# Benefit Capture: Evidence from a River Corridor Benefit Cost Evaluation *

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## Introduction

Pearce and others have suggested that environmental economics is concerned with not just the measurement but also the capture and internalization of benefits and costs. Considerable research activity over the past 20 years or more has been concerned with non-market valuation techniques for measuring the economic benefits including non-use values of various environmental goods and services. Less attention has been given to how some of these benefits could be captured in a real world policy context. This is particularly true of benefits estimated with contingent valuation methods or surveys. After all, this technique was originally known as hypothetical valuation and it was and still is argued by some authors that if you ask a hypothetical question you will get a hypothetical answer. There are also tax-revenue implications not evident from changes in asset value (e.g., residential property) estimated in hedonic price analysis.

This paper takes a fairly pragmatic approach to benefit capture extending both contingent valuation and hedonic pricing methods from a recently completed benefit cost analysis of several water quality and infrastructure improvements (e.g., zoning, upgrades to historic locks and dams, improved household septic systems, and a bike trail extension) in the Muskingum River corridor of SE Ohio. Bid functions and property tax revenue functions are estimated to provide evidence on the potential for benefit capture. Given that a hedonic pricing function measures implicit prices of property attributes, one might conclude that benefit capture can be directly observed in the changes in asset (property) value. This is true for the owner of a property but school and other special districts (e.g., fire protection, waste management) and local governments may also gain or lose property tax revenue from changes in property values. The tax revenue functions allow these changes to be estimated and reported to local special districts and governments.

Bid functions for the willingness to pay from the contingent valuation survey may also be able to identify significant explanatory factors that allow greater capture of CVM benefits estimated. The actual results of the foregoing bid functions and property tax revenue functions are presented for the two Counties of the Muskingum River corridor in SE Ohio. The property tax function results are also presented for both local school districts and local governments with variations and implications discussed. The CVM bid functions discussion focuses primarily on results regarding explanatory variables such as previous use of the corridor by boaters, whether or not respondents have ever visited the Muskingum River Museum, income, etc that might facilitate greater benefit capture. Finally, a number of implications for both current policy and future research are developed.

## Hedonic Tax Revenue Functions

The goal of the hedonic pricing research by Ayalasomayajula was to identify the structural, neighborhood and environmental factors that affect the variation in assessed-market property values in the corridor. Characteristics that increase property values imply a higher tax base and revenue for the region.

A first stage hedonic technique was applied to determine the factors affecting the variation in assessed market property value. Hedonic technique is the basic method used in the analysis of environmental amenities or disaminities related to property values, and the theory states that the implicit price of each characteristic is embedded in the price of the composite good. The use of the HPM technique is based on the assumption that the properties in the river corridor are differentiated goods and any marginal changes in the 'focus' or key variables are perceived by the residents. Any fluctuation in these variables will be reflected in the values of residential properties in the corridor. The impact of improvements in the corridor on the

community as a whole will be reflected in fluctuation in the value of the properties as well as increase in tax base and annual revenue generated in the community. A simple algebraic calculation,

tax millage*coefficient estimate* number of houses in the area/1000

was used to estimate the annual increase in annual tax revenue due to the specific corridor improvement represented by the coefficient estimate. Each coefficient represents a marginal increase in property value given a specific attribute such as zoning or effective household septic system.

**Estimation of Benefits to the Community**

Zoning regulations increase property values and imply higher tax revenues accruing to the community. Ideally, the expected increases in tax revenues to the zoned communities should be calculated using coefficients for each of these communities. One of the objectives of this research was to determine if there was any significant difference regarding the magnitude and/or sign of coefficients between results using data from only Morgan County versus using all three Counties in the corridor. Morgan County is very different from the other two counties with respect to economic development indices, and is positioned between the two counties Muskingum and Washington. It was not possible to ignore Morgan County while using the river corridor as a unit for research purposes. On the other hand, we could not ignore the fact that Morgan County has different characteristics than the other two counties and hence potentially different results. Another objective was to isolate the effects of the focus variables in Morgan County. Consequently, the analysis was extended using a sample from only Morgan County, and another sample including Muskingum and Washington Counties. Table 1 presents the implications of zoning in increased tax revenues for Muskingum and Washington Counties.

**Table 1. Estimated Property Tax Revenues Increases from Corridor Improvements**

| City | Tax Millage ($) | Coefficient Estimate | Number of Houses in the Area | Tax Revenue Increase ($) |
|---|---|---|---|---|
| **Zoning** | | | | |
| Zanesville | 44.22 | 269 | 485 | 5782.21 |
| Marietta | 43.18 | 269 | 464 | 5389.55 |
| **Septic System** | | | | |
| Zanesville | 44.22 | 67 | 1002 | 2975.38 |
| Marietta | 43.18 | 67 | 726 | 2100.36 |

The total increases in property tax revenue as a result of zoning in the cities of Marietta and Zanesville are estimated to be $11,172 annually. Similarly, the increases in tax revenues in the two counties as a result of increases in asset value due to rural septic systems are also shown in Table 1. The coefficient of sewer has a negative sign, indicating that it does not contribute to increases in tax revenue. The interpretation of a negative coefficient is that it contributes to a decline in the asset value, and hence will result in a decline in tax revenue. However, the coefficient was not statistically significant even at 20 percent level of confidence, hence we did not include it in our analyses.

Besides the increase in local government revenues generated due to increase in asset value, the asset increase also contributes to the tax revenues received by the school districts. Table 2 presents the increases in revenues from tax to the school districts. There are 6 school districts each in Muskingum and Washington Counties, and each school district levies a different rate of tax on the residents of the district. The millage rate for each county was weighted by the total value of the taxes and an average millage rate for each county was calculated. A total

increase of $18,240 annually was estimated to accrue to the school districts as a result of the particular corridor improvements.

**Table 2. Estimated School District Tax Revenues Generated by Zoning and Septic System**

| County | Tax Millage ($) | Coefficient Estimate | Number of Houses in the Area | Increase in Tax Revenue ($) |
|---|---|---|---|---|
| **Zoning** | | | | |
| Muskingum | 24.61 | 269 | 1487 | 9844.07 |
| Washington | 26.23 | 269 | 1190 | 8396.49 |
| **Septic** | | | | |
| Muskingum | 24.61 | 67 | 1002 | 1652.6 |
| Washington | 26.23 | 67 | 726 | 1275.70 |

## Bid Functions and Benefit Capture

Our Contingent Valuation survey of the general adult population of Ohio was designed based on the standard reference: *Using Surveys to Value Public Goods: the Contingent Valuation Method* by Carson and Mitchell. In order to identify the characteristics of people who are willing to pay for the locks and dams, bike trail and/or septic program, we utilize bid functions. A bid function explains willingness to pay (WTP) as a function of various characteristics of the respondent. Community leaders and policy makers could use this information to identify what constituency they should be targeting in legislative, referendum or fund raising efforts. By soliciting only those people who are likely to vote favorably or contribute, transaction costs could also be reduced.

## Locks and Dams

Three different equations will be presented to explain the probability that WTP for the maintenance, repair and operation of the Locks and Dams is positive (prob(WTPLDYES ≥

$10)). Equation 1 modeled prob(WTPLDYES ≥ $10) as a function of $(INC/HS)^{-1}$ (the inverse of household income divided by household size), NOTIMPORTANT (a dummy variable for which a 1 indicates the respondent indicated that the locks and dams are not important), BOATED (a dummy variable for which a 1 indicates the respondent has previously boated along the Muskingum), LDOTHER (a dummy variable for which a 1 indicates the respondent has previously used a lock in a river other than the Muskingum) and MUSEUM (a dummy variable for which a 1 indicates that the respondent had previously visited the Ohio River Museum). The results are shown in Table 3[1].

| **Table 3: Results of Probit Estimation of WTPLDYES: Equation 1** | | |
|---|---|---|
| **Variable** | **Coefficient** | **P Value** |
| $(INC/HS)^{-1}$ | -4785.830 | 0.0133 |
| NOTIMPORTANT | -1.234 | 0.1421 |
| LDOTHER | 0.594 | 0.3113 |
| MUSEUM | 0.151 | 0.7101 |
| BOATED | 0.858 | 0.2337 |

The insignificance of the coefficients on LDOTHER, BOATED, and MUSEUM result from the intercorrelation of the three variables combined with the small size of the data set (87 observations). We therefore estimated three more simplistic equations reported in Table 4 (Equation 2, 3 and 4) each of which incorporates either LDOTHER, BOATED, or MUSEUM as an independent variable[2].[3]

[1] These coefficients cannot be interpreted as marginal effects. They are however of the same sign as the marginal effects. If a coefficient is insignificant then its corresponding marginal effect is insignificant as well; a significant coefficient may have a corresponding marginal that is significant or that is insignificant.

[2] Equation 2 estimates prob(WTPLDYES ≥ $10) as a function of $(INC/HS)^{-1}$, LDNOTIMPORTANT, and LDOTHER. Equation 3 estimates prob (WTPLDYES ≥ $10) as a function of $(INC/HS)^{-1}$, NOTIMPORTANT, and MUSEUM. Equation 4 estimates prob(WTPLDYES ≥ $10) as a function of $(INC/HS)^{-1}$, LDNOTIMPORTANT, and BOATED. The results are as shown in Table 7.

| Table 4: Results of Probit Estimation for WTPLDYES: Equations 2, 3 and 4 | | | | | | |
|---|---|---|---|---|---|---|
| | Equation 2 | | Equation 3 | | Equation 4 | |
| *Variable* | *Coefficient*[2] | *P-value* | *Coefficient* | *P-value* | *Coefficient* | *P-value* |
| $(INC/HS)^{-1}$ | -4370 | 0.015 | -5100 | 0.0085 | -4400 | 0.014 |
| NOTIMPORTANT | -1.31 | 0.038 | -1.17 | 0.035 | -1.06 | 0.054 |
| LDOTHER | 0.9 | 0.075 | *NA* | *NA* | *NA* | *NA* |
| MUSEUM | *NA* | *NA* | 0.57 | 0.071 | *NA* | *NA* |
| BOATED | *NA* | *NA* | *NA* | *NA* | 1.118 | 0.046 |

All of the coefficients are of expected sign and are significant to at least the 90% level. The coefficient on $(INC/HS)^{-1}$ is negative for all three equations indicating that as income increases the probability of a positive WTP increases. A person who believes the locks and dams are not important is less likely to report a positive WTP. Equation 2 shows that respondents who have used locks and dams in a river other than the Muskingum are more likely to report positive WTP. Equation 3 indicates that respondents who have previously visited the Ohio River Museum are more likely to have a positive WTP. Respondents who have boated in the Muskingum are more likely to have a positive willingness to pay.

**Septic**

The probability of observing a positive WTP for the proposed septic program prob(WTPSEPTICYES $\geq$ \$10) was modeled as a function of $(INC/HS)^{-1}$, FISH (a dummy variable that equals 1 if the respondent had previously fished in the Muskingum), MUSEUM, BTOTHER (a dummy variable that equals 1 if the respondent noted that poor water quality in a river other than the Muskingum prevented his use of it for recreational purposes). The results are shown in Table 5.

| Table 5: Results of Probit Estimation of WTPSEPTICYES: Equation 5 | | |
|---|---|---|
| **Variable** | **Coefficient** | **P Value** |
| $(INC/HS)^{-1}$ | -10720 | 0.000 |
| FISH | 2.384 | 0.001 |
| MUSEUM | -1.090 | 0.044 |
| BTOTHER | 0.640 | 0.061 |

The income variable is of the expected sign. Respondents who had previously fished in the Muskingum are more likely to report positive WTP. Previous visitors to the museum are less likely to report positive WTP for septic. Users of the bike trails that run along a river other than the Muskingum are more likely to have positive WTP for the septic program. All of the coefficients are significant to the 95% level with the exception of BTOTHER which is only significant to the 90% level.

**Bike Trail**

The probability of WTP for the bike trail extension being positive (prob(WTPBTYES ≥ $10)) was explained as a function of $(INC/HS)^{-1}$, MRBIKETRAIL (a dummy variable for which a 1 indicates the respondent has previously used the bike trail that runs along part of the Muskingum), MUSEUM, MALE (a dummy variable for which a 1 indicates the respondent is male), ORBIKETRAIL (a dummy variable for which a 1 indicates the respondent has previously used a bike trail that runs along an Ohio river other than the Muskingum). The results are shown in Table 6.

| Table 6: Results of Probit Estimation of WTPBTYES: Equation 6 | | |
|---|---|---|
| **Variable** | **Coefficient** | **P Value** |
| $(INC/HS)^{-1}$ | -5790 | 0.026 |
| MRBIKETRAIL | 1.420 | 0.077 |
| MUSEUM | -0.608 | 0.213 |
| MALE | -0.799 | 0.016 |
| BTOTHER | 0.793 | 0.034 |

The probability of observing positive WTP for the bike trail increases as income increases; this effect is significant at the 95% level. Respondents who have previously used the bike trail in question have a higher likelihood of reporting positive WTP; this coefficient is significant to the 90% level. Respondents who previously visited the museum are less likely to report positive WTP for the bike trail extension; this result is only significant at the 78% level. Male respondents are less likely to report positive WTP; this is significant at the 98% level. Respondents who have used a bike trail that runs alongside another river are more likely to report positive WTP; this coefficient is significant at the 95% level.

## Summary and Conclusions

The hedonic based tax revenue functions showed increases in tax revenue from zoning accruing to the cities of Zanesville and Marietta to be about two times larger than the increases from improved household rural septic systems in Muskingum and Washington counties. The hedonic based tax revenue functions for school districts in Muskingum and Washington counties showed six fold differences between zoning and improved septic system impacts. However, the annual revenue increases from zoning and household septic system improvements are generally larger to the school districts than to the local governments in Muskingum and Washington counties.

The CV instrument was not originally designed with bid function estimation in mind, and a limited number of observations were available. Despite these limitations there are some general conclusions that can be drawn regarding what groups of people are more likely to have positive WTP for the three amenities.

Previous boaters of the Muskingum River and Museum visitors are likely to have higher WTP for the locks. These two groups can be easily solicited using address lists of museum visitors and lock users. Museum visitors are, however, less likely than non-museum visitors to have positive WTP for the bike trail or the septic program. This would suggest that the museum visitors should only be solicited for the locks and not for bike trail or the septic program. Users of bike trails that are adjacent to rivers other than the Muskingum are more likely to have positive WTP for both the bike trail and the septic program; this group of people could be targeted for both programs.

## References


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