ECONOMIC VALUATION OF A RIVER CORRIDOR: INTEGRATION OF NATURAL RESOURCE AND DEVELOPMENT ECONOMICS

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Introduction

Rivers have the potential to play an important role in the development of an economically depressed region by providing water supply, transportation, waste assimilation, and a wide array of recreation and tourism activities. The Muskingum River, which flows thorough Coshocton, Muskingum, Morgan and Washington Counties in Southeastern Ohio, provides an example of the roles a river can play in regional development. Throughout the length of the river are ten sets of locks and dams that were constructed between 1837 and 1841 to facilitate transport of products by barge (Woolpert 1993). The original features of the locks have been maintained throughout the century, making them an interesting attraction for boaters and fishermen as well as for tourists, even though little cargo moves through them now.

Several local officials have expressed concern that the Muskingum River is underutilized, but has the potential to become a more popular tourist attraction and catalyst for economic growth. Over the years, the condition of the river corridor has deteriorated and information is needed to determine the economic feasibility of various options for restoring and upgrading the corridor. Traditionally, development economics has focused on growth in private market activities whereas natural resource economics has focused on non-market valuation of natural resources and the environment. An increase in private market activities related to natural resources such as rivers and improved methods of non-market valuation make it possible for stronger complementarity of natural resource and development economics.

During the initial phase of the study, the authors developed methodologies to estimate the recreation and tourism value of the river as well as the impact of property, community and environmental attributes on values of residential properties along the river. During the second phase, the authors are determining the costs and benefits of improving water quality through residential sewering, extending the existing bike trail, improving recreational infrastructure such as increased access to fuel, repairing the locks and dams, and implementing zoning and subdivision restrictions in Muskingum, Morgan, and Washington counties. This paper focuses on quantifying benefits resulting from recreation and tourism, hedonic pricing of selected corridor improvements and discussing a method for quantifying the net benefits from corridor improvements, with sewer and septic for illustration.

Lock Use Data

The majority of the recreation and tourism use data, as well as the data for lock amenities, was obtained from records maintained by Blue Rock State Park in Muskingum County. The data represents annual use of the locks and dams; it is collected daily by lockmasters at each lock. Because of significant asymmetry in the data between years, this portion of the study uses an average of the values taken from 1995-1997. Five categories of lock users were examined: lock boaters, other boaters, fishermen, picnickers, and visitors. Lock boaters are the number of people in boats that use the locks; other boaters are those that navigate the pools without using the locks. The fishermen values are for people that fish in the river either from a boat or the riverbank. People at the lock were classified as either picnickers or visitors according to what the lockmaster perceived was the primary purpose of their trip. Table 1 shows this data.

Table 1: Recreators Counted at Locks Annually (in the Thousands)

Recreator Type	Lock 2	Lock 3	Lock 4	Lock 5	Lock 6	Lock 7	Lock 8	Lock 9	Lock 10	Lock 11	Total
Boaters	5.83	1.31	0.97	0.93	0.94	2.16	1.90	0.95	0.41	0.39	15.77
Other Boaters	2.61	4.76	4.25	3.15	1.93	2.55	3.75	3.12	4.09	3.20	36.38
Fishermen	10.76	9.06	4.63	4.09	4.48	7.71	6.06	8.08	10.17	8.94	73.97
Picnickers	3.74	3.76	7.80	2.34	4.31	3.84	3.64	1.58	5.87	5.93	42.80
Sightseers	25.89	16.85	23.49	6.98	13.18	20.53	12.54	5.15	16.37	16.88	157.84
Total	48.84	35.73	41.14	17.48	24.83	36.80	27.89	18.86	36.91	35.33	326.77

A spatial distribution of lock users was obtained for the 1995-1997 time period. A total of 775 boats used the locks from 1995-1997; of this, 26 (3.3%) were from 10 states outside of Ohio (WV, PA, IL, MD, TN, IN, AL, MI, MO, VA). Of the remaining 745 boats from Ohio, 404 (54.2%) were from 15 cities in Ohio. Zanesville ranked first, followed by Columbus, Marietta, Lowell, and McConnellsville.

The data set for this study follows expected trends, such as increased usage in the summer and during lock related festivals. The boater data for boaters that use the locks likely has the least measurement error; every boat that uses a lock must complete a short questionnaire. The number of boaters using the locks is therefore not the result of estimation, but rather of actual events. However, the other categories of usage have several weaknesses. Other boaters, fishermen, picnickers, and visitors are based on estimations made by the lockmasters who are only on site for a portion of the day. Double counting is also a problem. People fishing from boats are counted as both fishermen and boaters. Further double counting occurs if the same boat uses more than one lock during a given day. Anyone that partakes in two different activities during the same trip is also counted twice. However, this problem appears relatively minor since lockmasters only record users as far as they can see in either direction from the lock and some use in the pools is thereby omitted. Any overvaluation due to double counting is probably offset by the use of lock visitation as a proxy for visitation throughout the river.

In addition to lock use data, annual visitation and revenues were obtained from several river-related businesses in the corridor. These businesses include sternwheelers in Marietta and Zanesville, the Ohio River and Campus Martius Museums, and two marinas (marina revenues were approximated from information provided by the owners regarding fees and the number of club members). The average annual revenues of the six businesses have been assessed at approximately $250,000. These annual revenues are generally additive with the benefit transfer values of recreation (discussed in the next section). The authors are currently compiling a list of industries that were built along the river in order to use the river waters for cooling and/or other purposes. The industries' revenues will be compared to the benefit transfer results. It may be that industry revenues are far larger than recreational ones, but this is unlikely as there is little industrial activity along the river and even less industrial activity that depends on the river. The property values of these industries will also be compared to the residential property values in order to determine the relative importance of industrial and residential real estate.

Benefit Transfer

Boyle and Bergstrom (1992) define benefit transfer as "the transfer of existing estimates of non-market values to a new study which is different from the study for which the values were originally estimated". They refer to the area from which the values originated as the "study site" and the area to which the values will be transferred as the "policy site". Several problems are inherent in the transfer process. In particular, the commodity, site and population characteristics of the study site must closely approximate those of the policy site. However, benefit transfer plays an important role; it provides a rough estimate of benefits for those studies with limited budgets.

The benefit transfer values used for this study were derived from a 1992 meta-analysis published by Walsh, Johnson and McKean. The authors reviewed 120 outdoor recreation studies from sites in the U.S. between 1968 and 1988. Benefit estimates were constructed for various recreational activities including camping, fishing, boating, hunting, picnicking, swimming and sightseeing. The activities and their mean economic values per recreator day were as follows:

Table 2: Average Recreational Expenditure Found by the Walsh Study

Recreator Type	Average Expenditure	Recreator Type	Average Expenditure
Boater (motorized)	$25.67	Picnicker	$12.82
Boater (nonmotorized)	$25.36	Visitor	$19.72
Fisherman	$22.50		

Because the proportion of motorized to nonmotorized boating on the river was unknown, the average of the two values was used to calculate the benefits. Lock visitors probably do not spend more than an hour at a site and it is unknown whether or not they stop at more than one lock, or other river businesses. Thus, the value found by the Walsh study was divided in half for the purposes of this study. The values from Walsh et al's study were appreciated to 1996 dollars (the midpoint of the 1995-1997 period) using a consumer price index:

Table 3: Average Recreational Expenditure Adjusted for Use in This Study

Recreator Type	Average Expenditure	Recreator Type	Average Expenditure
Boater	$35.25	Picnicker	$17.71
Fisherman	$31.08	Visitor	$13.62

These values were then multiplied by the number of various recreational users by lock area to approximate the economic benefits of river related recreation. The results for each recreational category by lock are presented in Table 4.

Table 4: Benefit Transfer Results (in Thousands of US Dollars)

Revenue	Lock 2	Lock 3	Lock 4	Lock 5	Lock 6	Lock 7	Lock 8	Lock 9	Lock 10	Lock 11	Total
Boaters	205.51	46.11	34.26	32.64	32.96	76.07	66.83	33.31	14.52	13.64	555.89
Other Boaters	92.00	167.72	149.95	111.00	68.10	89.96	132.08	109.80	144.28	112.87	1,282.47
Fishermen	334.52	281.47	143.87	127.06	139.33	239.71	188.37	251.10	315.94	277.72	2,299.08
Picnickers	47.99	48.18	99.99	29.96	55.22	49.28	46.70	20.22	75.19	75.98	758.02
Sightseers	352.64	229.48	319.89	95.01	179.47	279.61	170.78	70.09	223.01	229.89	2,149.86
Total	1,032.66	772.96	747.97	395.68	475.08	734.62	604.77	484.52	772.95	710.11	7,045.33

The average annual (1995-1997) recreational economic benefits for the corridor is approximately seven million dollars.

Hedonic Pricing of Residential Values

"The hedonic technique is a method for estimating the implicit prices of the characteristics which differentiate closely related products in a product class" (Freeman, 1971) and is the basic method used in the analysis of environmental amenities and disamenities related to property values. Hedonic prices are defined as "implicit prices of attributes and are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them"(Rosen, 1974). The econometric estimation of the hedonic pricing function consists of property value as the dependent variable and all other characteristics as independent variables. Freeman (1971) developed a two-stage model of individual choice. In the first stage, he assumes that the housing market is in equilibrium and each individual's utility is a function of his/her consumption of a composite commodity, X, which is a vector of some characteristics, and the price of the ith residential location, P_i. The hedonic function is given by: $P_i=P(S_i\ C_i\ Q_i)$ where S_i represents the structural characteristics, C_i represents the community characteristics and Q_i represents the environmental characteristics. The second stage estimation is used to reveal the marginal willingness to pay or demand function. Our analysis will focus on first stage implicit price estimates.

Structural characteristics of a house are described by: number of rooms, number of bathrooms, garage spaces, age, various utilities including water supply, sewer system, septic system and electricity. Other things equal, we expect that an additional bedroom or bathroom represents an extra amenity. The lifespan or durability of a house is associated with age and or type of construction. Since a majority of the houses were of the same type of construction, we did not include this variable. In light of the historical significance of houses more than a century old, we attempted to define age as a non-linear (inverse) variable in the model. Since the results were not conclusive, a log form was adopted.

Zoning regulations are included in the hedonic equation to represent one community characteristic. Jud concluded in his study on the effects of zoning on residential values in North Carolina that "purchasers of residential housing seek a uniformity in neighborhood land use… and are willing to pay a premium for it" (1980). An important purpose of zoning is to protect the neighborhood residents from externalities arising from undesirable uses of land in the same area. Zoning increases the value of land in the neighborhood by preventing these uses and therefore has a beneficial effect. Similarly, presence of an effective drainage and septic system as a mandatory requirement by law improves property values. Another set of community characteristics is represented by the cost and quality of the school system (Li and Brown 1980); 'high school graduation rate' was included as a proxy output variable. Expenditure per pupil was not included as an input variable, because the school districts in the corridor were of vastly different sizes. Distance to the three urban centers (Marietta, McConnellsville and Zanesville) is intended to provide a measure of relative locational advantage. A dummy variable specifying whether a property has direct river access or not, is intended to measure an environmental amenity, but lack of data made it difficult to include water quality in our model. Earlier work by Epp and Al-Ani (1979) found river water quality to be an important determinant of nearby non-farm residential property values. We did not measure the elevation of the parcels, which may be an important factor in determining property values where flooding is regarded as a disamenity, or an elevated view as an amenity. Classification of houses into permanent versus vacation homes and trailers versus solid foundation houses was not possible from auditor records.

The functional form that performed the best was a log-linear mixed form. The assessed value of property (the dependent variable), total acreage of the parcel, total living area, and age of the house were specified in log form. Log-linear mixed form incorporates diminishing marginal utility. A linear model would not have been desirable because it assumes that implicit price is constant regardless of the quantity of the attribute.

Theoretically, it is best to take sale values as the dependent variable. However, the study area is very small and the number of sales occurring in a period of one year are not sufficient to make an adequate sample size. The county auditor's office assesses the value of the house by measuring the structural characteristics of the house by a pre-determined pricing ladder and recent sales in the area. All the sales within the sample were regressed against the market assessed values and it was found that the deviation was about five percent, i.e., sale values were higher on average by five percent than market assessed values. For these reasons, the assessed property value (as estimated by the county auditor's office) served as a proxy for sale value. The research used cross sectional data from the county auditors' offices. The observations for the dummy variable, river access, were identified by matching each individual observation or parcel with the corresponding maps provided by the county engineers' offices. The sample was selected from the townships adjoining the Muskingum River on either side. Particular attention was given to include townships with and without zoning. The sample consists of 476 observations. A simple sampling procedure of random proportional sampling was adopted. The hedonic price function for the model is expressed as $P_j=b_0+\Sigma b_{si}\, S_{ij}+\Sigma b_{ci}\, C_{ij}+\Sigma b_{qi}\, Q_{ij}$, where P_j is the market price of the jth property, S_i is the vector of variables describing structural characteristics of the property, C_i is the vector of community variables and Q_i is the vector of environmental characteristics.

The model explains 64% (adjusted R^2) of the variation in the data. Fifteen of the 21 estimated coefficients are significantly different from zero at the 5% significance level as illustrated in Table 5. The estimated coefficient of water is different from its expected sign and is significantly different from zero at the 5% confidence level. Existence of community drinking water supply to a house is expected to have a positive effect on property value. The environmental amenity variable, river distance is significantly different from zero at the 10% level of significance. The variables measuring locational advantage are significantly different from zero at 10% significance.

Table 5: Preliminary Hedonic Price Gradient Estimates

Dependent Variable = Natural Logarithm of Home Assessed Value

Variable	Coefficient Estimate	t-value	Variable	Coefficient Estimate	t-value
Electricity	.686	5.3	Age	-.036	-2.8
Water	-.254	-2.6	Sewer	.114	1.6
Gas	.094	1.6	Septic	.247	3.5
Basement	.067	1.0	River Distance	.107	1.9
Acreage	.102	6.3	Zoning	.231	2.81
Living Area	.333	6.0	Distance to Marietta	-.018	-1.9
Rooms	.027	1.9	Distance to McConnellsville	-.008	-2.0
Bathrooms	.167	.335	Distance to Zanesville	-.018	-2.6
Air Conditioning	.416	6.8	Income Tax Rate	.019	-2.6
Garage	.171	3.9	High school Graduation Rate	.001	.4

The estimated coefficient of tax rate responded contrary to the expected relationship to assessed value; we expected the coefficient to be negative, but it was positive and not significant. The coefficients for living area, acreage and age are elasticities, interpreted as percentage change in the value of a property due to a 1% change in the quantity of that characteristic, other things remaining the same. The other coefficients represent change in the price due to a unit change in the respective variables. As the area of the property increases by one percent, the value of the property is expected to increase by approximately 0.102 percent. Similarly, as the total living area increases by one percent, the value of the property is expected to increase by 0.333 percent. As the age of the house increases by one year, the value of the house is expected to decrease by

.036 percent. The value of the property is expected to increase by $231 if the property is located in a zoned area, an additional room will increase value by $27, an additional bathroom by $167 and river access by $107. Provision of utilities like electricity, gas, sewer and septic system are expected to increase value by $686, $94, $114 and $247 respectively.

The focus of this study is the impact of corridor improvement or attribute variables, viz., zoning, sewer, septic systems and river proximity on the property values. Table 6 illustrates the impact of these variables. These infrastructure and environmental factors in the corridor are valued at more than two and half million dollars in increased residential property values.

Table 6: Aggregate Values For Select Variables

Variable	Total Value ($)
Zoning	879,640
Sewer	418,880
Septic	940,570
River Proximity	407,450

In the first stage, adopting a log-linear mixed model specification, derivatives of the estimated coefficients were taken with respect to each of the characteristics specified in its logarithmic form. The derivatives yield estimates of the marginal implicit price of these characteristics described as P/Z_i = $-P/Z^* \beta_i(\ln Z_i)$ where i is the characteristic of which the derivative is taken. The average assessed market value was estimated at $45,820 and marginal implicit prices were calculated for the average house. Table 7 illustrates the marginal implicit prices for the three continuous variables, parcel area in acres, square footage of the living area and age of the structure.

Table 7: Marginal Implicit Prices (in Dollars)

Area (acre)	1,640
Living Area (sq feet)	12.5
Age (years)	94.5

Since the sample (8%) was drawn in a random manner, average residential property value ($45,820) times 12.5 times sample size (476) gives the total corridor residential property value ($272,629,000). This value can be converted into an annual rent equivalent of (272,629,000 * 0.08 = $21,810,320) where 0.08 is the mortgage interest rate. The annual rent equivalent of only the corridor improvements and attribute values is equal to $211,733 ($2,646,540*0.08).

Net Benefits of Corridor Improvements

Cost estimates are currently being developed for the earlier discussed corridor improvements; they will be compared with the residential property and recreation benefit estimates. For example, the value a septic system added to the market price of a residential property is small when compared to the cost of septic system installation. Preliminary estimates show that the average cost of installing a septic system averages $5000. Septic systems can therefore not be justified if one only considers the benefit revealed by the hedonic model. However, septic systems clearly have other benefits. They improve water quality, which could in turn increase the amount of recreation in the corridor. The authors are currently estimating this value through regression and benefit transfer analysis.

The recreation values at individual dams and locks can be explained as a function of usage at adjacent locks, repairs made on the lock, fuel availability, rural or urban location of the lock, water quality and other independent variables. Because water quality data for the Muskingum River is incomplete, this analysis will use a set of proxy variables that represent potential threats to water quality. These include the concentration of houses without septic systems or with poorly functioning septic systems, of industry, and of livestock and row crop agriculture close to the river. The coefficient for absence of septic should reveal the effect that septic installation would have on recreation. The sum of the benefit from the change in the level of recreation and the value of septic to residential housing values more closely approximates the total value of septic installation. An important value that is not included in this sum is the existence value of such septic systems.

Tentative Conclusions

The conservative estimate of annual recreation and tourism values (1995 - 1997) in the Muskingum River corridor is $7.3 million. If one adds the annual rental equivalent value of riverside residential properties of $21.8 million, the corridor total is $29.1 million annually for recreation, tourism and residential rent equivalents. The recreation and tourism value is a lower bound estimate and the rental equivalent value is an upper bound estimate, at least for residential property. However, commercial and industrial property in the corridor is not yet included, so both estimates and thus the totals are probably conservative.

Several preliminary models of statistical inference including dam and lock use, and property values have been estimated to determine what factors influence corridor value. The statistical results identified key statistically significant explanatory variables and their relationship to dam and lock use as well as residential property values. For example, variations in residential property value are explained by several characteristics of the property itself, plus existence of zoning or subdivision controls, water, sewer systems, availability of septic and gas hook-ups, and proximity to the river and urban centers. In the next phase, further visitation and benefit transfer as well as contingent valuation surveys and cost estimates of specific Muskingum River corridor improvements are underway to provide a rank order plan for economic development of the corridor; they should be available for presentation by early August, 1999.

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