Implicit Value and Risk Perception: Sales of Floodplain Property

William A. Donnelly

William A. Donnelly, Ph.D., is Professor of Economics at the University of Wisconsin/La Crosse and a Senior Research Fellow at The Australian National University, Canberra. He is the author of *The Econometrics of Energy Demand.*

Introduction

The use of mass appraisal techniques, and, more specifically multiple regression analysis (MRA), can facilitate the determination of the degree of disutility which buyers associate with, as measured by the differential value they place upon – specific house characteristics, *e.g.*, a location in a floodplain. Park and Miller (1982) consider flood risk perception, and Shilling, *et al* (1986), present an argument in relation to the capitalized value of flood insurance premiums. The literature has established MRA as a procedure useful for the designation of the component values relating to the attributes of a composite good, that is, an item which is a "bundle" of diverse characteristics. Early empirical studies relating to the valuation of a complex good measure the quality change in automobiles (Court, 1939, and Griliches, 1961); then Rosen (1974) established the theoretical basis for the models. The MRA parameter estimates obtained from such studies provide the means for measuring the implicit value of the individual characteristics of the good; this is referred to as the "hedonic price index" technique. The housing market receives much attention, because of the ready availability, and the good quality, of house-sales data, and the data sources include: US Bureau of the census surveys, Federal Housing Administration summary reports, tax assessor's records, and MultiList Service files, among others. The most detailed and reliable information on the characteristics of properties sold are the files that are maintained by tax assessor's offices and by MultiList Service (MLS) co-operatives, and those latter data are used to illustrate the hedonic technique for identifying the decrement to a residence's selling price as a consequence of its location in a floodplain. These data are currently considered by appraisers as ancillary information, but the application of MRA has awaited the requisite hardware and software to accomplish the analysis effectively. Donnelly and Andrews (1988) demonstrate how the current generation of microcomputers and electronic spreadsheet software can be used to implement regression based appraisals, and how the regression routine can easily generate confidence intervals for forecast values. In the context of determining the disutility of a floodplain location to the purchaser, the primary interest of the analysis is in the identification of the model's parameters, and not on the forecast value of the property *per se*. Thus, in this context, the presence of some degree of collinearity and its magnitude in the independent variable set are important concerns;

The MRA parameter estimates obtained from such studies provide the means for measuring the implicit value of the individual characteristics of the good.

TABLE 1

Regression Model Output

(SHAZAM 6.01)[4]

R-SQUARE = 0.8304 R-SQUARE ADJUSTED = 0.8253

VARIANCE OF THE ESTIMATE = 0.83787E + 08 STANDARD ERROR OF THE ESTIMATE = 9153.5

MEAN OF DEPENDENT VARIABLE = 49970. LOG OF THE LIKELIHOOD FUNCTION = -3620.46

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 333 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
RESIDTAX	31.645	3.0069	10.524	0.4996	0.32741	0.56744E-16
AGE	-275.66	79.804	-3.4542	-0.1860	-0.21748	-0.23976
LIVSPACE	20.386	1.8897	10.788	0.5089	0.46418	0.54259
GARSIZE	7.4682	2.4264	3.0778	0.1663	0.76945E-01	0.49223E-01
LOTSIZE	0.86266	0.21161	4.0766	0.2180	0.14708	0.12075
AC	6711.9	1059.8	6.3333	0.3279	0.15184	0.57398E-01
FIREPLACE	9394.6	1143.3	8.2170	0.4106	0.19730	0.56839E-01
STHSIDE	1990.6	881.26	2.2588	0.1228	0.43856E-01	0.25245E-01
YEARDUM	-2190.2	913.41	-2.3978	-0.1303	-0.49257E-01	-0.17965E-01
FLOOD	-5.2006	1.9973	-2.6039	-0.1413	-0.81892E-01	-10381E-01
CONSTANT	20790.	6836.0	3.0413	0.1644	0.00000E+00	0.41606

these issues are taken up in the explication which follows.

Implicit Value Model

This model is parsimonious in explanatory variables, containing ten explanatory variables, and differs from the specification of Shilling, *et al.* (1985), in that it is based upon theoretical considerations; namely, there is a tautological relationship between the dependent variable, selling price, and the explanatory variable for the floodplain, the flood insurance premium in the Shilling, *et al.* specification.[1] Instead, in this paper, the previous assessed value of the property is used to weight the floodplain zero/one dummy variable. This variable is determined prior to the sale, and must therefore be independent of the selling price.

The MultiList data used here make reference to 344 houses which sold in La Crosse, Wisconsin between January 1984 and December 1985. La Crosse is a regional service center having a population of about 50,000 with roughly 13,000 residential properties. The city is situated on terraces of the Upper Mississippi River, and the area exhibits a low crime rate, clean air and water, relatively uniform quality of public and private schools, and good access to employment, and to community private and public services. MLS records represent around 50 percent of the residential sales. The database includes information on selling price (PRICE), date of sale, days on market, financing utilized, property TAX, AGE of house, finished floorspace (LIVSPACE), size of garage (GARSIZE), LOTSIZE, existence of a dining room, porch, air conditioning (AC), fireplace (FIREPLCE), *etc.*; and neighborhood, location in floodplain, and other attributes. From this set of variables the preferred model is:[2]

PRICE = f(TAX, AGE, LIVSPACE, GARSIZE, LOTSIZE, AC, FIREPLCE, STHSIDE, YEARDUM, FLOOD)

The recorded property liability on these houses in the year prior to the sale amounted to \$371,726. The average AGE of the houses which sold during this period is 43.5 years old with that house containing 1,300 sq. ft. of LIVSPACE. Eighty-six-point nine percent of the houses in the data set have garages, the average size being 329 sq. ft. or roughly 16.5 ft. by 20 ft. The LOTSIZE average is 6,995 sq. ft.; that is to say, the approximate dimensions of the average lot are 58 ft. by 120 ft. Forty-two-point-seven percent of the houses sold have AC and 30.2 percent have a FIREPLCE. The variables, STHSIDE, YEARDUM,

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and FLOOD, are each dummy variables constructed from the data. The first two of these are zero/one dummy variables included so as to be able to identity the parameters in the hedonic pricing model. They represent the area of the city: division is based upon the average neighborhood selling price, and is essentially the north- or south-side, and the year of the sale 1984 or 1985. The majority of sales occurred in the STHSIDE, 63.4 percent, and during 1984, 59.0 percent. Nine-point-six percent of sales are of houses in a floodplain. The FLOOD variable is constructed as the product of the floodplain, zero/one variable, and the property's tax liability. This variable is designed to measure the value which house buyers place on the location of a property in a floodplain. The model is estimated in a linear regression, using the dedicated statistical package SHAZAM on an IBM-PC clone. The estimation could as easily have been accomplished in an electronic spreadsheet, such as LOTUS 123 or QUATTRO – see White and Haun (1988) and Donnelly and Andrews *op. cit.* The specification adopted is standard, in that it incorporates attributes that have been confirmed in other studies. The expected algebraic sign of the parameter estimates is positive, except for AGE and FLOOD, both of which would be expected to reduce the selling price of the property and, therefore, have negative signs. There is no prior assumption made concerning the sign, or the magnitude, of the "year of sale" variable.

The hedonic price technique thereby provides a means for measuring the implicit market value of an attribute which is itself not traded directly.

Regression Results

The multiple regression parameter estimates and regression statistics are presented in Table 1.

The interpretation of the regression results is relatively straightforward, with all of the parameters exhibiting the anticipated algebraic signs, and statistical significance. The explanatory power of the model is deemed to be quite acceptable in having an R^2 of 0.830.[3] Finished living space is valued at just over $20.00 per square foot, while a garage is worth about $7.50 per square foot. The values of houses with air conditioning and fireplaces increase by roughly $6,700, and $9,400, respectively. Houses on the south-side of the city sell for a premium of about $2,000, which would have been offset if that house had sold in 1985, rather than 1984, inasmuch as there were layoffs and firings in several important industries during 1985 in the area.

The interpretation of the FLOOD parameter estimate is, that for a house located in the floodplain, the selling price is reduced by $5.20 for each dollar of property tax liability. Since assessed values in the State of Wisconsin are to be based upon "market value" this decrement in selling price will differ among properties. Thus, a property attracting a tax of $1,000, when located in the floodplain, would be reduced in selling price by $5,200, *ceteris paribus*.[5] The hedonic price technique thereby provides a means for measuring the implicit market value of an attribute which is itself not traded directly. This is an extension of the concept of "comparables" in the market analysis approach with the weighting factors

TABLE 2

Indicator-Variable Estimates and Standard Errors

(SHAZAM 6.01)

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 333 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
•	•	•	•	•	•	•
RESIDTAX	31.645	3.0069	10.524	0.4996	0.32741	0.56744E-16
AGE	-275.66	79.804	-3.4542	-0.1860	-0.21748	-0.23976
•	•	•	•	•	•	•
FLOOD	-5.2006	1.9973	-2.6039	-0.1413	-0.81892E-01	-10381E-01
IV-1	50501.	9168.0	5.5084	n.a.	n.a.	n.a.
IV-2	44739.	9282.3	4.8198	n.a.	n.a.	n.a.
IV-3	44510.	9284.7	4.7940	n.a.	n.a.	n.a.
IV-4	52455.	91777	5.7155	n.a.	n.a.	n.a.
CONSTANT	20790.	6836.0	3.0413	0.1644	0.00000E+00	0.41606
•	•	•	•	•	•	•

n.a. - not applicable

for the characteristics being statistically determined by the data set.

Several points should be made concerning the estimation. First, the reader will note that the property tax variable in Table 1 is denoted as RESIDTAX. A transformation of the property tax value is required, because the level of collinearity between that variable and the other "independent" (exogenous) variables is deemed to be too high, the coefficient of multiple determination for that relationship being 0.730–for a discussion on a simple procedure for identifying collinearity, see Farrar and Glauber (1967). Since multicollinearity precludes the identification of the individual contribution of each of the explanatory variables due to their joint contributions toward the variation in the preferred model's dependent variable, the presence of a "high" level of collinearity prevents the making of definitive statements about the magnitudes of the individual parameter estimates, one objective of this particular analysis. The existence of a high level of collinearity, however, does not affect the model's ability to forecast, so long as the nature of the collinearity remains stable over the range of the data considered. One corrective procedure for dealing with problematic collinearity is to remove [and replace] the explanatory variable in question. Another approach is resort to ridge regression, see Sweetland and Colclough (1986). What is desired is an alternative which will remove the influence of the other explanatory variables from the variable which obscures the results. This may be accomplished by regressing the collinear variable, in this instance TAX, against the remaining nine explanatory variables. Then the residual from this regression, RESIDTAX, is used in place of the original TAX observations; therefore, the acronym RESID, used as a prefix, is applied to the "new" variable. This transformed variable now reflects the unique contribution of the property tax in establishing a house's selling price, with the influences of the other variables eliminated. When this residualization approach to coping with collinearity is adopted, it must be recognized that the other parameter estimates derived include, by necessity, the joint influence of the offending variable and these estimates are, therefore, no longer unbiased ones. Statistical significance tests, however, can be made with confidence. Another point concerning the estimation has to do with heteroscedasticity, a non-constant variance in the model's error term. It is to be expected in data such as these that the variance in selling prices will differ between the low- and the high-end of the market. An intuitive explanation is simply, "There is a greater potential range of prices for expensive houses than for low priced houses." The consequence of this problem is that the parameter estimates are rendered "inefficient;" or,

...a corrective procedure is available to handle the existence of an unknown form of heteroscedasticity...

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more specifically, the estimated standard errors of the parameters are larger than necessary. Fortunately, a corrective procedure is available to handle the existence of an unknown form of heteroscedasticity, and the correction is employed in the results reported here.[6]

FORECASTING

The model, in addition to providing insight into the component values, provides forecasts as well. This is best accomplished by use of the indicator variable procedure illustrated by Donnelly and Andrews, *op. cit.* The technique provides for the forecast calculations to be accomplished within the regression estimation and, also, for confidence intervals to be derived. This forecasting strategy requires the inclusion of a weighted zero/minus-one dummy variable in the model specification to identity properties located in the floodplain. This FLOOD is a "scaled" dummy variable. In a regression model, the parameter estimate for the appropriately-defined indicator variable is the desired point-estimate forecast and the standard error of the parameter is the standard deviation of the forecast value. The calculation requires the addition of an observation to the model data set for each collection of property attributes for which forecast values are sought. The PRICE observation value of this "additional" property is set to zero. If the original model has "n" observations, this become the "n + 1" st observation. An indicator-variable, taking on the value of zero for all of the "true" observations.and a minus one for the "new" observation "n + 1," is defined and added to the model structure and its data set. The preferred regression model, with these modifications, is reestimated, and the point-estimate and standard deviation results are calculated automatically. Donnelly and Andrews, *op. cit.* explain this process with respect to hedonic housing prices in more detail.

So as to illustrate this forecasting approach, four "observations" are added to the MLS data set; these are defined at the mean-value of the characteristics for: (1) all of the houses which sold (two observations here for in and out of the floodplain); (2) for houses outside the floodplain as if it were within the floodplain: and (3) for houses within the floodplain as if it were outside the floodplain. The PRICE is set to zero for each of the "new" observations. The extended data set totals 349 observations (one actual observation is dropped in the analysis because no previous assessed value is available for it), plus the four indicator-variables. These are denoted IV-1 and IV-4. The preferred regression model is rerun with these changes incorporated and a portion of that output is presented in Table 2.

As was stated, the original variable parameter estimates remain unchanged, *e.g.* RESIDTAX, AGE, FLOOD, etc. The "estimated coefficient" values for the indicator-variables are the point-estimate forecasts. Thus, the forecast value for the "average" property which is not located in the floodplain (IV 1), when evaluated at the mean value of the explanatory variables, is $50,501, with a standard deviation of $9,168.0. The similar, "average" property when located within the floodplain (IV-2) has a value of $44,739, with a standard deviation of $9,282.3. Considering the average house of the 311 which are not located in the floodplain, but assuming that "average house" is moved to the floodplain one would find a selling price of $44,510, rather than the observed average for those houses of $50,402. If the same "average" house of the 33 which are located in the floodplain, is assumed to be moved off of, the house would have a selling price of $52,455, rather than the actual value of $45,891. This represents a discount of 12.5 percent.

The standard deviation values are used to generate the confidence interval, and a 95% confidence interval (CI) for the actual-selling price about the point-estimate forecast would be +/-1.96 times the standard deviation, as reported in the regression output. It is argued in Donnelly and Andrews *op cit.*, that the most relevant CI to the present context is that one defined about the mean value forecast. This interval is derived from the preferred regression model's standard error of the estimate, and the standard deviation of the forecast point-estimate. The mean value confidence intervals are presented in Table 3.

Since the passage of the National Flood Insurance Program in 1968, cities have been required to develop flood mitigation programs in order to qualify for federal disaster payments.

These results indicate that the 95 percent mean-value CI for the "average" house – one which is not located in the floodplain – is between $49,500 and $51 ,500, the IV-1 point-estimate is $50,500; the mean selling price for these data is $49,970. With respect to the floodplain value, the 95 percent CI is between $41,700 and $47,800. The floodplain discount on the "average" house is thus $5,762. This represents 11.4 percent of the selling price.

Since the passage of the National Flood Insurance Program in 1968, cities have been required to develop flood mitigation programs in order to qualify for federal disaster payments and for properties located in their boundaries to be eligible to purchase flood insurance from the Federal Government. Most lenders require that borrowers obtain flood insurance for any properties located within the floodplain, as identified in the Flood Insurance Rate Map (FIRM). The amount of the insurance premium depends upon whether the house was constructed before or after the initial entry of the area into the program – this is the date of the FIRM for the community – and whether there is a basement or not. Since almost all of the houses in La Crosse have a basement, a basement in each will be assumed.

The flood insurance premium, at present, includes a flat fee of $45.00 plus coverage for the value of the building and optional coverage for the contents, if this latter is chosen by the purchaser. Naturally, mortgagors only require coverage of the house, and the proportion of buyers who choose the optional-contents coverage is not known. For those houses constructed in the floodplain before the initial date for FIRM (pre-FIRM), the insurance premium for the building is $0.60 per hundred dollar value up to $40,000 and then $0.30 per hundred dollars to a maximum of $18,000. For pre-FIRM houses "contents" insurance is not available. For those houses constructed after the FIRM date (post-FIRM), the rates are $0.55 and $0.40, respectively for a house with a basement having a floodplain elevation of -1 foot. The post-FIRM contents insurance is $0.22 per hundred dollars for the first $15,000 and $0.11 for the next $45,000. These rates translate to an annual premium for a $44,739 house of $299.22 for the pre-FIRM house and $322.87 for the post-FIRM house, the latter amount including contents coverage to the value of $22,370. Converting these annual premiums to annuity values, and assuming a 10 percent rate of interest, results in a pre-FIRM capitalized value of $2,992 and in a post- FIRM value of $3,229. Recall that the floodplain discount for the "average" house is $5,760. The discrepancy is $2,768 for the pre-FIRM, and $2,531 for the post-FIRM, house. That is to say, buyers in the floodplain apply an additional dis-

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TABLE 3

Mean-Value 95% Confidence Intervals

Name	Lower Bound	Point-Estimate	Upper Bound
IV-1	$49,491	$50,501	$51,511
IV-2	$41,719	$44,739	$47,759
IV-3	$41,462	$44,510	$47,558
IV-4	$51,150	$52,455	$53,760

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count to the value of the property over and above the capitalized value of the mandated flood insurance premium. It suggests that the perceived risk of the buyer differs from the actuarial risks, as those are established by the Federal Emergency Management Agency -the office responsible for maintaining the fiscal integrity of NFIP. This additional discount applied by buyers may be due to lack of information or it may reflect a "hassle premium." In the case of the pre-FIRM properties a portion of this amount may reflect "self-insurance" coverage for contents damage. This implies that, individuals are risk averse to floods, through their not wanting to deal with the aftermath of a flood. The conventional wisdom that buyers are myopic concerning floodplain locations is demonstrably not the case. Rather the opposite is true, buyers discount the house by almost double the capitalized value of the actuarially determined risk. These are tentative results and the issue should be further explored before any more definitive statements are made.

Summary

The paper demonstrates the use of MRA to ascertain the level of disutility imposed upon a residential property because of its location in a floodplain. A regression model is specified, estimated, and used to develop point-estimate and confidence interval forecasts for the specific attributes of the "average" property. The estimation is accomplished on a PC-type microcomputer. On average, the loss in market value attributable to the floodplain is $5,762; that is to say, similar properties located in and out of a floodplain vary, differentially, by about $5,800, in selling price. These results are site-specific, and therefore alternative specification will likely be required for other cities. However, since the data utilized are readily available for most geographic markets, and the hardware and software required for the analysis are readily available, as well, the site specificity should not pose a problem to the analyst. In addition, it is feasible to evaluate the "value" that buyers place upon environmental amenities such as aspect, view, quality of schools or clean air, by way of this technique. Comparisons could in similar manner be made in regard to the cost of ameloriating deficiencies, such as, for example, poor schools, thereby revealing the actual dollar value of the disutility which individuals place on such characteristics.

Foot Notes

1. The floodplain variable which they specify is defined as the flood insurance premium for the property. This premium they calculate as a fee of $20 plus "$0.45 per $100 of coverage" up to $35,000, the federally subsidized limit; plus $0.70 per $100 in excess of that amount, plus the cost of the "contents" insurance coverage. This later is a proportion of the house's insured value. This variable then, by construction, is a nonlinear function of the selling price and must, therefore have a high correlation with the selling price. Obviously, these are values that are determined ex post. It is argued here that the use of the property tax liability figure, which is known a priori, is not only the more correct formulation for the flood variable, but also the more relevant measure for inclusion in any hedonic analysis. In addition, it is totally independent of the actual selling price of the property. Replication of the Shilling, et al. eight- explanatory variable semi-logarithmic specification with the La Crosse data results in a coefficient of multiple determination, adjusted for degrees of freedom, of 0.650 in which only AGE, LIVSPACE, net area, and FLOOD are statistically significant. In the original paper, only four explanatory variables are statistically different from zero, i.e. age, living area, days on market, and the floodplain dummy.

2. The model data are available on IBM format diskette upon request from the author.

3. The coefficient of multiple determination, R2, ranges between zero andone, and describes the proportion of the variation in the dependent variable that is "explained" by the model's exogenous variables.

4. This table represents an abbreviated printout from SHAZAM. The complete regression results are available from the author

5. Lee and Donnelly (1988) report on a seven-variable model using these La Crosse data. Their results provide a constant, negative value of approximately $5,300, for floodplain location. The mean-selling price of a house in La Crosse during 1984-85, was $49,900; therefore, on average, the utility reduction implied by that model is 10.6 percent.

6. The SHAZAM 6.01 program provides for an heteroscedasticity adjustment as an ordinary least squares (OLS) command "option."

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addition to considering the cost of cleanup action, the prospective purchaser must also consider the devaluation of the property value after finding hazardous wastes have been disposed on it.

There are legal remedies to these hazardous waste liabilities, but the purchaser must protect himself before acquisition to not only retain the legal defense provided under the regulations, but also retain the option of not consummating the purchase agreement until an environmental site assessment has been complete on the property.

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