_{jk} is the error term.

Following Brown and Rosen (1982), we use 4) to calculate the implicit prices p_1, p_2,...p_n of the components of housing.[4] Following Palmquist (1984), we adjust expenditures on housing to change the nonlinear budget constraint into a linear function so that the linearized budget constraint is tangent at the observed consumption point. Let c_{Hjk} denote adjusted expenditures on housing, so that

5) $c_{Hjk} = (1+t_k) \sum_{i=1}^{n} (p_{ijk}*q_{ijk})$.

In 5), we account for the level of community taxes t that are levied to provide local public goods because the total expenditures on housing include local property taxes.[5] A community with a lower tax rate will yield higher household utility for a given expenditure on housing compared with a community with a higher tax rate.

The next step in the AIDS model is to calculate the budget shares, w, of the components of adjusted housing expenditure:

6) $w_{ijk} = (p_{ijk}*q_{ijk}) / c_{Hjk}$.

The budget shares form the dependent variables in the AIDS model.

AIDS is difficult to estimate in its non-linear form; therefore, we use the Stone price index to linearize the demand model in its parameters. Normally the index is derived in log

form; however, due to the possibility of negative price terms in our formulation, we measure the Stone price index as:

7) $P_{jk} = \sum_{i=1}^{n} (w_{ijk} * p_{ijk})$.

AIDS models can be estimated as a system of equations with cross-equation restrictions; however, most studies that estimate a fully restricted AIDS system reject the cross-equation restrictions imposed on the model. If a system of demand equations is estimated using erroneous restrictions, the resulting parameter estimates are misleading. For this reason we focus our attention on estimating only the budget share equation for school quality. Following Deaton and Muellbauer, the form of demand equation in the AIDS model is]:

8) $w_{sjk} = \beta_1 \log (c_{Hjk}/P_{jk}) + \beta_2 \log (\tau_k) + \sum_{i=1}^{n} \beta_{3i} \log (p_{ijk}) + \beta_4 z_k + \varepsilon_2$

where c_{Hjk} and P_{jk} are defined above and the other explanatory variables are defined as in the median voter model. Demand elasticities are calculated as in Bejranonda (1996), so that, for example, the own price elasticity of demand for schooling is $[(\beta_{3s} - \beta_1 * w_s)/w_s] - 1$, where w_s is the budget share of public school quality. The cross-price elasticities are $(\beta_{3i} - \beta_1 * w_s)/w_s$ and the expenditure elasticity is $(\beta_1/w_s) + 1$. In this model, the income elasticity of demand for schooling is $[(\beta_1/w_s) + 1]$ E(h,y), where E(h,y) is the income elasticity of demand for housing.

4. DATA AND IMPLEMENTATION

The primary source of data for the hedonic house price regressions is a record of single family home purchases that occurred during 1991 in Ohio (Amerestate 1991). We focus on non-farm urban properties and thus any house with lot size greater than two acres is deleted. Houses that transact at prices above $400,000 ($1991) are deleted as being unrepresentative, and houses that transact for less than $10,000 are deleted because they likely are either uninhabitable or a gift between family members. In addition, properties that are outliers in square feet of housing and garage size are deleted. Any community with less than 17 house transactions is deleted for fear of not producing a reliable hedonic estimates. Our sample consists of 40,116 houses in 134 communities, and the mean deflated house value is $73,107.[6] The *School District Data Book* (MESA Group, 1994), the Ohio Department of Education, and the Office of Criminal Justice Services of the State of Ohio provide the remainder of the explanatory variables.

The first step of the empirical analysis is to estimate the implicit prices of community characteristics. We estimate six hedonic house price equations covering six Ohio MSAs. The results are listed in the appendix.[7] The hedonic estimations fit the data well and the explanatory variables have the expected signs. School quality is measured by the performance of a community's students on a proficiency test that measures the percentage of students in each school district who pass all four sections of the statewide 9th grade proficiency exam. Its coefficient is positive and significant implying a positive implicit price. Median community income, the level of safety, and the percent of white residents in a community all have positive implicit prices.

The form of the median voter model is specified in 1). The dependent variable is the natural log of the school quality measure. Explanatory variables include the

community's median household income, the tax price of local public goods, the own price of school quality, the prices of other community attributes, and the set of RSR variables to capture the sorting of residents to desired public service levels. The RSR variables are a central city dummy tariable and the proportion of new residents. The central city dummy variable represents the resident's lack of choice among public good bundles; people may sort to central cities for reasons not related to public good bundles, like convenient access to work. The proportion of residents who have lived in the community for less than six years is chosen to represent newcomers. Because newcomers have moved in recently, the level of public services provided is probably similar to the level that induced the residents to move to the community.

Equation 8) indicates the form of the AIDS estimation. The dependent variable is the share of expenditures on housing devoted to schooling. Explanatory variables include the adjusted total expenditure on housing, the tax price, own price, prices of other community attributes, and the RSR variables. The sources, means, and definitions of the variables used in the school quality demand regressions are shown in Table 1.

[Insert Table 1]

5. DEMAND FOR EDUCATION ESTIMATION RESULTS

The regression results are shown in Table 2. Nearly all variables have statistically significant parameter estimates.

[Insert Table 2]

Table 3 converts the parameter estimates of Table 2 into in elasticities in order to more easily compare the estimates from the two models.

[Insert Table 3]

Table 3 shows that the AIDS and median voter methods yield similar demand elasticities, regardless of whether RSR (1987) sorting variables are included or not. The estimate of the own price elasticity for school quality ranges from -0.66 to -0.52. This value is slightly larger than that found in prior research. The implication is that if school quality is capitalized into house prices, then residents of the community react by reducing their demand for schooling. Households also pay for school quality through higher taxes and taxes also generate a demand response with elasticity estimates ranging from -0.30 to -0.05. Prior studies found tax elasticities of demand for schooling between -0.20 and -0.40 (Reiter and Weichenrieder, 1997).

Our study is unique in that it analyzes the complements and substitutes for public schooling consumption.[8] We find that public schooling quality in a community is a substitute for high-income in that neighborhood. Our hedonic house price estimates indicate that high median income in a community is valued as an amenity and it increases the price of housing. Our demand for education estimates indicate that when it becomes more expensive to purchase a house in a high-income neighborhood, all else constant, households' demand for public school quality increases. The magnitude of the effect is small, though, with elasticity estimates ranging from 0.005 to 0.2. We also find that public schooling and public safety are substitutes. Three of the four elasticities are positive. Again, the elasticity is small, the largest estimate being 0.14. The two models yield conflicting results regarding whether the racial composition of a community is a complement or a substitute for public school quality.

The median voter model yields a direct estimate of the income elasticity of demand for public school quality. We find the values are 0.46 to 0.57, higher than that found by RSR. The AIDS estimation yields an estimate of the "expenditure elasticity" of demand for school quality, ranging from 0.65 to 0.72. To convert this to an income elasticity of demand, we must multiply the expenditure elasticity by the income elasticity of demand for housing. This value is not directly estimated in the model but many estimates are reported in the literature. Their range is from about 0.5 to 1.0 depending on the concept of income used (Goodman and Kawai 1982). Thus, the AIDS model yields an estimate of the income elasticity of demand for school quality in the range of 0.3 to 0.7, corresponding closely with the median voter model estimate.

6. CONCLUSION

Communities, of course, differ in the bundle of amenities offered to residents. Less frequently acknowledged is that these amenities differ in rates of capitalization into house prices. For example, Brasington (2002b) found that there is an inverse relationship between the elasticity of housing supply and capitalization rates. Specifically, he found that the capitalization of schooling and crime was weaker toward the edge of an urban area where housing supply elasticities and developer activity are greater. Thus, the "entry price" into a community offering a particular bundle of schooling and other amenities varies over space not only because the bundle differs but also because the implicit prices of a community's amenities differ. Households are faced with a choice of which bundle to select when they select their residence. This choice implies households make tradeoffs among the amenities; that is, the amenities are substitutes or complements in the usual

sense. These demand relationships have not been estimated in prior studies. The cross-price elasticities with respect to public schooling are particularly interesting because they reveal the tradeoffs households are willing to make among amenities.

We estimate the demand for public school quality. The implicit prices of amenities are generated from a hedonic house price estimation using a sample that consists of house-level data drawn from a large number of communities. We use these prices to estimate own and cross-price elasticities in two models—the traditional median voter model and the less frequently applied Almost Ideal Demand System model. The price and income elasticity estimates are quite similar in these models, yielding additional confidence about their validity.

We find the own price elasticity of demand for schooling is about -0.6 and an income elasticity of demand of 0.5. The cross-price elasticity between public safety and school quality is about 0.1 suggesting that public safety and school quality are weak substitutes. We also find the cross-price elasticity of demand between school quality and a household's decision to locate in a high-income neighborhood is about 0.2. The only case where the models differ is the response to variations in the implicit price of a community's racial composition, where the median voter model predicts they are substitutes and the AIDS model suggests they are complements.

Brasington's (2002b) result that there tends to be little capitalization of amenities in suburbs far from the CBD suggests that these households do not face higher house prices when school quality is high. Thus, the price elasticity estimate of -0.6 has little effect on the quantity of school demanded in suburban areas. Further, these households do not have to face tradeoffs among community amenities because of the lower degree of

capitalization. In contrast, capitalization is stronger in central cities and inner ring suburbs. In these areas, our results suggest that good public schools will result in higher house prices and households will respond by reducing their demand for high quality education. These differences in demand levels help to explain spatial differences in the observed levels of school quality.

ENDNOTES

[1] Further, implementing the full two-step analysis as envisioned by Rosen (1974) is difficult, as noted by Brown and Rosen (1982).

[2] Data sets do not identify the median voter, so researchers must find proxies for the values of the explanatory variables of the median voter.

[3] Rubinfeld, Shapiro, and Roberts (1987) show that household sorting can bias estimates of demand elasticities in both micro level and aggregate data. They identify variables that are likely to affect sorting but not demand (1987: 432) such as the percentage of recent movers and a variable that indicates the amount of jurisdicational choice that is available.

[4] The implicit prices are the partial derivatives of house price with respect to each house characteristic. Here they equal the coefficient of an explanatory variable multiplied by the house value. Recent examples of the calculation of the implicit price of schooling from house price hedonics include Brasington (2000) and Brasington and Hite (2005).

[5] The adjustment is that the implicit price is multiplied by (1 + t) where t is the effective tax rate expressed in dollars. For example, a tax rate of 33 mills is 33/1000 = $0.033.

[6] Dollar denominated variables are deflated (1991 base year) using cost of living estimates at the metropolitan statistical area level (ACCRA 1991, 1992).

[7] The variables' names in the hedonic estimation are self explanatory. More details are available in Brasington (2002a).

[8] Brasington and Hite (2005) investigate the complements and substitutes for the consumption of environmental quality.

Table 1
Variable Definitions and Means

Variable	AIDS Model Mean	Median Voter Model Mean
School Quality Share: w_{skj} in 8). It is the share of expenditures on on housing devoted to schooling, calculated as in 6).	0.043	-
School Quality: s_k in 1). It is the percentage of students in each school district who passed all four sections of the 9th grade proficiency exam in 1990.	-	31.6
Own Price: Implicit price of school quality.	299	185
Expenditure on Housing: c_{Hjk}/P_{jk} in 8). It is the adjusted transaction price of (i.e., expenditure on) housing divided by a price index; in thousands of dollars.	27.01	-
Income: y_k in 1). It is the median community income in thousands of dollars.	-	39.1
Price of Income: Implicit price of community income.	337	272
Price of Race: Implicit price of the percent of community residents who are white	28,199	26,908
Price of Safety: Implicit price of lack of violent crimes.	10,623	10,354
Tax Price: τ_k in 1) and 8). It is house value multiplied by the community property tax rate, divided by taxable property valuation per pupil.	0.028	0.029
Central City: A dummy variable, 1 if central city.	0.27	0.03
Newcomer: Proportion of residents who have lived in the community for less than six years.	0.47	0.45
Number of observations for AIDS: 33,876. Number of observations for median voter model: 135.		

Table 2 Demand for School Quality				
Variable	AIDS no RSR	Median Voter no RSR	AIDS yes RSR	Median Voter yes RSR
Log Own Price	0.0147**	-0.56**	0.0207**	-0.53**
Log Expenditure	-0.0125**	-	-0.0157**	-
Log Median Income	-	0.57**	-	0.46**
Log Price of Income	0.0050**	0.18**	0.0095**	0.20**
Log Price of Race	-0.0050**	0.14*	-0.0107**	0.16**
Log Price of Safety	0.0024**	0.14**	-0.0027**	0.14**
Log Tax Price	-0.0136**	-0.05	-0.0141**	-0.11**
Central City	-	-	-0.0134**	-0.23*
Newcomer	-	-	-0.0404**	0.85**
Intercept	-0.0470**	0.86*	0.0263**	0.40
Adjusted R-square	0.45	0.77	0.57	0.79
Parameter estimates are shown. ** = significant at 0.05, * = significant at 0.10. The dependent variable for the AIDS estimation is School Quality Share. The dependent variable for the median voter regression is School Quality.				

Table 3 Elasticities of Demand for School Quality				
Variable	AIDS no RSR	Median Voter no RSR	AIDS yes RSR	Median Voter yes RSR
Own Price	-0.66	-0.56	-0.52	-0.53
Expenditure	0.72	-	0.65	-
Median Income	-	0.57	-	0.46
Price of Income	0.12	0.18	0.23	0.20
Price of Race	-0.10	0.14	-0.22	0.16
Price of Safety	0.07	0.14	-0.04	0.14
Tax Price	-0.29	-0.05	-0.30	-0.11

REFERENCES

ACCRA. 1991. *Cost of Living Index* 24 (2). Louisville, KY: 1.7-1.8.

ACCRA. 1992. *Cost of Living Index* 25 (1). Louisville, KY: 1.7.

Amerestate. 1991. *PaceNet Data Set*. Cincinnati, OH.

Bejranonda, Somskaow. 1996. "An Assessment of the Soil Erosion Impacts on Lakeside Property Values in Ohio: A Hedonic Pricing Method (HPM) Application." Doctoral Dissertation. The Ohio State University.

Bergstrom, T. C., D. L. Rubinfeld and P. Shapiro. 1982. "Micro-Based Estimates of Demand Functions for Local School Expenditures," *Econometrica* 50: 1183-205.

Bergstrom, Theodore C. and Robert P. Goodman. 1973. "Private Demands for Public Goods." *American Economic Review* 63: 280-296.

Brasington, David. 2000. "Demand and Supply of Public School Quality in Metropolitan Areas: The Role of Private Schools." *Journal of Regional Science* 40: 583-605.

Brasington, David M. 2002a. "The Demand for Local Public Goods: The Case of Public School Quality," *Public Finance Review* 30: 161-187.

Brasington, David M. 2002b. "Edge Versus Center: Finding Common Ground in the Capitalization Debate," *Journal of Urban Economics* 52: 524–541.

Brasington, David and Donald R. Haurin, "Educational Outcomes and House Values: A Test of the Value Added Approach," forthcoming, *Journal of Regional Science*.

Brasington, David M. and Diane Hite. 2005. "Demand for Environmental Quality: A Spatial Hedonic Analysis," *Regional Science and Urban Economics* 35: 57-82.

Brown, James N. and Harvey S. Rosen. 1982. "On the Estimation of Structural Hedonic Price Models." *Econometrica* 50: 765-768.

Deaton, Angus and John Muellbauer. 1980. “An Almost Ideal Demand System.” *American Economic Review* 70: 312-326.

Downes, Thomas A. and Jeffrey E. Zabel. 2002. “The Impact of School Characteristics on House Prices: Chicago 1987-1991,” *Journal of Urban Economics*, 52, 1-25.

Figlio, David N. and Maurice E. Lucas. 2004. “What’s in a Grade? School Report Cards and the Housing Market,” *American Economic Review*, 94, 591-604.

Goldstein, Gerald S. and Mark V. Pauly. 1981. “Tiebout Bias on the Demand for Local Public Goods.” *Journal of Public Economics* 16: 131-143.

Goodman, Alan and M. Kawai. 1982. “Permanent Income, Hedonic Prices, and Demand for Housing: New Evidence,” *Journal of Urban Economics*:12: 214-237.

Haurin, Donald R. and David M. Brasington. 1996. “The Impact of School Quality on Real House Prices: Interjurisdictional Effects.” *Journal of Housing Economics* 5: 351-368.

Inman, Robert P. 1978. “Testing Political Economy’s ‘as if’ Proposition: Is the Median Income Voter Really Decisive?” *Public Choice* 33: 45-65.

Jud, G. Donald and James M. Watts. 1981. “Schools and Housing Values.” Land Economics 57: 459-470.

Mathis, Edward J. and Charles E. Zech. 1986. “An Examination into the Relevance of the Median Voter Model: Empirical Evidence Offers Support for the Model and Certain Uses.” *American Journal of Economics and Sociology* 45: 403-412.

MESA Group. 1994. *School District Data Book*. National Center for Education Statistics, U.S. Department of Education, Washington, D.C.

Palmquist, Raymond.1984. “Estimating the Demand for the Characteristics of Housing.” *Review of Economics and Statistics* 66: 394-404.

Reiter, Michael and Alfons Weichenrieder. 1997. “Are Public Goods Public? A Critical Survey of the Demand Estimates for Local Public Services.” *Finanzarchiv* N.F. 54: 374-408.

Rosen, Sherwin. 1974. “Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition,” *Journal of Political Economy*.82: 34-55.

Rubinfeld, Daniel L. 1977. “Voting in a Local School Election: A Micro Analysis.” *Review of Economics and Statistics* 59: 30-42.

Rubinfeld, Daniel L., Perry Shapiro and Judith Roberts. 1987. “Tiebout Bias and the Demand for Local Public Schooling.” *Review of Economics and Statistics* 69: 426-437.

Tiebout, Charles. 1956. “A Pure Theory of Local Expenditures.” *Journal of Political Economy* 64: 416-424.

APPENDIX 1. HEDONIC HOUSE PRICE REGRESSIONS

Hedonic House Price Regression						
Variable	Akron	Cincinnati	Cleveland	Columbus	Dayton	Toledo
INTERCEPT	6.17**	8.04**	7.52**	7.49**	7.52**	5.95**
AIR CONDITIONING	0.08**	0.12**	0.054**	0.12**	0.13**	0.10**
FIREPLACE	0.14**	0.16**	0.14**	0.19**	0.13**	0.16**
LOT SIZE	0.0016	0.016**	0.016**	0.034**	0.018**	0.032**
LOT SIZE SQUARED	$-0.2x10^{-5}$	$-0.17x10^{-3}$	$-0.21x10^{-3}$**	$-0.46x10^{-3}$**	$-0.23x10^{-3}$**	$-0.5x10^{-3}$**
AGE	-0.0014	0.0070**	0.014**	-0.0002	0.0077**	0.028**
AGE SQUARED	$0.34x10^{-4}$**	$-0.11x10^{-4}$*	$-0.36x10^{-4}$**	$0.14x10^{-4}$*	$-0.14x10^{-4}$**	$-0.86x10^{-4}$**
ROOMS	0.19**	0.063**	0.10**	0.17**	0.18**	0.032**
ROOMS SQUARED	-0.010**	0.0014	-0.0036**	-0.0074**	-0.0082**	-0.011**
GARAGE	0.22**	0.14**	0.21**	0.10**	0.26**	0.29**
FULL BATHROOMS	0.16**	0.12**	0.12**	0.13**	0.11**	0.21**
PART BATHROOMS	0.11**	0.028**	0.13**	0.10**	0.11**	0.15**
DECK	0.032	0.052**	0.070**	0.046**	0.092**	0.083**
POOL	0.042	0.034	0.028	0.078	0.086**	0.058
Q2	0.044**	0.051**	0.062**	0.072**	0.050**	0.016
Q3	0.049**	0.058**	0.065**	0.070**	0.043**	0.023
Q4	0.054**	0.063**	0.066**	0.070**	0.039**	0.003
INCOME	0.0049**	0.0033**	0.0058**	0.0057**	0.0057**	0.0039**
LOG PROFICIENCY TEST SCORE	0.30**	0.11**	0.14**	0.12**	0.072**	0.088
DISTANCE	0.0037	0.011**	0.011**	0.028**	0.018**	0.014
SAFETY	0.17	0.51**	0.14**	0.017	0.055	0.22
PERCENT WHITE	1.76**	0.16*	0.33**	0.63**	0.51**	0.20
Number of observations	2550	5240	13963	7602	6879	3882
Adjusted R-Squared	0.68	0.71	0.66	0.60	0.70	0.74
Parameter estimates are shown. **significant at .05, *significant at .10, otherwise statistically insignificant. Dependent variable is LOG HOUSE PRICE.						