Willingness to Pay for Public Goods:

A Hedonic Demand Model for Neighborhood Safety, School and Environmental quality

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Abstract

A two-stage hedonic price and demand model was developed to estimate the willingness to pay for school quality, neighborhood safety and environmental quality in six Ohio metropolitan areas. Environmental quality and public safety were complements while school quality and house size were substitutes for them.

Introduction

Hedonic models have been widely used to explain the effects of public goods such as safety, and school and environmental quality on the value of adjacent properties (e.g. Burnell, 1998; Brasington, 1999; Hite et. al., 2001; Weimer and Wolkoff, 2001). Recent studies use a two-stage approach in conjunction with multiple metropolitan data to estimate hedonic price models with which to obtain the marginal implicit price of individual characteristics in the first stage and to then use prices to derive demand curves for public goods.

The transaction prices of houses located in different areas reflect buyers' willingness to pay for different property characteristics. Housing prices are determined by both structural housing characteristics and the social and neighborhood characteristics where the house is located. Generally, housing values are derived from the number of bedrooms, housing area, lot size, age, and other amenities added to the house. In addition to housing characteristics, house values are affected by many other spatial characteristics such as quality of schools, reported crime rates, distance to market centers, and distance to hazardous release sites. Users value each of these characteristics, positively or negatively, based on their preferences, to derive an aggregate housing value.

About half of the counties in Ohio are within one of fifteen metropolitan areas. We focus on six metropolitan areas in which the mean housing prices vary from $64,503 to $78,817. While investigating the property-value impacts of landfill sites in Franklin County, Hite et. al. (2001) found that crime rates and a school competitiveness index were significant variables in the hedonic price model, and that presence of landfill sites significantly affected the property-value in the neighborhood. Brasington (1999) provides empirical evidence that school characteristics are capitalized in to housing prices in six Ohio MSAs.

This study measures the amount users are willing to pay for three particular local public goods – public school quality, as measured by test scores, neighborhood safety, as measured by the inverse of neighborhood crime rates, and environmental quality, as measured by distance to a local hazard. To achieve model identification, we use multiple MSAs (see Brasington and Hite for details).

Literature review

The hedonic model has been used in valuation of properties and to derive attribute demands considering different mode of environmental characteristics (Hite, 1998; Atkinson and Halvorsen, 1984; Rosen, 1974). The effect of landfills on residential properties has widely been documented in the literature (Hite et al., 2001; Palmquist; 1984). Many studies have examined the effect of environmental quality and other public goods represented by distance from hazardous sites, public safety and school qualities on the property values. Environmental features increase or decrease land and house value as they are seen as desirable or undesirable characteristics. Considering environmental quality as a housing characteristic and measuring it in the form of distance to environmental disamenity, many scholars (Hite et al., 2001; Hite, 1998; Palmquist, 1984; Nelson et al., 1992) have found negative effects of such environmental bads on residential property values, generally on housing values.

A study by Deller and Ottem (2001) in Wisconsin counties suggests that murder and rape, two different kinds of crime variables, have very high disamenity values with implicit prices of -$4,400 to -$3,500 for metropolitan counties. They also found that disamenity values of crime in rural areas are generally higher than metropolitan areas, which suggests that rural residents are more sensitive to crime overall than urban residents. Some types of crime, such as burglary, are attracted to high quality of life areas.

Brasington (1999) found that school qualities are internalized by the residents in housing values. Using data from six metropolitan areas in Ohio, he found that the passing rates for math, science and citizenship proficiency tests for 9th grade students added a $72.3 marginal implicit value to the housing value. Expenditure per student was used as an indicator for school quality. In a study of Monroe County in New York, Weimer and Wolkoff (2001) found that housing values in the central city were elastic with respect to improvements in elementary school outputs. Jud (1985) found evidence that public schooling quality, as measured by reading achievement, has a significant effect on community housing values Los Angeles and San Francisco.

Michaels et al. (1990) used a hedonic model to investigate the impact of hazardous waste sites on house prices in suburban Boston and found that property values increased with distance from the house to the nearest hazardous waste site. Kohlhase (1991) studied the impact of toxic sites in Houston on property values before and after the sites have been listed in Superfund National Priorities List (NPL) and reported that toxic sites had significant impact on house prices after listed in NPL. The distance from the house to nearest site had positive relationship up to 6.2 miles.

Nelson et al (1992) examined the effect of a landfill in Minnesota on house sales. They concluded that the landfill had a negative impact on house values for homes within two miles and value of a house located on the landfill boundary could decrease by more than 12 per cent.

Analytical framework

This study employs a two-stage hedonic price and demand model for housing characteristics. In the hedonic model, a semi-log regression of housing price over housing and spatial characteristics is used to determine the implicit price for each characteristic. Marginal implicit prices are derived from the partial derivative of the predicted hedonic price function with respect to each of the variables. A particular focus of the study is to estimate an accurate functional form for school quality, neighborhood safety, and environmental quality. A quadratic or higher order functional form in these variables helps to determine the point at which positive or negative impacts of local public goods becomes irrelevant to house value.

The first stage model is estimated as follows:[1].

$$HPRICE = \exp(a0 + a1*patio + a2*air + a3*bedrooms + a4*deck + a5*fire + a6*fullbath + a7*partbath + a8*gargdum + a9*garg + a10*hsize + a11*hsizesq + a12*lot + a13*lotsq + a14*age + a15*agesq + a16*mindist + a17*sqmindist + a18*safety + a19*expend + a20*distance + a21*graddeg + a22*poverty + a23*pwhite + a24*pcchange + a25*income + a26*popcbg + a27*pvac + a28*hunit + a29*pkidtot) \qquad (1)$$

House characteristics such as presence of patio, deck, central air conditioning, fireplace, number of full and partial bathrooms, garage size, household size and lot size are expected to

[1] A description of variables and their unit of measurement are provided in Table 1.

have positive effect on housing price. Environmental qualities as measured by the distance from nearest hazard site, school quality as measured by the expenditure per student in school district and public safety measured by inverse crime ratio are all expected to be positive. Percent of residents in a neighborhood (as defined by a Census block group) under the poverty level is expected to have a negative influence on housing values, as is age of the house. It is expected that hazardous sites cease to influence housing value after a certain distance and house price starts to fall beyond that point with respect to the hazard site, suggesting a quadratic term.

Three final demand models are obtained by regressing different dependent variables over instrumental variables of marginal implicit prices, along with other shift variables. The second stage demands are estimated by the following Seemingly Unrelated Regression model:

$$MINDIST = \exp(a0 + a1*phmindist + a2*psafety + a3*pexpend + a4*phhsize + a5*income + a6*graddeg + a7*pkidtot) \quad (2)$$

$$SAFETY = \exp(a0 + a1*phmindist + a2*psafety + a3*pexpend + a4*phhsize + a5*income + a6*graddeg + a7*pkidtot) \quad (3)$$

$$EXPEND = \exp(a0 + a1*phmindist + a2*psafety + a3*pexpend + a4*phhsize + a5*income + a6*graddeg + a7*pkidtot) \quad (4)$$

where MINDIST is distance to nearest hazardous site, SAFETY is the inverse crime ratio, and EXPEND is expenditure per student in school district. PHMINDIST, PHHSIZE, PSAFETY, PEXPEND are the instrumental variables for mean distance, house size, public safety and expenditure per student. Shift variables are income, proportion of graduate degree population and proportion of household with children under 18 years age.

Welfare analysis

Predicted hedonic house prices are derived for the mean and inflection point of the distance curve in each MSA as well as for the entire sample. Welfare effects resulting from a move from the mean distance to the inflection point distance can be measured by changes in consumer surplus. This is estimated for the other two demand functions by estimating consumer surplus at the mean value plus an arbitrary value. Derived consumer surplus is then used to estimate Willig's bound (Willig, 1976) for compensating variation, that is:

$$CV_i = CS_i*(1+CS_i*\eta) / (2*INC)$$

where, CS_i is consumer surplus at price *i*, η is income elasticity and INC is income.

Data

Transaction values for 45,222 houses in Akron, Cincinnati, Cleveland and Toledo metropolitan areas for calendar year 1990-1991 are obtained from Amerstate, Inc. After cleaning for missing values for some observations and removing outliers, the sample size was 43,538. Each transaction record includes a number of physical housing characteristics and neighborhood characteristics. Crime rates are obtained from the Office of Criminal Justice Service. School quality is derived from the Ohio Office of the Department of Education – EMIS data. Other socioeconomic and demographic data are obtained from the Census of Population 1990.

Results

The means of hedonic variables are given in Table 2. Aggregate mean house price is $72,986 which ranges from $64,503 in Akron to $78,816 in Cincinnati. Dayton has the second highest average housing price of $77,044. Aggregate mean distance to hazard (environmental quality), inverse crime ratio (public safety) and expenditure per student (school quality) are 1.31 miles, 27.46 and $4,959 respectively. The lowest mean distance from hazardous site was found in Akron (0.998 miles) and the highest was found in Dayton (1.505 miles). The index of public safety was highest in Cleveland (40.416) and lowest in Columbus (19.152) making them the safest and least safe MSAs in terms of crime ratios. School expenditure was highest in Columbus ($5,183 per student) and the lowest in Akron ($4,634).

Table 3 presents the results of hedonic regression models run for each MSA. The reported standard errors are corrected using White's method. The presence of a patio in the house does not affect the housing price significantly, whereas, presence of air conditions, deck, fireplace, garage, number of bedrooms and bathrooms, size of house, lot and garage all have significant results. Since these characteristics are considered desirable in a house, they have positive parameter coefficients, except for number of bedrooms which are negative for Akron and Toledo. Squared terms of house size, lot size and age of house are also significant.

Marginal implicit prices of environmental quality, school quality, public safety, and house size are given along with other variables that shift the demand for those characteristics . Income, proportion of residents with graduate degree and proportion of households with children under 18 years of age included as shift variables. Marginal implicit prices for environmental quality and public safety are $384.82 and $192.38 respectively. Similarly, adding one thousand dollar per student expenditure in school district adds $3,006.50 to average housing value.

The estimated demand equations for environmental quality and public safety are given in the second and third column of Table 5. The price of environmental quality, public safety, school quality, and house size are all significant along with the shift variables income, proportion of residents with graduate degree and proportion of households with children under 18 years. People demand environmental quality and public safety together while price of school quality is a substitute for these two variables. People would substitute environmental quality for a bigger house. A higher proportion of residents with graduate degree will demand for better environmental quality. Presence of children in a household forces people to find larger houses which comes at the cost of better environmental quality, as house size and environmental quality are substitutes. Since public safety and environmental quality are jointly determined, they show similar patterns of relationship with other variables.

Column three in Table 5 shows the demand for school quality. The price of school quality has a significant relationship with price of environmental quality and public safety. The price for school quality, price of house size, and presence of children in family are complementary to each other. The interpretation is that households with children look for larger house and better school quality. Larger houses are more affordable in areas with lower school quality price.

Table 6 presents the own-price and cross-price elasticities of demand with respect to characteristics. The mean demand elasticities are significant at 99%+. It is interesting to note that price elasticities of demand for environmental quality, public safety, school quality and house size are all significant for environmental quality and public safety, while demand elasticity for school quality is not significant for any of the characteristics. People are likely to observe the perceived direct risk of hazardous sites and crimes in the community and respond to them accordingly than the less observed salient features of school quality.

A proxy for mean compensating variation was calculated for each demand model using Willig's bound from the change in consumer surplus due to change in mean and an alternative value of the demand variable. Using implicit prices of environmental quality, school quality and public safetys, we estimated the change in prices of those characteristics. The hedonic method estimated an increase of house price by $556.22 by moving the houses from the current mean distance of 1.31 miles to 2.58 miles (the point where the distance ceases to exert any influence in house value) while other variables are held at their current level. Similarly, by decreasing the crime rate to increase the index of public safety by 10 points, the house price would go up by $1,947. Increasing school expenditure by $1000 per students would increase the housing price by $3,078. The compensating variations were calculated for those changes in environmental quality and school quality and found to be $1,839 and $1,774 respectively.

Conclusion

The relationship between house price and characteristics for housing and neighborhood characteristics were investigated in this study. The demand for environmental quality, public safety and school quality were estimated. Both the hedonic and demand estimation used a semi-log model OLS estimation as part of 2-stage estimation.

The first stage hedonic price estimation suggested that house prices are affected significantly by both physical housing characteristics and neighborhood characteristics such as the level of education, income, poverty, race, household structure and environmental disamenities like distance to hazard sites. Those characteristics bore a positive or negative marginal implicit price as internalized by the housing market based on the whether theose features were desirable or undesirable.

The second stage demand model indicated that demand for environmental quality, public safety and school quality are influenced by the price of those characteristics along with other variables that shift demand. People responded by demanding less of the characteristics when implicit price of those characteristics increased.

Environmental quality and public safety were complementary to each other whereas the school quality was substitute public good to both of those characteristics. Price of house size was a substitute for environmental quality and public safety and a complement for school quality. Similarly, a higher proportion of residents with graduate degree demanded more environmental quality and public safety while those without graduate degree and having children at home demanded higher school quality.

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Table 1. Description of variables

Name	Variable Description
AGE	Age of house, years
AGESQ	Square of age of house
AIR	Presence of central air condition (1=Yes, 0=No)
BEDROOMS	Number of bedrooms in house
COMMUTE	Accessibility of ease of commute within MSA
COMT	Average commuting distance in minute
DECK	Presence of deck in house (1=Yes, 0=No)
DISTANCE	Distance from center of school district to the center business district, miles
EXPEND	Indicator of school quality, expenditure per student, thousands dollar
FIRE	Presence of fireplace in house (1=Yes, 0=No)
FULLBATH	Number of full bathrooms
GARG	Garage size, thousands square feet
GARGDUM	Presence of garage in house (1=Yes, 0=No)
GRADDEG	Proportion of residents in cbg who have graduate degree
GROWTH	Growth of MSA population between 1980 and 1990
HPRICE	House transaction price for 1991 sales, deflated by MSA
HSIZE	House size, thousands square feet
HSIZESQ	Square of house size
HUNIT	Number of housing units (1000)
INCOME	Average income of residents in cbg, thousands dollar
LOT	Lot size, tens of thousands square feet
LOTSQ	Square of lot size
MINDIST	Distance to nearest hazard site, miles
PARTBATH	Number of partial bathrooms
PATIO	Presence of patio in house (1=Yes, 0=No)
PCCHANGE	Change in population growth in school district between 1980 and 1990
PHEXPEND	Price of extra unit of school quality (additional thousand dollar spent per student) derived from hedonic regressions

PHHSIZE	Price of extra thousand square feet of house size derived from hedonic regressions
PHLOT	Price of extra ten thousand square feet of lot size derived from hedonic regressions
PHMINDIST	Price of extra mile of distance to nearest hazard derived from hedonic regressions
PHSAFETY	Price of extra unit of public safety derived from hedonic regressions
PKIDTOT	Proportion of households in census block group that have children under 18 years of age
POPCBG	Population count in CBG (1000)
POVTOT	Proportion of residents in cbg who are below poverty level
PVAC	Proportion of vacant housing in the school district
PWHITE	Proportion of residents in cbg who are white
RECREATN	Recreation
SAFETY	Indicator of public safety, an inverse crime ratio (crime ratio=number of crimes per capita in the census block group)
SQMINDIST	Square of distance to nearest hazard site

Table 2. Hedonic means

Variables	Akron (n=4813)	Cincinnati (n= 7123)	Cleveland (n = 13321)	Columbus (n = 7636)	Dayton (n = 6770)	Toledo (n = 3875)
Patio	0.008 (0.090)	0.264 (0.441)	0.053 (0.224)	0.320 (0.487)	0.509 (0.500)	0.189 (0.392)
Air condition	0.228 (0.419)	0.520 (0.500)	0.192 (0.393)	0.502 (0.500)	0.474 (0.499)	0.349 (0.477)
Bedrooms	2.973 (0.702)	2.925 (0.764)	3.067 (0.673)	3.116 (0.610)	2.999 (0.663)	3.046 (0.692)
Deck	0.066 (0.248)	0.151 (0.359)	0.106 (0.308)	0.127 (0.333)	0.085 (0.279)	0.089 (0.284)
Fire	0.350 (0.477)	0.418 (0.493)	0.333 (0.471)	0.452 (0.498)	0.451 (0.498)	0.353 (0.478)
Fullbath	1.240 (0.458)	1.394 (0.559)	1.212 (0.435)	1.331 (0.492)	1.422 (0.534)	1.231 (0.448)
Partbath	0.332 (0.503)	0.309 (0.468)	0.352 (0.498)	0.399 (0.499)	0.287 (0.470)	0.392 (0.516)
Garage dummy	0.849 (0.358)	0.817 (0.386)	0.922 (0.269)	0.750 (0.433)	0.872 (0.334)	0.895 (0.307)
Garage size	0.313 (0.205)	0.282 (0.189)	0.355 (0.165)	0.274 (0.210)	0.346 (0.189)	0.369 (0.278)
House size	1.383 (0.479)	1.483 (0.522)	1.452 (0.495)	1.451 (0.472)	1.476 (0.534)	1.457 (0.540)
House size^2	2.141 (1.617)	2.472 (1.831)	2.354 (1.754)	2.327 (1.619)	2.465 (1.898)	2.416 (1.922)
Lot size	1.152 (1.008)	1.180 (0.969)	1.042 (1.020)	0.895 (0.606)	1.077 (0.712)	0.913 (0.676)
Lot size^2	2.343 (5.586)	2.331 (5.743)	2.127 (6.773)	1.167 (3.507)	1.668 (3.427)	1.290 (3.380)
Age of house	47.381 (23.600)	43.277 (26.233)	46.196 (23.894)	35.422 (22.704)	38.561 (22.23)	42.076 (25.977)
Age ^2	2801.8 (2490.4)	2561.0 (2748.8)	2705.0 (2621.3)	1770.2 (2206.2)	1998.7 (2388.0)	2445.1 (2636.3)

Distance to hazard	0.998	1.264	1.295	1.476	1.505	1.174
	(0.611)	(0.870)	(0.754)	(1.126)	(0.853)	(0.777)
Distance to hazard^2	1.370	2.355	2.246	3.445	2.992	1.982
	(2.050)	(3.483)	(2.581)	(5.407)	(3.427)	(4.109)
Public safety	21.361	20.295	40.416	19.152	23.063	27.774
	(10.737)	(13.604)	(30.053)	(9.150)	(15.358)	(42.557)
School Quality	4.634	4.763	5.068	5.183	4.944	4.935
	(0.377)	(0.840)	(0.954)	(0.617)	(0.568)	(0.284)
Distance	4.579	11.607	12.177	6.488	6.317	5.839
	(4.204)	(6.429)	(7.357)	(4.783)	(4.082)	(3.637)
Graduate degree	0.067	0.083	0.072	0.093	0.083	0.079
	(0.071)	(0.076)	(0.083)	(0.095)	(0.073)	(0.078)
Poverty	0.109	0.074	0.078	0.084	0.082	0.084
	(0.127)	(0.096)	(0.097)	(0.113)	(0.100)	(0.102)
White population	0.890	0.899	0.853	0.866	0.891	0.909
	(0.210)	(0.197)	(0.264)	(0.220)	(0.217)	(0.174)
Population change	0.011	0.054	0.042	0.061	0.017	-0.006
	(0.080)	(0.091)	(0.082)	(0.125)	(0.046)	(0.055)
Income	37.208	42.986	41.044	42.281	40.890	43.235
	(18.542)	(19.685)	(19.660)	(19.641)	(17.147)	(20.814)
Population	1.280	1.852	1.464	1.613	1.956	1.245
	(.901)	(1.881)	(1.050)	(1.641)	(1.534)	(0.957)
Vacant houses	0.046	0.044	0.039	0.045	0.041	0.046
	(0.042)	(0.038)	(0.041)	(0.041)	(0.042)	(0.044)
Housing units	0.509	0.719	0.576	0.627	0.782	0.483
	(0.314)	(0.797)	(0.396)	(0.628)	(0.593)	(0.348)
Family with kids	0.339	0.360	0.336	0.367	0.338	0.366
	(0.113)	(0.125)	(0.113)	(0.134)	(0.108)	(0.118)
House price	64503	78816	71274	74008	77044	69592
	(44099)	44449	40974	41439	41353	44044

Table 3. OLS results of first stage hedonic model

Variables	Akron	Cincinnati	Cleveland	Columbus	Dayton	Toledo
Intercept	9.588 *** (0.086)	10.131 *** (0.049)	10.102 *** (0.036)	9.881 *** (0.060)	9.661 *** (0.050)	9.562 *** (0.102)
Patio	0.018 (0.045)	-0.009 (0.007)	-0.003 (0.011)	0.006 (0.006)	0.012 ** (0.006)	0.007 (0.008)
Air condition	0.036 *** (0.008)	0.055 *** (0.007)	0.024 *** (0.005)	0.078 *** (0.007)	0.062 *** (0.006)	0.018 ** (0.009)
Bedrooms	-0.012 * (0.007)	0.027 *** (0.005)	0.014 *** (0.004)	0.001 (0.006)	0.030 *** (0.005)	-0.006 (0.007)
Deck	0.020 ** (0.010)	0.032 *** (0.008)	0.047 *** (0.005)	0.050 *** (0.007)	0.089 *** (0.008)	0.051 *** (0.010)
Fireplace	0.110 *** (0.010)	0.088 *** (0.008)	0.070 *** (0.005)	0.091 *** (0.007)	0.052 *** (0.006)	0.053 *** (0.009)
Fullbath	0.129 *** (0.009)	0.096 *** (0.007)	0.041 *** (0.005)	0.053 *** (0.007)	0.073 *** (0.006)	0.111 *** (0.009)
Partbath	0.073 *** (0.008)	0.008 (0.007)	0.070 *** (0.005)	0.034 *** (0.007)	0.056 *** (0.005)	0.048 *** (0.008)
Garage dummy	0.155 *** (0.020)	0.068 *** (0.013)	0.031 ** (0.014)	-0.022 ** (0.011)	0.110 *** (0.014)	0.160 *** (0.026)
Garage size	0.155 *** (0.021)	0.086 *** (0.023)	0.086 *** (0.019)	0.127 *** (0.019)	0.066 *** (0.017)	0.168 *** (0.034)
House size	0.354 *** (0.035)	0.179 *** (0.029)	0.361 *** (0.022)	0.304 *** (0.030)	0.265 *** (0.026)	0.505 *** (0.039)
House size^2	-0.030 *** (0.008)	0.031 *** (0.007)	-0.018 *** (0.005)	0.005 (0.007)	-0.009 (0.006)	-0.047 *** (0.008)
Lot size	0.053 *** (0.010)	0.060 *** (0.007)	0.085 *** (0.005)	0.100 *** (0.009)	0.067 *** (0.008)	0.062 *** (0.011)
Lot size squared^2	-0.004 ** (0.001)	-0.002 * (0.001)	-0.007 *** (0.001)	-0.008 *** (0.001)	-0.006 *** (0.001)	-0.001 (0.001)
Age	-0.008 *** (0.001)	-0.005 *** (0.000)	-0.008 *** (0.000)	-0.005 *** (0.001)	-0.010 *** (0.000)	-0.007 *** (0.001)

Age^2	0.000 ***	0.000 ***	0.000 ***	0.000 ***	0.000 ***	0.000 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Distance to hazard	0.036 **	0.051 ***	-0.029 ***	-0.032 ***	0.085 ***	0.023 **
	(0.017)	(0.010)	(0.010)	(0.009)	(0.010)	(0.009)
Distance to hazard^2	-0.010 *	-0.011 ***	0.007 **	0.009 ***	-0.021 ***	-0.001
	(0.005)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
Public Safety	0.004 ***	0.002 ***	0.001 ***	0.007 ***	0.002 ***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
School Quality	0.048 ***	0.035 ***	0.026 ***	0.035 ***	0.089 ***	0.020
	(0.012)	(0.004)	(0.002)	(0.007)	(0.007)	(0.015)
Distance	0.002	-0.007 ***	-0.004 ***	-0.010 ***	-0.009 ***	0.001
	(0.002)	(0.001)	(0.000)	(0.001)	(0.001)	(0.002)
Graduate degree	1.281 ***	1.436 ***	0.488 ***	1.040 ***	0.789 ***	0.712 ***
	(0.072)	(0.048)	(0.035)	(0.041)	(0.049)	(0.064)
Poverty	-0.691 ***	-0.731 ***	-1.119 ***	-1.000 ***	-0.838 ***	-0.537 ***
	(0.070)	(0.069)	(0.054)	(0.062)	(0.062)	(0.087)
White population	0.507 ***	0.304 ***	0.419 ***	0.369 ***	0.440 ***	0.578 ***
	(0.043)	(0.026)	(0.017)	(0.028)	(0.025)	(0.049)
Population change	-0.175 **	0.173 ***	0.018	0.151 ***	0.427 ***	0.309 ***
	(0.071)	(0.043)	(0.027)	(0.031)	(0.065)	(0.100)
Income	0.001 ***	0.001 ***	0.002 ***	0.001 ***	0.001 ***	0.002 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Population	-0.043 ***	-0.055 ***	-0.091 ***	-0.047 ***	-0.106 ***	-0.021
	(0.015)	(0.012)	(0.008)	(0.007)	(0.008)	(0.020)
Vacant houses	0.058	-0.247 **	-0.296 ***	0.103	-0.256 **	-0.437 ***
	(0.101))	(0.104)	(0.069)	(0.102)	(0.100)	(0.110)
Housing units	0.142 ***	0.134 ***	0.247 ***	0.126 ***	0.261 ***	0.087 *
	(0.041)	(0.031)	(0.020)	(0.018)	(0.022)	(0.052)
Family with kids	-0.283 ***	-0.323 ***	-0.091 ***	-0.092 ***	0.040	-0.267 ***
	(0.039)	(0.032)	(0.025)	(0.92)	(0.033)	(0.046)
Adjusted R-Squared	0.833	0.796	0.785	0.800	0.837	0.855
No. of observation	4813	7123	13321	7636	6770	3875

*** significant at 1% level; ** significant at 5% level; * significant at 10% level

Table 4. Means of variables in demand equations (n = 43538)

Variable	Mean (Std. Dev.)
Distance to Hazard (miles)	1.311 (0.867)
Public safety (inverse crime ratio)	27.465 (24.715)
School Quality (expenditure per student, $1000)	4.959 (0.751)
Price of distance to hazard	384.815 (554.177)
Price of public safety	192.381 (152.445)
Price of school quality	3006.50 (1569.19)
Price of house size (per 1,000 sq.ft.)	21193.58 (1813.19)
Price of lot size (per 10,000 sq. ft.)	4558.94 (728.263)
Income ($1000)	41.326 (19.35)
Graduate Degree (proportion of total population)	0.079 (0.082)
Households with children (proportion of total households)	0.349 (0.12)

Table 5. Results of second stage demand models

Variables	Environmental Quality (Distance to hazard)		Public Safety (Inverse crime ratio)		School Quality (Expenditure per student)	
Intercept	-22.5444	***	-13.0959	***	2.2797	***
	(0.8762)		(1.0826)		(0.1929)	
Price of distance to hazard	-0.01243	***	-0.00995	***	0.000432	***
	(0.0005)		(0.0006)		(0.0001)	
Price of public safety	-0.00798	***	-0.00842	***	0.000281	***
	(0.0003)		(0.0004)		(0.00007)	
Price of school quality	0.004748	***	0.003664	***	-0.00016	***
	(0.0002)		(0.0002)		(0.00004)	
Price of house size	0.00069	***	0.000491	***	-0.00002	***
	(0.00003)		(0.00003)		(0.00000)	
Income	0.004895	***	0.006851	***	0.000018	
	(0.0002)		(0.0002)		(0.00005)	
Graduate degree	-0.71072	***	-0.60097	***	0.707698	***
	(0.0572)		(0.0663)		(0.0107)	
Family with children	0.231082	***	0.409646	***	-0.27438	***
	(0.0267)		(0.0334)		(0.00579)	
No. of obs	43538		43538		43538	
Adjusted R-Squared	0.054		0.146		0.207	

Table 6. Demand elasticities for environmental quality, public safety and school quality demands

Variables	Environmental Quality	Public Safety	School Quality
Price of distance to hazard	-4.783	-3.829	0.166
Price of public safety	-1.535	-1.620	0.054
Price of school quality	14.275	11.016	-0.481
Price of house size	14.623	10.406	-0.424
Income	0.202	0.283	0.0007
Graduate degree	-0.056	-0.048	0.057
Family with children	0.081	0.143	-0.096