The Impact of School Quality on Real House Prices: Interjurisdictional Effects*

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ABSTRACT

This study focuses on explaining variations in real constant-quality house prices in jurisdictions located in multiple MSAs. Using a hedonic house price framework, we test competing theories of house price determination. Using two variants of the random coefficients model, we find that public school quality has a very large impact on real constant-quality house prices. Our results suggest that capitalization of school quality differences occurs on a per lot basis rather than per square foot of land. Also important to the explanation of variations in house prices are variables derived from urban theory, such as distance to the CBD, and from the amenity literature, such as a community's crime rate, arts, and recreational opportunities.

CLASSIFICATION NUMBERS: R21, I29, H22

LIST OF SYMBOLS

α	Greek alpha
β	Greek beta
δ	Greek delta
ϵ	Greek epsilon
γ	Greek gamma
μ	Greek mu
τ	Greek tau
σ	Greek sigma

Many articles have focused on explaining cross-sectional or time-series variations in metropolitan real constant-quality house prices. Such explanations are important for testing theories of house price determination and for predicting future variations. Our study uses 134 jurisdictions in six metropolitan areas to test competing explanations of why real constant-quality house prices vary, where we define a constant-quality house as a unit where structural and land attributes, but not community attributes, are held constant. Included in the paper are tests of hypotheses derived from spatial urban theory, local public economics, and the urban amenity literature.

Our paper differs from most in that we include a wide array of jurisdictions in multiple MSAs in the sample. Most studies of constant-quality house prices confine their analysis to consider price variations in one class of urban areas such as MSAs, central cities, or the suburbs of a single central city. By including suburban localities from multiple MSAs in the sample, we open the analysis to consider intraurban house price variations explained by spatial urban economic models, jurisdiction-specific amenities, and local public finance theory, as well as interurban variations in metropolitan-wide variables such as the expected growth rate.

A particular focus of our study is analysis of the impact of variations in public school outcomes on real constant-quality house prices. This focus results from the importance of school quality to a household's locational choice (Graves and Linneman, 1979) and from the importance of public schools in models of local public taxes and expenditures. We find that a measure of student achievement is very important in explaining spatial variations in real constant-quality house prices.

I. MODELS OF HOUSE PRICE DETERMINATION

A. *Prior Studies*

Theoretical models of house price determination can be separated, somewhat arbitrarily, into those explaining intraurban variations in house prices and those explaining interurban variations. The monocentric urban model suggests that land and housing rental rates are functions of transport costs, household income, metro area population size, and agricultural rental rates (Mills, 1967; Muth, 1969). Extensions to land and housing prices, rather than rents, by Capozza and Helsey (1989, 1990) and Capozza and Schwann (1989) suggest land prices are determined by transport costs, agricultural rents, income, population, the discount rate, and the expected growth of income and population. Intraurban studies of house price differentials caused by variations in amenities are numerous (Jackson, 1979; Li and Brown, 1980; McMillan, Reid, and Gillen, 1980; Diamond, 1980; Michaels and Smith, 1990). Jud (1980), Pollakowski and Wachter (1990), and Pogodzinski and Sass (1991) added zoning to the list of explanatory factors. Other land use or supply restrictions were included by Hamilton (1978), Fischel (1980, 1981), and Rose (1989), these studies reporting a mixed impact of land use restrictions on housing prices.

Theoretical models of interurban house price variation include those highlighting the impact of variations in site-specific factors such as local climate (Haurin, 1980), air pollution and other amenities (Rosen, 1979; Roback, 1982), or shocks to the urban labor market (Haurin and Haurin, 1988). Empirical studies with an interurban focus introduced factors such as crime, recreational opportunities, and population demographics (Blomquist, Berger, and Hoehn, 1988; Beeson and Eberts, 1989; Peek and Wilcox, 1991; Blomquist and Berger 1992; Potepan 1994).

A few studies adopted a supply and demand framework to explain house price variation among metro areas. Ozanne and Thibodeau (1983) explained 58% of the variation in house prices among 54 MSAs, but they found only three significant factors: percent nonelderly singles, price of farm land, and number of municipalities in the MSA. Follow-up studies include Fortura and Kushner (1986), who used Canadian data, and Manning (1986, 1989), who used 94 U.S. MSAs and found better correspondence between theoretical predictions and the empirical results. Manning explained 84% of the variation in house prices and found the most important explanatory variables to be construction costs, farm land prices, climate, percentage of high income households, and a measure of household operating and utility costs. However, crime, pollution, total population, density, and population growth had no effect. Hendershott and Thibodeau (1990) found variations in real income among 18 cities significantly affected real house prices, but spatial variations in land supply restrictions and amenities had no impact. Studies that explain variations in a single representative value of the house price index among multiple MSAs tend to ignore local taxes and public goods because of the heterogeneity of taxes and public services within the MSA.

Many empirical studies have linked measures of local public goods and taxes to house price variations. Interest increased after Oates' 1969 2SLS test of the Tiebout hypothesis. Using aggregate data, Oates found that increased school expenditures raise property values while increased taxes lower values, this result replicated by Rosen and Fullerton (1977). Oates' interpretation was critiqued by Linneman (1978), Hamilton (1976), Sonstelie and Portney (1980), and Pollakowski (1982). Linneman and Hamilton argued that in equilibrium neither effect would be present, thus neither regression coefficient would be significant. This point was countered by Yinger (1982) who argued that supply restrictions allow local taxes and services to be capitalized into house prices. Sonstelie and Portney used gross rent rather than market value to test the Tiebout hypothesis. Pollakowski objected to Oates' list of predetermined variables in his 2SLS approach, noting they may be correlated with the error term in the property value equation. A comprehensive critical review of the property tax literature and further empirical study is contained Yinger, Bloom, Borsch-Supan, and Ladd (1988). They argue that the property value equation should be specified in log rather than linear form and note that the effective property tax rate as measured in most micro data studies is endogenous because it is computed as the ratio of the tax on a property to its value. The tax on a property depends on assessor practices as well as the stated tax rate; thus, they argue for using the community's nominal tax rate and variables related to assessor errors as instruments in a 2SLS econometric model. In a study of changes in property values in response to changes in tax rates, Yinger, et al. find evidence for modest capitalization of property taxes.

A recent flood of papers on MSA house price determination has been generated by an interest in understanding observations of substantial intertemporal fluctuations in particular cities or regions. This research has been aided by the development of better panel data sets (Thibodeau, 1989,1995; Nothaft, Gao, Wang, 1995; Pollakowski, 1995). Generally, the fundamental forces hypothesized to affect MSA-wide house prices are found important in explaining long term movements in house price. Poterba (1991) finds that shifts in income and construction costs are important, but aggregate demographic effects and user cost variations have weak or no effect. Significant effects of population demographics are found by Mankiw and Weil (1989) and Case and Shiller (1990). In a panel data model, Kim (1993) finds that MSA house prices are explained by construction costs, interest rates, metro population, income, income growth, and climate. However, city-specific intertemporal residuals follow a cyclical pattern that is not explained by actual or expected changes in market fundamentals. These short term fluctuations in house prices may be driven by speculative bubbles forming and bursting (Abrahm and Hendershott, 1993, 1996). While these studies are informative and provide support for the hypotheses derived from theoretical economic models of urban areas, they study only a single representative house price in each MSA; in contrast, our approach combines intraurban and interurban models and focuses on multiple jurisdictions within MSAs.

B. *Current Study*

We include factors influencing both intraurban and interurban variations in house prices.

Examples of factors believed to influence the price of housing within an MSA include distance from the central business district, local amenities, jurisdiction-specific public services and property tax rates. Examples of factors that primarily influence entire metropolitan areas and may differ among MSAs include climate, overall accessibility, arts and recreational opportunities, and the expected growth of the metro area.

Our primary community-level public sector explanatory variable is a measure of the outcome of local public education. The literature regarding the appropriateness of our proficiency test score is discussed later in the paper, but similar measures have been used in other hedonic house price studies. Other community-level variables included in the explanation of variations in constant-quality house prices are derived from urban spatial theory (e.g., distance from CBD), local public economics (e.g., property tax rate), or urban-amenities theory (e.g., crime rate).

The standard urban economic monocentric model argues that within a metro area, the principal variable causing variations in constant-quality house prices is land price. Spatial variations in the rental rate or price per unit of land exist because of differences in transport costs to the metro area's central business district. A typical land rental (p) equation is $p(r) = P\ e^{\alpha(R-r)}$ where r is distance from the CBD, P is agricultural land rental, R is the distance to the metro area edge, and α is a conversion parameter that depends on transport cost per mile and community income.[1] The land rental equation suggests that distance to the CBD should be included in the house price model.[2] Agricultural land cost and transport cost per mile are very similar among our MSAs because the areas are in close proximity; thus, we do not include these variables in our model.[3]

We also test for the impact of MSA-level variables on real constant-quality house prices. Examples include expected growth of the MSA and a measure of overall MSA accessibility. Justifications for these variables are given in aggregative urban models such as Henderson (1985) - accessibility, and Capozza and Helsey (1989, 1990) - growth. We include two MSA level amenity measures, one measuring the opportunity to attend art events, the other measuring recreational opportunities.

Our study uses the hedonic house price method to develop a measure of real constant-quality house prices. Because our data are cross-sectional, alternative methods such as the repeat-sales approach are not feasible. Our variant of the hedonic approach is to relate the natural log of the real transaction prices for houses (ln V) to a set of structural and land characteristics (X).[4] To find the deflated house price, we divide the observed nominal price by the nonhousing price index for the MSA.[5] We similarly deflate all other nominal variables in the study.

C. *Model*

Two forms of hedonic price equation are tested. In the first, the estimation interacts the jurisdiction dummy variables with a property's lot size (L_i):

$$\ln V_{ij} = X_{ij}\beta + (L_{ij}\, J_j)\, \delta_j + \epsilon_{ij} \qquad (1)$$

where i is a transacted house, j is the school district, and ϵ is a random error. δ_j represents jurisdiction-specific shifts in the implicit price of a square foot of land, thus testing one form of the capitalization hypothesis. The second form includes a series of dummy variables (J_j) indicating the jurisdiction (school district) of an observation:

$$\ln V_{ij} = X_{ij}\beta + J_j\delta_j' + \epsilon_{ij} \qquad (2)$$

The coefficients δ_j' represent the percentage deviations of an average house price in district j from that of a constant-quality house. Only the regression intercept changes among districts, thus testing another form of the capitalization hypothesis.

In the second step of the analysis, the coefficients δ_j and δ_j' are related to a vector of community and MSA level variables Z_j:

$$\delta_j = Z_j\gamma + \mu_j \qquad (3)$$

$$\delta_j' = Z_j\gamma' + \mu_j'. \qquad (3')$$

Eqns. (3) and (3') are the capitalization tests for the community and MSA variables. The functional form of eqns. (2) and (3') tests for an impact through changes in the implicit price of land, thus the impact differs among houses within a jurisdiction depending on a property's lot size. In contrast, the form of (1) and (3) tests for an equal percentage impact of variations in lot size on all houses in a district.

II. DATA AND METHODS

A. *Data*

The primary source of data for this study is a file of 1991 housing transactions in the six largest metro areas in Ohio (Amerestate, 1991). We limit the sample to single-family detached houses and eliminate outliers.[6] Eliminating any school district having less than 17 observed house sales trims the sample to 140 school districts. This process yields a sample of 45,236 transactions with over a third being from the central cities of our six MSAs. Variable means and standard deviations are reported in Table I for both the complete sample and a sample that excludes the central city transactions. Detailed definitions of all variables are listed in the data appendix. Explanatory variables in (3) are drawn from various sources including the *Places Rated Almanac* (Savageau and Boyer 1993), the Ohio Department of Education, the *School District Data Book* (MESA Group 1994), and the Office of Criminal Justice Services of the State of Ohio.

[INSERT TABLE I]

B. *Method*

The pair of eqns. (1) and (3) or the pair (2) and (3') are forms of random coefficient models; estimation methods are discussed by Amemiya (1978). We follow the method of Garman and Richards (1990) where equations (3) and (3') are substituted into (1) and (2) respectively. The resulting single equation models are:

$$\ln V_{ij} = X_{ij}\beta + (L_{ij} Z_j)\gamma + \mu_j + \epsilon_{ij}. \tag{4}$$

and

$$\ln V_{ij} = X_{ij}\beta + Z_j\gamma' + \mu_j' + \epsilon_{ij} \tag{4'}$$

The form in (4) is the same as in Garman and Richards where a multistep GLS procedure is used to correct for the heteroskedastic error. Assuming the errors in (1) and (3) are uncorrelated, the variance of the error in (4) is $(\tau^2 L_{ij}^2 + \sigma^2)$ where τ^2 is the variance of μ_j and σ^2 is the variance of ϵ_{ij}. These variances are estimated in auxiliary regressions of (1) and (3) where δ_j in (3) is the vector of estimated coefficients of the interaction variables in (1). The final step is to estimate (4) correcting for the estimated heteroskedasticity, yielding consistent and asymptotically efficient estimates.

Eqn. (4') is a random effects model, this frequently used in the analysis of panel data and requiring use of generalized least squares. It is appropriate in our case because we test for jurisdiction-specific mean zero random errors in house prices (μ_j).[7]

C. *Explanatory Variables*

Measures of the house and lot characteristics include age, square footage of house and garage, full and part baths, unenclosed and enclosed porches, deck, patio, pool, air conditioning, fireplace, number of outbuildings, and quarter of sale within the survey year.

The highlighted local public service is a measure of public school outcomes, specifically, the percentage of ninth grade students passing all four parts of a proficiency test administered in all public schools in the state. This variable has a mean of 43.2 and ranges from 6 to 89. The test is administered each year of high school; thus, aggregate passage rates rise as a cohort of students moves through high school. State law requires that a student pass each of the four components of the test to receive a high school diploma.[8] The literature on measuring the outcomes of K to 12 education raises the question as to the best measure of school quality: test scores, attendance rate, college continuation rate, dropout rate, or wages later in life. We argue that our measure is easily observed (results are published in newspapers), varies greatly among districts, and is directly relevant for parents' judging the probability of a student receiving a high school diploma; thus, it is an appropriate measure.

Prior studies have included measures of school quality or outcomes when explaining house price variations. Li and Brown (1980) find that 4th graders' test scores have a positive and significant impact on house prices in Boston. Jud and Watts (1981) used test scores in a hedonic house price study of a single jurisdiction and estimated the demand for school quality in a second stage estimation. Dubin and Sung (1990) use a J test to contrast alternative combinations of variables to use in their semilog hedonic house price equation and decide to exclude their two measures of school quality because measures of race and socio-economic status dominate. Pogodzinski and Sass (1991) find that scores on a statewide achievement test positively and significantly affect house prices.

The other public sector variable in our model is the property tax rate in the community. Our data set does not contain the tax on each property or the assessed value of the property; thus, we cannot construct the effective tax rate for each property. Rather, we must use the nominal rate reported for each jurisdiction. This measure is exogenous and Yinger, et al. (1988) proposed its use as an instrumental variable for the effective tax rate. The omitted component of the property tax rate is the property-specific assessor's error (Goodman, 1983).

Other explanatory variables in the house value equation include three suggested by the urban model: distance of a property to the CBD, an aggregate measure of accessibility in each MSA, and expected MSA population growth. We expect increased accessibility or expected growth, and decreased distance to the CBD to be positively related to constant-quality house prices. We measure expected growth by the ratio of 1990 to 1980 MSA population, the accessibility measure is from Places Rated Almanac (1993), and distance to CBD is approximated by the distance of a jurisdiction's centroid to the MSA's CBD.

The amenity literature suggests that an increased crime rate in a jurisdiction reduces the price per unit of housing. Our measure is the number of serious crimes per capita; the definition includes murders, rapes, robbery, aggravated assault, motor vehicle theft, and arson. We also include average income and MSA recreational and arts opportunities as measures of amenities present in a jurisdiction.[9] The final variables included in the estimation are the percentage of nonwhite households, this potentially capturing variations in house prices resulting from discrimination, and the percentage of households residing in the jurisdiction for fewer than six years, this being a measure of community stability.

III. RESULTS

Preliminary regressions of eqns. (1) and (2) reveals substantial variation in house prices among jurisdictions. From (1) we find that constant-quality house prices range from 35% lower to 70% higher than the reference district, Columbus OH. Evaluated at the mean lot size, we find from (2) constant-quality variation in the price of land of 30% lower to 85% higher than the reference district. Both results suggest a much greater spread of constant-quality house prices at the community level than at the MSA level. In the six MSAs in our study, the average MSA price variation compared with the Columbus MSA ranged from 6.4% lower to 7.7% higher.[10] Results of estimating eqns. (4) and (4') are contained in Table II. We report the results based on the sample of jurisdictions excluding the six central cities, leaving 134 localities and 29,718 observations. Estimated coefficients are somewhat sensitive to whether central city properties are included, suggesting possible specification problems when extending the model to cover both central cities and suburbs.[11]

A. *GLS Model with Lot Size Interaction Variables: Eqn (4)*

The house and lot characteristics generally have the expected signs and are significant. One exception is the number of outbuildings, this not significant. The interpretation of increased lot size is complicated by the inclusion of the interaction terms, but the overall marginal impact is positive. We find that increased square footage of the house or garage increase house price, but at a decreasing rate. Increasing age reduces house value and the negative coefficient for AGE SQUARED implies housing depreciates at an increasing rate.

In our estimation of (4) we include both the community variable-lot size interactions and the level of the community variables (e.g., both TEST SCORE and LOT*TEST SCORE). If only the coefficient of the interaction variable is significant, then the impact of the community level variables is solely through changes in a property's implicit price per square foot of land. Thus, large lots are impacted at a higher rate. However, if the impact of high quality schools is to create a fixed premium per property independent of lot size, then the coefficient of TEST SCORE will also be significant. For example, a positive TEST SCORE coefficient combined with a negative coefficient for the LOT-SCORE interaction implies that the capitalization of high quality schools into property values is a greater percentage for small properties than large, this result consistent with a relatively fixed school quality premium per property.

Table II's results show that all community variables' coefficients have the expected sign. Moreover, all are significant except the MSA growth rate and the tax rate (both have t-values of 1.2). Generally, the lot size-community variable interactions have the opposite sign of the community variables, the exceptions being the aggregate accessibility variable (not significant) and average income and recreational opportunities (both significant). Thus, although the community variables clearly affect the value of property in a jurisdiction, the change is not simply a constant percentage increase or decrease in the price per unit of land.

The impact of our focal variable, school quality, on property value is shown through the following example. Compare a house with sample mean value of $76,115 in a community with a test score of 43 to an identical house and community except test score is one point higher. The result is that house value rises by $380. If the community's proficiency test pass rate is two standard deviations above the sample mean (this value is still below the sample maximum), house value rises to $89,930, an 18 percent increase.[12]

Another evaluation of the impact of variations in school quality is to compare two houses, one with a larger lot than the other, but otherwise identical, in each of two communities. In the community with a higher TEST SCORE the value of both houses is higher, but the changes depend on the strength of the negative coefficient of the LOT*TEST SCORE variable compared with the impact of the nonlinear estimation.[13] The resolution of the offsetting effects is that within a standard deviation of the mean lot size, the impact of a higher test score on house value is nearly independent of lot size.[14] We find that superior school quality is capitalized into property values, but the capitalization is about the same for all properties in a school district.

B. *Random Effects Model: Eqn. (4')*

Generally, the results in the random effects model are similar to those in the interaction variable model. Some differences are noted for the age of a house and the number of out buildings. Overall explanatory power is the same. The coefficient of TEST SCORE implies that every additional percent of students passing the test raises house value by $400, equaling one-half percent of mean house value.[15]

V. CONCLUSIONS

Our study focuses on explaining variations in constant-quality house prices among 134 communities in multiple MSAs. Explaining differences in house prices requires hypotheses to be drawn from both intraurban and interurban economic models. We find that real constant-quality house prices are explained by factors from both perspectives and they combine to explain 70% of the observed price variation.

School quality is the most important cause of the variation in constant-quality house prices.

We find that each percentage point increase in the pass rate of ninth grade students on a statewide proficiency exam increases house prices by one-half percent. Because pass rates vary among sampled communities from 6 to 89 percent, constant-quality house prices vary greatly due to this factor alone. The estimation results suggest that the capitalized premium for high quality schools is relatively constant per lot rather than being constant per square foot of land.

Other factors important to the explanation of constant-quality house prices include distance from the CBD, metro area accessibility, crime rate, percentage of nonwhite households, average household income, and indexes of metro area arts and recreational opportunities. We found no consistent impact of expected population growth, the nominal property tax rate, or community stability.

Prior studies of a single house price representative of an entire MSA have been limited in two ways. First, they exclude hypotheses about house price variations derived from spatial models of urban areas and from local public economics. Second, they do not attempt to explain the substantial house price variation among communities within a single MSA. Developing a model that explains why house prices vary among communities within an MSA and among MSAs is the greatest challenge, requiring hypotheses from both intraurban and interurban perspectives.

Footnotes

1. The negative exponential form is derived under the restriction that the price elasticity of demand for housing is -1.0.

2. Some studies use population density instead of distance to the CBD. We select distance because it is a more fundamental variable and density may be endogenous. If substituted for distance, density works equally well in our estimation.

3. Construction costs are also relatively constant in the jurisdictions in the sample.

4. This semi-log form has been used in many studies with justifications listed in Thibodeau (1989). We used a Davidson-MacKinnon test (1981) to determine whether a semi-log or a linear form of hedonic equation is preferable; however, the test result is inconclusive. King (1977) objects to inclusion of the property tax rate in a linear hedonic, but Sontelie and Portney (1980) note that this objection is ameliorated if a semi-log form is used. We opt for the semi-log form based on the literature and because the estimated coefficients better conform to theoretical expectations.

5. The deflators are from the American Chamber of Commerce cost of living index (ACCRA 1991, 1992).

6. We deleted observations with lot sizes greater than two acres and those with transaction prices over $400,000 or below $10,000. Outliers in lot size, square feet of housing, and garage size were also eliminated. Mean real house value is $76,115.

7. We use Limdep 7.0 (1995, Ch. 17.3) which uses a two step procedure.

8. Students completing high school, but failing to pass the exam receive a certificate of attendance.

9. Climate is not included because the relatively close proximity of the six MSAs in the sample yields little variation. Measures of zoning or land supply restrictions are not available.

10. The six MSAs in the sample are Akron, Cincinnati, Cleveland, Columbus, Dayton, and Toledo.

The smallest PMSA is Toledo with 1990 population of 0.61 million and the largest is Cleveland with population 2.20 million.

11. We tested for systematic differences in house characteristic implicit prices between central city properties and suburban properties by running separate hedonic regressions, then pooling the data. A Chow test of the equality of the two sets of coefficients strongly rejects equality. Further, coefficient equality is rejected even if a dummy variable for central city location is included in the pooled regression.

12. A quadratic test score was tried in the estimation, but it proved to be insignificant with a coefficient near zero.

13. That is, if the only impact of a higher test score was the linear term in the hedonic, house value would rise more for the house with the larger lot because of the logarithmic form.

14. The point estimates suggest that the amount capitalized decreases slightly as lot size rises, but not by a economically significant amount.

15. The results in the full sample are generally similar. Differences include the MSA growth rate becoming significant and positive, as expected, and the tax rate unexpectedly becoming positive and significant. The impact of TEST SCORE on house value is about the same, $400 per point.

REFERENCES

Abrahm, J. M. and Hendershott, P. M. (1993). “Patterns and Determinants of Metropolitan House Prices, 1977-91,” in *Real Estate and the Credit Crunch (*Browne and Rosengren, Eds.), pp. 18-42. Boston MA: Proceedings of the 25th Annual Boston Fed Conference.

Abrahm, J. M. and Hendershott, P. H. (1996). “Bubbles in Metropolitan Housing Markets,” *J. Housing Res.* forthcoming.

ACCRA (formerly American Chamber of Commerce Researchers Association). (1991). *Cost of Living Index*, Louisville, KY: ACCRA Press. **24**, 1.7-1.8.

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

Amemiya, T. (1978). “A Note of a Random Coefficients Model,” *International Econ. Rev.* **19**, 793-795.

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

Beeson, P. E. and Eberts, R. W. (1989). “Identifying Productivity and Amenity Effects in Interurban Wage Differentials,” *Rev. Econ. and Statistics* **71**, 443-452.

Blomquist, G. C., Berger, M. C., and Hoehn, J. P. (1988). "New Estimates of Quality of Life in Urban Areas,” *Amer. Econ. Rev.* **78**, 89-107.

Blomquist, G. C. and Berger, M. C. (1992). “Mobility and Destinations in Migration Decisions: The

Roles of Earnings, Quality of Life, and House Prices," *J. Housing Econ.* **2**, 37-59.

Capozza, D. R. and Helsey, R. W. (1989). "The Fundamentals of Land Prices and Urban Growth," *J. of Urban Econ.* **26**, 295-306.

Capozza, D. R. and Helsey, R. W. (1990). "The Stochastic City," *J. Urban Econ.* **28**, 187-203.

Capozza, D. R. and Schwann, G. M. (1989). "The Asset Approach to Pricing Urban Land: Empirical Evidence," *AREUEA J.* **17**, 161-174.

Case, K. E. and Shiller, R. J. (1990). "Forecasting Prices and Excess Returns in the Housing Market," *AREUEA J.* **18**, 253-273.

Davidson, R. and MacKinnon, J. G. (1981). "Several Tests for Model Specification in the Presence of Multiple Alternatives," *Econometrica* **49**, 781-93.

Diamond, D. (1980). "The Relationship Between Amenities and Urban Land Prices," *Land Econ.* **56**, 21-32.

Dubin, R. A. and Sung, C-H. (1990). "Specification of Hedonic Regressions: Non-Nested Tests on Measures of neighborhood Quality", *J. of Urban Econ.* **27**, 1: 97-110.

Fischel, W. A. (1980). "Zoning and the Exercise of Monopoly Power: A Reevaluation," *J. Urban Econ.*, **8**, 283-293.

Fischel, W. A. (1981). “Is Local Government Structure in Large Urbanized Areas Monopolistic or Competitive?” *National Tax J.* **34**, 95-104.

Fortura, P. and J. Kushner. (1986). “Canadian Inter-City House Price Differentials,” *AREUEA J.*, **14**, 525-536.

Garman, D. M. and Richards, D. J. (1990). “Wage Inflation, Unionization, and Monopoly Power,” *J. Industrial Econ.* **38**, 269-281.

Goodman, A. (1983). “Capitalization of Property Tax Differentials Within and Among Municipalities,” *Land Economics* **59**, 211-219.

Graves, P. and Linneman, P. (1979). “Household Migration: Theoretical and Empirical Results,” *J. Urban Econ.* **6**, 383-404.

Greene, W. H. (1995). *Limdep, Version 7.0 User’s Manual.* Bellport, N.Y.*:* Econometrics Software Inc.

Hamilton, B. (1976). “The Effects of Property Taxes and Local Public Spending on Property Values: A Theoretical Comment.” *J. Polit. Econ.* **84**, 647-650.

Hamilton, B. (1978). “Zoning and the Exercise of Monopoly Power,” *J. Urban Econ.* **5**, 116-130.

Haurin, D. R. (1980). "The Regional Distribution of Population, Migration, and Climate," *Quarterly J. Econ.* **XCV**, 293-308.

Haurin, D. R. and Haurin, R. J. (1988). "Net Migration, Unemployment, and the Business Cycle", *J. Regional Sci.* **28**, 239-254.

Hendershott, P. H. and Thibodeau, T. G. (1990). “The Relationship Between Median and Constant Quality House Prices: Implications for Setting FHA Loan Limits,” *AREUEA J.*, **18**, 323-334.

Henderson, J. V. (1985). *Economic Theory and the Cities*, New York: Academic Press.

Jackson, J. R. (1979). “Intraurban Variation in the Price of Housing,” *J. Urban Econ.* **6**, 464-479.

Jud, G. D. (1980). “The Effects of Zoning on Single-Family residential Property Values: Charlotte, North Carolina,” *Land Econ.* **56**, 142-154.

Jud, G. D. and Watts, J. M. (1981). “Schools and Housing Values,” *Land Economics* **57**, 459-70.

Kim, D. (1993). “The Determinants of Urban Housing Prices in 1982-1990,” unpublished dissertation, Ohio State University, Columbus, OH.

King, A. T. (1977). “A Note on Local Tax Rates, Public Benefit Levels, and Property Values,” *J. Polit. Econ.* **85**, 425-432.

Li, M. M. and Brown, H. J. (1980). “Micro-Neighborhood Externalities and Hedonic Housing Prices,” *Land Econ.* **56**, 125-141.

Linneman, P. (1978). “The Capitalization of Local Taxes: A Note on Specification,” *J. Polit. Econ.* **86**, 535-538.

Mankiw, N. G. and Weil, D. (1989). “The Baby Boom, the Baby Bust, and the Housing Market,” *Reg. Sci. Urban Econ.* **19**, 235-258.

Manning, C. A. (1986). “Intercity Differences in Home Price Appreciation*,” J. of Real Estate Res.* **1**, 45-66.

Manning, C. A. (1989). “Explaining Intercity Home Price Differences,” *J. of Real Estate Finan. Econ.* **2**, 131-149.

McMillan, M. L., Reid, B. G., and Gillen, D. W. (1980). “An Extension of the Hedonic Approach for Estimating the Value of Quiet,” *Land Econ.* **56**, 315-328.

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

Michaels, R. G. and Smith, V. K. (1990). “Market Segmentation and Valuing Amenities with Hedonic Models: The Case of Hazardous Waste Sites,” *J. of Urban Econ*. **28**, 223-242.

Mills, E. S. (1967). “An Aggregative Model of Resource Allocation in a Metropolitan Area,” *Amer. Econ. Rev. Papers and Proceedings* **57**, 197-211.

Muth, R. F. (1969). *Cities and Housing*. Chicago IL: University of Chicago Press.

Nothaft, F. E., Gao, A. H., and Wang, G. H. K. (1995). “The Stochastic Behavior of the Freddie-Fannie Conventional Mortgage Home Price Index,” paper presented at the January 1995 AREUEA Meeting.

Oates, W. E. (1969). “The Effects of Property Taxes and Local Public Spending on Property Values: An Empirical Study of Tax Capitalization and the Tiebout Hypothesis,” *J. Polit. Econ.* **77**, 957-971.

Ozanne, L. and Thibodeau, T. G. (1983). “Explaining Metropolitan Housing Price Differences,” *J. of Urban Econ*. **13**, 51-66.

Peek, J. and Wilcox, J. A. (1991). “The Measurement and Determinants of Single Family House Prices,” *AREUEA J.* **19**, 353-382.

Pogodzinski, J. M. and Sass, T. R. (1991). “Zoning and Hedonic Housing Price Models,” *J. Housing Econ.* **1**, 271-292.

Pollakowski, H. O. (1982). *Urban Housing Markets and Residential Location*. Lexington MA: Lexington Books.

Pollakowski, H. O. (1995). “Data Sources for Measuring House Price Changes,” *J. Housing Res.* **6**, 377-388.

Pollakowski, H. O. and Wachter, S. M. (1990). “The Effects of Land-Use Constraints on Housing Prices,” *Land Econ.* **66**, 315-324.

Potepan, M. J. (1994). “Intermetropolitan Migration and House Prices: Simultaneously Determined?” *J. Housing Econ.* **3**, 77-91.

Poterba, J. M. (1991). “House Price Dynamics: The Role of Tax Policy and Demography,” *Brookings Papers on Econ. Activities*, 143-183.

Roback, J. (1982). “Wages, Rents and the Quality of Life,” *J. of Polit. Econ.* **90**, 1257-1278.

Rose, L. A. (1989). “Topographical Constraints and Urban Land Supply,” *J. of Urban Econ.* **25**, 335-347.

Rosen, H. S. and Fullerton, D. J. (1977). “A Note on Local Tax Rates, Public Benefit Levels, and Property Values,” *J. of Polit. Econ.* **85**, 433-440.

Rosen, S. (1974). “Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition,” *J. of Polit. Econ.* **82**, 34-55.

Rosen, S. (1979). “Wage Based Indexes of Urban Quality of Life,” in *Current Issues in Urban Economics* (P. Mieszkowski and M. Straszheim, Eds.), pp. 74-104. Baltimore MD: Johns Hopkins University Press.

Savageau, D. and Boyer, R. (1993)*. Places Rated Almanac: Your Guide to Finding the Best Places to Live in North America*. New York: Prentice Hall Travel.

Sonstelie, J. C. and Portney, P. R. (1980). “Gross Rents and Market Values: Testing the Implications of Tiebout’s Hypothesis,” *J. Urban Econ.* **7**, 102-118 .

Thibodeau, T. G. (1989). “Housing Price Indexes from the 1974-1983 SMSA Annual Housing Surveys,” *AREUEA J.* **17**,100-117.

Thibodeau, T. G. (1995). “House Price Indices from 1984-92 MSA Annual Housing Survey,” *J. of Housing Res.* **3**, 439-482.

Yinger, J. (1982). “Capitalization and the Theory of Local Public Finance,” *J. Polit. Econ.* **90**, 917-943.

Yinger, J., Bloom, H. S., Borsch-Supan, A., and Ladd, H. F. (1988). *Property Taxes and House Values*. Boston, MA: Academic Press.

TABLE I
Descriptive Statistics

Values for the full sample of 45,236 are reported first, followed by values for the sample of 29, 718 transactions in suburban jurisdictions.

Variables	Full Sample		Suburban Sample	
	Mean	Standard Dev.	Mean	Standard Dev.
Age (10s)	4.21	2.48	3.44	2.25
Air Conditioning	0.36	0.48	0.44	0.49
Autumn Sale	0.28	0.45	0.28	0.45
Crime Rate	0.02	0.01	0.01	0.01
Deck	0.11	0.31	0.14	0.35
Distance to CBD	8.95	6.59	12.27	5.75
Enclosed Porches	0.15	0.38	0.14	0.36
Fireplace	0.39	0.49	0.47	0.50
Full Bath	1.31	0.50	1.40	0.54
Garage Size (1000s)	0.33	0.19	0.36	0.19
House Size (1000s)	1.46	0.51	1.55	0.54
Log House Price	11.04	0.61	11.24	0.51
Lot Size (10000s)	1.06	0.89	1.26	1.00
MSA Accessibility Index	47.88	6.03	48.72	5.74
MSA Arts Index	11.56	4.50	12.13	5.56
MSA Population Growth	1.73	4.93	1.39	4.70
MSA Recreation Index	20.91	4.59	21.03	4.80
Out Buildings	0.03	0.18	0.04	0.20
Part Bath	0.35	0.49	0.44	0.52
Patio	0.21	0.41	0.25	0.43
Nonwhite Households	0.18	0.17	0.08	0.11
Pool	0.01	0.11	0.02	0.13
Property Tax Rate	35.12	6.16	35.02	6.36
Real Income	32.64	14.67	39.33	13.77
Test Score	33.71	17.98	43.17	14.85
Turnover Rate	0.48	0.08	0.47	0.09
Summer Sale	0.31	0.46	0.31	0.46
Unenclosed Porches	0.76	0.73	0.67	0.70
Winter Sale	0.24	0.43	0.23	0.42

TABLE II
Estimation of Real House Prices [a]

	Interacted Model		Inte rcept Model	
Variables	Coefficient[b]	Standard Error[b]	Coefficient	Standard Error
Constant	986.82**	5.7	948.77**	11.15
Age	-3.96**	0.28	-6.00**	0.29
Age-squared	-0.07**	0.03	0.06**	0.02
Lot Size	-2.60	4.29	10.12**	0.50
Lot Size Squared	-0.10**	0.01	-0.93**	0.07
House Size	43.22**	1.72	42.99**	1.66
House Size-squared	-2.88**	0.45	-2.95**	0.43
Garage Size	33.13**	2.36	34.86**	2.23
Garage Size-squared	-23.99**	3.52	-23.53**	3.24
Deck	5.52**	0.51	5.22**	0.50
Unenclosed Porches	1.62**	0.29	1.27**	0.28
Enclosed Porches	1.29**	0.52	1.62**	0.51
Fireplace	8.14**	0.41	8.12**	0.41
Air Conditioning	6.81**	0.41	6.69**	0.40
Full Bath	6.31**	0.46	6.88**	0.45
Part Bath	5.67**	0.40	5.73**	0.39
Out Buildings	0.78	0.88	1.93*	0.81
Pool	3.32**	1.30	4.30**	1.19
Patio	2.36**	0.49	2.48**	0.46
Summer Sale	5.09**	0.49	5.18**	0.47
Autumn Sale	5.58**	0.50	5.75**	0.48
Winter Sale	5.22**	0.51	5.28**	0.50
Distance to CBD	-1.32**	0.07	-1.27**	0.15
Lot*Distance to CBD	1.14	0.60	----	
Test Score	0.68**	0.04	0.52**	0.09
Lot*Test Score	-0.10**	0.03	----	
Property Tax Rate	-0.08	0.06	0.23	0.12
Lot*Property Tax Rate	0.14**	0.05	----	
Real Income	0.21**	0.04	0.31**	0.08
Lot*Real Income	0.05*	0.02	----	
Crime Rate	-292.73**	39.80	-272.38**	98.24
Lot*Crime Rate	73.95*	33.30	----	
Turnover Rate	-9.45**	4.46	17.22	9.08
Lot*Turnover Rate	8.46**	3.38	----	

Variables	Coefficient[b]	Standard Error[b]	Coefficient	Standard Error
Nonwhite Households	-49.19**	3.95	-32.69**	7.32
Lot*Nonwhite Household	22.92**	3.73	----	
MSA Population Growth Rate	0.12	0.10	0.30	0.19
Lot*MSA Population Growth Rate	-0.03	0.08	----	
MSA Accessibility Index	0.46**	0.08	0.78**	0.16
Lot*MSA Accessibility Index	0.05	0.06	----	
MSA Arts Index	1.18**	0.10	0.81**	0.23
Lot*MSA Arts Index	-0.35**	0.08	----	
MSA Recreation Index	0.24**	0.09	0.60**	0.19
Lot*MSA Recreation Index	0.20**	0.07	----	
Adjusted R^2	0.70		0.70	

[a]Dependent Variable is 1990 Log Real Transaction House Price. Sample size is 29, 718 transactions in suburban jurisdictions. *Significant at 5% level, **Significant at 1% level.

[b]All coefficients and standard errors are x10 $^{-2}$.

DATA APPENDIX

VARIABLE NAME	DESCRIPTION and SOURCE (in parentheses)
House Characteristics	
AGE	Age of house in tens of years (2)
AIR CONDITIONING	Air conditioning dummy (2)
DECK	Deck dummy (2)
ENCLOSED PORCHES	Number of enclosed porches (2)
FIREPLACE	Fireplace dummy (2)
FULL BATH	Number of full bathrooms (2)
GARAGE SIZE	Garage size in thousands of square feet(2)
HOUSE SIZE	House size in thousands of square feet (2)
LOG REAL TRANSACTION HOUSE PRICE	Log of transaction amount for house, deflated by MSA nonhousing price index (2)
LOT SIZE	Lot size in tens of thousands of square feet (2)
OUT BUILDINGS	Number of out buildings on property (2)
PART BATH	Number of partial bathrooms (2)

PATIO	Patio dummy (2)
POOL	Pool dummy (2)
UNENCLOSED PORCHES	Number of unenclosed porches (2)

Community /MSA Characteristics

CRIME RATE	Serious crimes including murder, forcible rape, robbery, aggravated assault, motor vehicle theft, and arson, per 1,000 residents (5)
DISTANCE TO CBD	A measured in mile of the distance from the centroid of a jurisdiction to the MSA's center
MSA ACCESSIBILITY INDEX	A measure of the MSA ease of accessibility. The variable is a weighted average of lower than average commuting time to work, mass transit availability, highway accessibility, air and train accessibility, in thousands (1)
MSA ARTS INDEX	A measure of the number of arts performances, museums, and library holdings in the MSA (1)
MSA POPULATION GROWTH RATE	1990 population of the MSA divided by 1980 population (1)
MSA RECREATION INDEX	A measure of recreational opportunities in the MSA including theaters, sports, parks, golf courses, zoo/aquarium, restaurants (1)
NONWHITE HOUSEHOLDS	The percentage of nonwhite households/100 (4)
PROPERTY TAX RATE	Nominal property tax millage rate (3)

REAL INCOME	Deflated average income, in thousands (4)
TEST SCORE	Percentage of ninth grade students who passed all sections of the 1990 state proficiency test. The test included sections on reading, writing, math, and citizenship (3)
TURNOVER RATE	Percentage of households who have lived in the district less than 6 years (4)

Sources:

(1) *Places Rated Almanac*.

(2) Amerestate housing tape.

(3) Ohio Department of Education, Division of Education Management Information Services.

(4) *School District Data Book* (MESA Group 1994).

(5) Office of Criminal Justice Services of State of Ohio.