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Public marginal willingness to trade off among water quality programs: Estimates of statewide and watershed-specific budget values

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Abstract. A budget survey is used to elicit individuals' relative values for various public water quality programs. Because a budget constraint is incorporated explicitly and people allocate across various statewide and watershed-specific programs, marginal willingness to trade off values is revealed. These values are useful in the decision making of state and federal agencies responsible for water quality programs. We estimate values using the results of a 1997 random sample of Kentucky residents, with oversampling of residents of a small watershed in eastern Kentucky. Results show that people allocate the largest amounts to combat illegal dumping, untreated sewage, and hazardous material disposal. The lowest-ranked budget category, farming erosion, receives less than half the amount allocated to illegal dumping. We find that in the watershed, while the top two categories are the same as for the state as a whole, mining drainage and logging erosion are more important.

1. Introduction

Public perceptions are a valued input in the decision making of the state and federal agencies responsible for water quality programs. Agency professionals, working with executive and legislative officials, must determine how to allocate the agency's financial resources among various possible uses. Information concerning the public's perception of the relative importance of different programs is one component in the allocation process. Public perception of water quality programs is part of the feedback mechanism decision makers use to facilitate improved water quality.

Economists have developed several techniques to aid decision makers in determining the value the public places on government projects. Of these techniques, benefit-cost analysis is the most widespread. Benefit-cost analysis is required in federal regulatory rule making (previously Executive Order 12291 now 12866 [*President*, 1981, 1993]). However, there are difficulties in using benefit-cost analysis to determine the relative values of many different agency programs at once. Modern benefit valuation techniques can be expensive, and program impacts can be difficult to value. Some evidence indicates that the public perceives water quality to be worse than the technical information merits [*McDaniels et al.*, 1998]. Even with these difficulties in determining public preferences, as *Simonovic and Fahmy* [1999] argue, water quality policy must be structured taking into account the values held by all the stakeholders. *Griffen* [1998] suggests that decision makers must be made aware of all values even if it requires the creation of multiple indices.

This paper concerns the use of a budget survey technique that can be used to elicit information concerning public preferences for water quality programs. The budget survey technique elicits public attitudes about the government's fiscal decisions concerning funds allocated to the various programs. Individuals are constrained by a hypothetical surplus in the government budget and are asked to allocate the specified amount of money across related budget categories. Because the survey design explicitly incorporates a budget constraint and requires individuals to allocate funds across several categories, the relative strength of citizen preferences for increased spending on different programs can be compared. Formally, individuals reveal their marginal willingness to trade off (MWTTO) among programs.

Public preferences for statewide and watershed-specific water quality programs are estimated using data collected in a 1997 statewide random sample survey of Kentucky citizens. We use the information to test for bias in, and check the reliability of, the budget survey technique.

2. Budget Survey Technique

The budget survey technique elicits public attitudes about program resource decisions and provides one way to determine people's general preferences for, and satisfaction with, each possible state program relative to all others. Individuals are

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constrained by a government budget and asked to allocate surplus funds over specific budget categories. Allocating nothing to a particular budget category can freeze funding for that category at existing levels.

In the budget survey technique we assume individuals know the current marginal benefit of each program. As more money from a given surplus budget is allocated to any program, the marginal benefits are assumed to be positive and diminishing. Each individual allocates the surplus budget in such a way that marginal benefits are equalized across programs. Individuals will allocate more of the surplus budget to programs for which there is a larger marginal benefit per dollar thereby decreasing the marginal benefit of the last dollar spent on those programs. The MWTTO is determined from the ratio of the budget surplus allocations across programs. The budget survey technique could be used with a hypothetical budget deficit to obtain similar results. In that case, individuals would reduce spending more on those programs for which there is a smaller marginal benefit per dollar thereby increasing the marginal benefit of the last dollar spent on those programs. The MWTTO could still be determined. We use a budget surplus instead of a budget deficit in this paper because public discussion at the time of the study was about how to spend the surplus and it seemed more realistic than deficits. We do not allow individuals to decrease the budget to any program.

The budget survey technique is based on the maximum welfare principle of budget determination. This principle yields the guideline that budget outlays should be allocated among various public programs in such a way that the additional (or marginal) return of satisfaction for each dollar outlay is equalized. If a budget is allocated this way, the last dollar spent in any program yields the same additional social benefit, and total social benefit is maximized. This total social benefit criterion is a useful benchmark for decision makers regardless of whether or not it is explicitly considered in the executive and legislative fiscal processes, through which policy is eventually made.

While an allocation elicited in the budget survey technique does provide general information concerning a particular program's marginal benefit per dollar, it does not decompose the allocation into program value and program productivity. An individual allocates to a particular program in an attempt to equalize the marginal benefits per dollar spent on all programs. A program may receive a relatively large allocation if individuals perceive a program's output goals to be highly valuable. Another reason a program may receive a relatively large allocation is that individuals perceived the program to be very good at producing progress toward goals. Regardless of the composition of the marginal benefit per dollar, the MWTTO still provides information concerning the relative values of programs.

An advantage of getting the public's MWTTO among programs is that these relative values not only allow the programs to be rank ordered by priority but that they allow the programs to be compared with respect to scale of relative importance. The relative strength of preferences for programs can be determined by simply dividing the dollar amount allocated to any budget category by the amount allocated to any other area within the same budget.

Because the budget survey technique relies on direct questioning, it is similar to contingent valuation. *Ekstrand and Loomis* [1998] have discussed some of the strengths and weaknesses of contingent valuation as a demand revelation method in an applied situation. The budget survey technique differs from standard contingent valuation studies in two important ways. First, the technique asks individuals to value more than one good at one time. In most contingent valuation studies, methods are used to elicit individuals' willingness to pay for one particular good. Second, the technique uses a government budget constraint instead of a personal income budget constraint. In the budget survey the surplus funds are described as "available to be added to existing budgets." The current availability of the funds is not made contingent upon future tax increases or future budget reductions. The importance of this distinction is that the individuals are not forced to make tradeoffs between the program areas in question and their personal consumption of private goods. We are not able to determine their marginal willingness to pay. However, the existence of the budget constraint forces individuals to consider intensity of preferences before assigning dollar amounts to different program areas. Because people must consider additions to each program relative to potential additions to the other programs, we can determine MWTTOs for each program category within a given budget.

3. A Budget Survey to Elicit MWTTO for Water Quality Programs in Kentucky

The budget survey was conducted in early 1997 for the Kentucky Natural Resources and Environmental Protection Cabinet, which was interested in establishing priorities for its statewide programs on a watershed basis. The results were used to provide a public perception component to the Cabinet's strategic planning process and Watershed Management Framework. See *Blomquist et al.* [1998] for a detailed description of the methodology and results of both surveys. The survey instrument is available at the Cabinet's web site at http://water.nr.state.ky.us/survey/.

The Kentucky Natural Resources and Environmental Protection Cabinet chose the North Fork of the Kentucky River Watershed as a test case. This small, rural watershed in eastern Kentucky contains 3.4% of the miles of stream in Kentucky and 2.3% of Kentucky's population. Forests cover 94% of the land, and there are five areas that are designated as having special ecological or aesthetic value. This paper focuses on the responses to two different budgets in the 1997 survey: (1) the Statewide Water Quality Budget to improve the overall state water quality and (2) and the North Fork Watershed Budget to improve the North Fork of the Kentucky River Watershed's water quality. To avoid potential embedding problems, the assignment of different values for the same good depending on the order in which the good falls among the other goods to be valued, the survey also elicited allocations for the overall state budget and the environmental state budget. *Carson and Mitchell* [1995] give a detailed description of the embedding problem. In another paper, however, *Blomquist et al.* [1999] used split sample surveys and found no significant embedding effect on budget allocations when prior budgets were removed from the survey.

3.1. Response Rate and Respondent Characteristics

The survey instrument was distributed to a random sample of all Kentuckians and North Fork residents using combination phone/mail surveys as recommended by *Dillman* [1978]. Random-digit dialing and 4-min preliminary telephone surveys were used to contact 1153 Kentuckians (as used here, residents of Kentucky but not North Fork) and an additional 169 North

Table 1. Comparison of Respondent Characteristics in the Budget Survey to U.S. Census Statistics for Kentucky and the North Fork Watershed Counties

	Budget Survey Characteristics		U.S. Census Statistics[a]	
	Kentucky Respondents[b]	North Fork Respondents[c]	Kentucky Residents	North Fork Residents
Age, years[d]	45.5	47.7	44.2	44.0
Income (1996 $1000)[e]	44.0	35.6	24.8	17.0
Race (White, %)	92.1	96.9	92.0	99.0
Education[f]				
Less than high school, %	13.9	28.1	32.9	53.9
High school, %	34.8	30.1	30.2	27.2
College, %	41.0	33.3	31.2	15.7
Graduate, %	10.3	8.5	5.7	3.2
Registered to vote (yes, %)[g]	86.9	93.5	87.6	94.0
Voted in November general election (yes given registered, %)	83.0	79.3	59.3	45.5
Physiographic region				
Blue grass, %	49.1	0.0	48.0	0.0
Eastern coal fields, %	17.5	100.0	16.4	100.0
Embayment, %	6.4	0.0	5.7	0.0
Plateau, %	16.8	0.0	23.0	0.0
Western coal fields, %	10.1	0.0	6.9	0.0

[a]U.S. Census statistics for Kentucky and the North Fork are from the *U.S. Bureau of Census* [1995]. Statistics for the North Fork are the aggregated statistics for the six counties comprising the North Fork watershed area.

[b]For the statewide sample the sample sizes for each characteristic are as follows: age, 868; income, 430; race, 445; education, 875; registered to vote, 876; voted in November general election, 757; and physiographic region, 873.

[c]For the North Fork sample the sample sizes for each characteristic are as follows: age, 153; income, 59; race, 64; education, 153; registered to vote, 153; voted in November general election, 140; and physiographic region, 153.

[d]Because survey respondents were required to be 18 years of age or older, the census statistic used is the average age of residents over 18.

[e]The income used for state population average is 1990 census data (1989 income), adjusted to 1996 using the Bureau of Labor Statistics consumer price index for all urban consumers, the CPI-U.

[f]The college category includes U.S. Census Bureau categories: "some college, no degree," "associates degree," and "bachelor's degree."

[g]The voter registration information was obtained from the Kentucky State Board of Elections worldwide web site at ⟨http://www.state.ky.us/agencies/sbe/sbehome.htm⟩ for the November 1996 general election.

Fork residents. Because of the importance of obtaining responses from residents in the North Fork watershed, who make up only 2.3% of the Kentucky population, North Fork residents were intentionally oversampled. The mail survey instruments were sent to those respondents who agreed to receive them. Follow-up cards were used, and second mailings were conducted to reach people who did not answer the first mailings. Of the Kentuckians contacted by phone, 509 (56.7%) eventually returned a mail survey. Of the North Fork residents contacted by phone, 73 (47.7%) eventually returned a mail survey.

The socioeconomic characteristics of the 509 Kentucky respondents and the 73 North Fork respondents who returned mail surveys can be compared to the average socioeconomic characteristics estimated by the U.S. Census. Table 1 lists seven characteristics. In both samples, respondents returning mail surveys, and thereby providing budget survey information, tended to have higher incomes, to have more formal education, and to be more likely to vote than the general population. As expected, the North Fork respondents tended to have lower incomes and less formal education than did the Kentucky respondents. Comparisons can be made using the information from the phone survey also.

On the basis of phone survey characteristics, comparisons were made (not shown) for people who agreed to participate in the mail survey and for people who refused. For many characteristics, no statistically significant difference was found. We did find that those agreeing are more likely to contribute to nature funds; to be more concerned with environmental issues; to hunt, fish, or participate in other forms of outdoor recreation; to be employed; and to have voted in the last general election. Also, on the basis of phone survey characteristics, comparisons were made for people who did and people who did not return a mail survey after receiving one. Respondents returning surveys tended to be older, have more formal education, and be more likely to have voted in the last general election. The MWTTOs elicited in the budget survey can be helpful to public decision makers in that they are more representative than other alternative sources of information such as lobbyists. Nonetheless, average differences between the survey samples and the state as a whole should be kept in mind.

3.2. MWTTO for Programs in the Statewide Water Quality Budget

The Statewide Water Quality Budget section of the mail survey instrument was designed to elicit the relative values people place on programs that reduce the effects of different pollution sources on water quality. The Kentucky Division of

CHOICES FOR KENTUCKY'S WATER QUALITY STATE BUDGET

Kentucky's water is found in rivers and streams, in lakes, and in the ground. Water quality affects Kentucky's people, animals, and plants. Poor water quality can affect our public drinking water systems and private wells. Poor water quality can also affect recreational activities such as boating, fishing, and swimming. Water pollution can come from many sources. Eleven sources of water pollution are listed below. Kentucky state water quality programs seek to reduce water pollution from these sources.

Budget choices are made all the time within state agencies. If you were making the choices and an **extra $500 thousand** were available to add to the existing water quality programs addressing the pollution sources shown below, **how much of the $500 thousand would you put in each program area?** If you put money into a given area, the programs in that area will be expanded. If no money is allocated to a given area, the programs will be frozen at current levels. The total should add up to 500.

_____ Sediment build-up and flow alteration caused by **CONSTRUCTION** in or near streams and lakes

_____ Illegal **DUMPING** of garbage

_____ Soil, waste, and chemical runoff from **FARMING** operations

_____ Erosion, sediment build-up, and habitat changes caused by **LOGGING**

_____ Disposal of **HAZARDOUS** materials

_____ Discharge of treated **INDUSTRIAL WASTEWATER**

_____ Acidic drainage, sediment build-up, and habitat loss caused by **MINING**

_____ Discharge of **MUNICIPAL WASTEWATER** from treatment plants

_____ Accidental chemical **SPILLS AND RELEASES**

_____ Discharge of **UNTREATED SEWAGE** from homes and businesses via straight pipes

_____ Soil and chemical runoff from **URBAN** businesses, lawns and roadways

500 TOTAL **<<Please check to see that your total is equal to 500>>**

Figure 1. Survey elicitation page for the Statewide Water Quality Budget.

Water suggested 11 budget categories as program areas that address sources of watershed pollution. Individuals were asked to use their own judgement to make choices on behalf of the state. For the Statewide Water Quality Budget, people were asked to allocate an extra $500,000 over 11 budget categories. Figure 1 shows the survey elicitation page for the Statewide Water Quality Budget.

The average Statewide Water Quality Budget allocations and their standard deviations are shown in Table 2. These values were obtained from the statewide sample of Kentucky residents. The illegal dumping category was valued highly. On average, respondents allocated $69,100 of the given extra $500,000 budget to address illegal dumping. This amount is significantly higher than the amount for the second-ranked group of categories: untreated sewage and hazardous materials disposal. The amounts for these two categories are not significantly different from one another. Industrial wastewater and municipal wastewater both received more than the simple average allocation for the 11 categories. There are no significant differences in the amounts for categories ranked below municipal wastewater. This indicates that while citizens have a strong preference for the more highly ranked categories, they are somewhat indifferent about the increments going to the lower-ranked categories. This is shown, in part, by the small differences in the increments going to the lower-ranked categories. It is also shown by the increased variation in responses, which can be seen in the coefficient of variation in Table 2. The lowest-ranked budget category, farming erosion and runoff, received less than half the amount allocated to illegal dumping.

3.3. MWTTO for North Fork Watershed Budget Programs

The North Fork Watershed Budget section of the mail survey instrument was designed to elicit the relative values people place on programs that reduce the effects of different pollution sources on the North Fork of the Kentucky River. The 11 budget categories used in the North Fork Watershed Budget

Table 2. Choices for the Statewide Water Quality Budget Using Responses From Kentucky Residents, $500,000 Increment

Budget Category	Mean Allocation, thousands of dollars	Standard Deviation	Coefficient of Variation
	Categories Receiving More Than Simple Average Allocation[a]		
Illegal dumping	69.1	54.3	0.786
Untreated sewage	60.0	50.5	0.842
Hazardous materials disposal	59.1	41.9	0.709
Industrial wastewater	51.3	43.1	0.840
Municipal wastewater	45.9	43.2	0.941
	Categories Receiving Less Than Average Allocation		
Chemical spills and releases	39.6	36.0	0.909
Mining drainage and habitat loss	38.1	34.9	0.916
Construction runoff	35.2	33.8	0.960
Urban runoff	34.3	32.3	0.941
Logging erosion and habitat loss	34.0	33.3	0.979
Farming erosion and runoff	33.5	33.8	1.009

Here $n = 341$. Mean allocations that are significantly different from each other at the 0.95 level are set apart. The t test is conducted for equality between each category and the next higher category.

[a]Average allocation is $45.5 thousand for all categories. Total allocation is $500,000.

were the same as those used in the Statewide Water Quality Budget.

Two pages of information concerning the North Fork watershed were provided before people were asked to allocate (extra) funds to the North Fork Watershed Budget. These pages are shown in Figures 2 and 3. People were asked to focus on the effects of the 11 programs on the North Fork watershed alone. They were then asked to allocate an extra $100,000 over the 11 budget categories. Figure 4 shows the survey elicitation page for the North Fork Watershed Budget.

The average North Fork Watershed Budget allocations and their standard deviations are shown in Table 3. These values were obtained from the sample of North Fork residents. Comparing Table 3 to Table 2 reveals that all Kentuckians and North Fork residents perceive illegal dumping and untreated sewage to be serious concerns. In this respect the concerns of the respondents are similar. However, while all Kentuckians also have large allocations for hazardous materials disposal, industrial wastewater, and municipal wastewater, North Fork residents have large allocations only for mining drainage and habitat loss. North Fork residents perceive a greater relative importance for programs to reduce problems from illegal dumping, valuing such programs 5.3 times higher than farming erosion and runoff, the program with the lowest amount.

3.4. Testing for Random MWTTO

One indication of a successful revelation of individual preferences in the budget survey technique is that the elicited MWTTOs are not random. We test the values in both budgets to determine whether or not the elicited amounts are significantly different than those which would be expected if allocations had been made according to a simple arbitrary rule. One arbitrary rule a respondent might use would be to give each budget category a simple average amount.

The simple average allocation for the Statewide Water Quality Budget shown in Table 2 was $45,450, $500,000 divided evenly across the 11 budget categories. The observed average allocations ranged from $69,100 for illegal dumping to $33,500 for farming erosion and runoff. For every budget category but one, municipal wastewater, the observed average allocation was found to be significantly different from the simple average allocation at the 0.95 level based on t tests.

The simple average allocation for the North Fork Watershed Budget shown in Table 3 was $9100, $100,000 divided evenly across the 11 budget categories. The observed average allocations ranged from $22,200 for illegal dumping to $4200 for farming–erosion and runoff. For each budget category the observed average allocations were found to be significantly different from the simple average allocation at the 0.95 level using t tests. This test is an indication that individuals are valuing the program categories and not simply allocating equal budget amounts to each of the program categories.

3.5. Differences in MWTTO Across Samples for Each Budget

Table 4 displays significant differences between all Kentuckians and North Fork residents with respect to the MWTTOs among Statewide Water Quality Budget programs. Such differences show how the two samples perceive the state's water quality problems. North Fork people show more variation in average allocated amounts. The most notable differences between the two samples of respondents are the North Fork's higher average allocations for illegal dumping, untreated sewage, mining drainage and habitat loss, and logging erosion and habitat loss.

Table 5 displays the significant differences between all Kentuckians and North Fork residents with respect to the amounts for North Fork Watershed Budget programs. Such differences show how the two samples perceive the North Fork's watershed problems. Differences between the two samples are not as pronounced as they were in Table 4, indicating that the samples have similar perceptions about the water quality problems of the North Fork watershed. The most notable differences in amounts between the two samples are the higher mean allocation for illegal dumping, untreated sewage, and mining drainage and habitat loss by the North Fork residents and the higher mean allocation for logging erosion and habitat loss and hazardous materials disposal by all Kentuckians.

Section 4. THE NORTH FORK WATERSHED PROGRAMS

The state of Kentucky can be divided into areas called watersheds. In this section, we will explain what a watershed is. Then we will focus on one particular watershed by comparing it to the whole state. Finally, we will ask you to make some choices concerning government programs to improve water quality in one particular watershed.

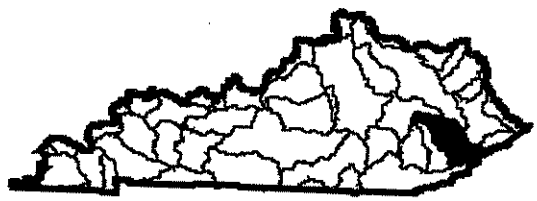
What is a Watershed?

A **watershed** is the land that water flows across or under on its way to a stream, river or lake. There are several watersheds in Kentucky. Within any one watershed, all the water runs to the lowest point on some stream, river, or lake. On its way, water travels over the surface of the land and across farm fields, forest land, suburban lawns, and city streets, or it seeps into the soil and travels as ground water.

Everyone lives in a watershed. Scientists sometimes think in terms of a watershed community. A **watershed community** consists of the people, animals, and plants that live in one watershed.

The North Fork of the Kentucky River Watershed

One watershed is the **North Fork of the Kentucky River**. This watershed is found in southeastern Kentucky, in parts of Lee, Wolfe, Breathitt, Knott, Letcher, and Perry counties. Covering 1,333 square miles, the North Fork of the Kentucky River Watershed makes up 3.4% of Kentucky's total area. Below is a map of Kentucky. The map shows how the state is divided into several watersheds. The darkened area on the map shows the location of the North Fork Watershed.



The state of Kentucky can be divided into 5 broad physical regions: the Eastern Kentucky Coalfields, the Blue Grass Region, the Western Kentucky Coalfields, the Mississippian Plateau, and the Purchase Area. The North Fork of the Kentucky River Watershed is found in the Eastern Kentucky Coalfields. The land around the North Fork of the Kentucky River is mountainous with steep-sided valleys.

Figure 2. North Fork watershed information page 1.

3.6. Differences in MWTTO Across Budgets for Each Sample

All Kentuckians were asked to allocate funds across the Statewide Water Quality Budget and the North Fork Watershed Budget. A difference across these two budgets in the amount allocated to any one program indicates that all Kentuckians perceive a difference in that category's importance in improving water quality for the North Fork watershed and the state as a whole. Table 6 lists the significant differences. For example, there are differences for mining drainage and habitat loss and logging erosion and habitat loss and for industrial wastewater. All Kentuckians perceive mining drainage and habitat loss and logging erosion and habitat loss to be of greater significance to the North Fork than to the state as a whole. Also, though industrial wastewater is viewed by the people in the state sample to be a significant issue to the state as a whole, the state sample sees this issue to be of less significance for the North Fork watershed.

North Fork residents were also asked to allocate funds across both the Statewide Water Quality Budget and the North Fork Watershed Budget. A difference across these two budgets in the amounts given to any one program indicates that the North Fork residents perceive a difference in that category's importance in improving water quality for their own watershed and the state as a whole. Table 7 lists these significant differences. While North Fork residents perceive illegal dumping to be a large

The North Fork of the Kentucky River Watershed is only one of several watersheds in the state. The following table compares the North Fork of the Kentucky River Watershed to Kentucky as a whole:

	The State of Kentucky	The North Fork of the Kentucky River Watershed
Population	**3,700,000**	**84,000** (2.3% of KY Total)
Persons per Square Mile	**93**	**63**
Miles of Stream	**89,240**	**3,000** (3.4% of KY Total)
Public Sewage Plants	**258**	**7**
Stream Miles per Sewage Plant	346	429
Persons per Sewage Plant	14,341	12,000
Drinking Water Supply Source (%):		
Public or Private Systems	**81**	**31**
Private Wells	**14**	**61**
Other	**5**	**8**
Land Use (%):		
Forest	**45**	**94**
Mining	**2**	**3**
Crops and Pasture	**46**	**2**
Urban/Residential	**4**	**1**
Other	**3**	--

The Kentucky state government has designated several areas throughout the state as having special ecological or aesthetic value. In the North Fork of the Kentucky River Watershed, these areas include Clemons Fork, Coles Fork, Buckhorn Creek, Lilly Cornett Woods, and Robinson Forest.

Please continue to the next page to consider the budget for Kentucky programs to improve the water quality of the North Fork Watershed.

Figure 3. North Fork watershed information page 2.

concern in their own watershed, they perceive farming and hazardous materials to be a larger concern for the state as a whole.

4. Regression Analysis to Determine Factors Significantly Affecting MWTTO

Socioeconomic information was collected in the phone and mail surveys. Split samples, different versions of the survey instrument format, were used in the mail surveys. Seemingly unrelated regression analysis was used to determine the partial effect of a change in each socioeconomic characteristic and survey format characteristic on the allocation to each Statewide Water Quality Budget category. To avoid the identification problem due to the budget constraint, only 10 of the 11 programs were included in the first seemingly unrelated regression. To estimate the coefficients for the omitted program, the regression was run again while omitting a different program. Because the independent variables are the same for each of the 11 regressions, the seemingly unrelated regression analysis is equivalent to running 11 distinct regressions. The same analysis was not conducted on the North Fork Watershed Budget because of the limited number of observations.

4.1. Effect of Socioeconomic Characteristics on MWTTO

Table 8 shows the differences in allocated amounts that can be attributed to changes in the various socioeconomic characteristics. The coefficients are given in terms of elasticities so that the effects of changes in socioeconomic characteristics can be read as percentage changes in allocations. For example, an individual who lives in the North Fork will contribute 38.3% more to untreated sewage than an individual who does not live in the North Fork, everything else being constant. Also, a 10% increase in education is associated with a 5.6% increase in allocations to mining drainage and habitat loss.

Table 8 provides information both down each column and

Below are the eleven sources of water pollution which you considered earlier. Please carefully consider how these sources of water pollution affect the **North Fork of the Kentucky River Watershed.** Kentucky state water quality programs seek to reduce water pollution from these sources.

If you were making the choices for the North Fork of the Kentucky River Watershed and an **extra $100 thousand** were available to add to the existing programs addressing the pollution sources shown below, **how much of the $100 thousand would you put in each program area?** If you put money into a given area, the programs in that area will be expanded. If no money is allocated to a given area, the programs will be frozen at current levels. The total should add up to 100.

_____ Sediment build-up and flow alteration caused by **CONSTRUCTION** in or near streams and lakes

_____ Illegal **DUMPING** of garbage

_____ Soil, waste, and chemical runoff from **FARMING** operations

_____ Erosion, sediment build-up, and habitat changes caused by **LOGGING**

_____ Disposal of **HAZARDOUS** materials

_____ Discharge of treated **INDUSTRIAL WASTEWATER**

_____ Acidic drainage, sediment build-up, and habitat loss caused by **MINING**

_____ Discharge of **MUNICIPAL WASTEWATER** from treatment plants

_____ Accidental chemical **SPILLS AND RELEASES**

_____ Discharge of **UNTREATED SEWAGE** from homes and businesses via straight pipes

_____ Soil and chemical runoff from **URBAN** businesses, lawns and roadways

100 TOTAL **<<Please check to see that your total is equal to 100>>**

Your opinions regarding water quality in the North Fork of the Kentucky River Watershed are important, even if you do not live in the North Fork of the Kentucky River Watershed.

Figure 4. Survey elicitation page for the North Fork Watershed Budget.

across each row. Looking down any column in Table 8, it is possible to see how each characteristic affects the allocation for a particular category. Looking across any row in Table 8, it is possible to see how an increase in any characteristic affects the amounts for the different categories. The underlying coefficients and t test values for each of the regressions found in Table 8 are available from the authors upon request.

Percentages followed by a superscript a measure the effects of characteristics having a statistically significant effect on an individual budget category. Everything else being constant, married people allocated a smaller amount for programs that reduce farming erosion and runoff. Increased years of schooling are associated with a larger amount for programs reducing mining drainage and habitat loss. Increased income is associated with a smaller amount for programs that reduce pollution from accidental chemical spills and releases. Residents of the eastern coal fields, a heavily forested area of the state, allocated a significantly larger amount for programs associated with logging erosion and habitat loss, industrial wastewater, and hazardous materials disposal. Respondents with high environmental health concerns allocate a smaller amount to address industrial wastewater and a larger amount for programs addressing farming erosion and runoff.

Those percentages followed by a superscript b are considered to be particularly significant in explaining citizens' allocations across all categories. The most significant socioeconomic characteristics explaining the allocations across all budget categories were whether or not respondents had lived

Table 3. Choices for the North Fork Watershed Budget Using Responses From North Fork Residents, $100,000 Increment

Budget Category	Mean Allocation, thousands of dollars	Standard Deviation
Categories Receiving More Than Simple Average Allocation[a]		
Illegal dumping	22.2	15.8
Untreated sewage	17.1	15.7
Mining drainage and habitat loss	12.8	10.2
Categories Receiving Less Than Average Allocation		
Logging erosion and habitat loss	8.6	6.2
Hazardous materials disposal	7.7	9.1
Construction runoff	6.0	4.6
Industrial wastewater	5.8	4.7
Municipal wastewater	5.6	4.5
Chemical spills and releases	5.0	4.8
Urban runoff	4.9	4.5
Farming erosion and runoff	4.2	3.8

Here $n = 62$. Mean allocations that are significantly different from each other at the 0.95 level are set apart. The t test is conducted for equality between each category and the next higher category.
[a]Average allocation is $9.1 thousand for all categories. Total allocation is $100,000.

in Kentucky their whole lives and whether or not they currently lived in the North Fork region. People who had lived their whole lives in Kentucky tended to attach a greater importance to programs that would reduce pollution from urban runoff and to attach less importance to programs reducing pollution from untreated sewage and accidental chemical spills and releases. North Fork residents tended to allocate more to programs reducing pollution from untreated sewage and illegal

Table 4. MWTTOs Among Statewide Programs: Significant Differences Between Kentucky and North Fork Respondents

Budget Category	Kentucky Respondents Mean Allocation, thousands of dollars	North Fork Respondents Mean Allocation, thousands of dollars
Illegal dumping	69.1 [1]	94.4 [1]
Untreated sewage	60.0 [2]	81.0 [2]
Hazardous materials disposal	59.1 [3]	47.7 [5]
Industrial wastewater	51.3 [4]	30.1 [7]
Municipal wastewater	45.9 [5]	25.8 [9]
Chemical spills and releases	39.6 [6]	25.1 [10 tie]
Mining drainage and habitat loss	38.1 [7]	60.5 [3]
Construction runoff	35.2 [8]	33.2 [6]
Urban runoff	34.3 [9]	26.8 [8]
Logging erosion and habitat loss	34.0 [10]	50.2 [4]
Farming erosion and runoff	33.5 [11]	25.1 [10 tie]

Kentucky respondents $n = 341$. North Fork respondents $n = 62$. Significant differences, at the 0.95 level, were found for all programs. Allocation rank is shown in brackets.

Table 5. MWTTOs Among North Fork Watershed Programs: Significant Differences Between North Fork and Kentucky Respondents

Budget Category	North Fork Respondents Mean Allocation, thousands of dollars	Kentucky Respondents Mean Allocation, thousands of dollars
Illegal dumping	22.2 [1]	12.9 [3]
Untreated sewage	17.1 [2]	13.0 [2]
Mining drainage and habitat loss	12.8 [3]	10.2 [5]
Logging erosion and habitat loss	8.6 [4]	13.2 [1]
Hazardous materials disposal	7.7 [5]	10.7 [4]
Industrial wastewater	5.8 [7]	8.0 [6]
Municipal wastewater	5.6 [8]	7.7 [7]
Chemical spills and releases	5.0 [9]	6.6 [8]
Farming erosion and runoff	4.2 [11]	6.4 [9]

Kentucky respondents $n = 341$. North Fork respondents $n = 62$. Significant differences, at the 0.95 level, were found for all of the programs except construction runoff and urban runoff. Allocation rank is shown in brackets.

Table 6. Significant Differences Between MWTTOs for Statewide and North Fork Programs: Kentucky Respondents

	Allocations Among Statewide Water Quality Programs, thousands of dollars	Rescaled Allocations Among North Fork Watershed Programs, thousands of dollars
Untreated sewage	60.0 [2]	64.8 [3]
Hazardous materials	59.1 [3]	53.5 [4]
Disposal industrial wastewater	51.3 [4]	39.9 [6]
Municipal wastewater	45.9 [5]	38.7 [7]
Chemical spills and releases	39.6 [6]	33.1 [8]
Mining drainage and habitat loss	38.1 [7]	51.2 [5]
Construction runoff	35.2 [8]	30.4 [10]
Logging erosion and habitat loss	34.0 [10]	65.9 [2]

Kentucky respondents $n = 341$. Kentucky respondents' allocations among North Fork Watershed Budget programs were rescaled by a multiple of 5 and compared against the allocations among Statewide Water Quality programs using t tests. Significant differences, at the 0.95 level, were found for these eight programs. Allocation rank is shown in brackets.

dumping and less to industrial wastewater programs. This small allocation is consistent with the watershed's rural characteristics and much publicized problems with "straight-pipe," untreated, sewage discharges and illegal trash dumps. For a description of the Kentucky Watershed Management program and issues of importance to water quality in Kentucky, see the Kentucky Division of Water home page at ⟨http://water.nr.state.ky.us/dow/watrshd.htm⟩.

The believable, systematic relationships between socioeconomic characteristics and allocated amounts suggest that the budget survey technique works. They give credibility to the method and the values estimated and indicate that the allocations provide reliable information for decision making.

4.2. Effect of Budget Category Headings on Allocations

As is the case with any survey, there are several potential sources of bias in the budget survey technique. *Mitchell and Carson* [1989] have written a detailed description of bias in contingent valuation surveys, which are related. Bias can exist in part because of the unintended influences of category order, budget information provision, and category headings. Innocuous differences in format should not influence the MWTTO. In order to test for bias, split samples were distributed to respondents. By including survey instrument format variables in the regression analysis as discussed in section 4.1, we were able to test for any significant effect due to survey format differences.

Split samples were used to test for order bias and information effects in an overall state budget allocation and an environmental budget allocation, both of which preceded the two water quality budgets. The ordering of categories was shown to have no significant effect on individuals' allocations. Significant effects were evident when people were provided with basic information about the existing, total state budget. People tended to concentrate their allocations more in the budget categories with large shares of the actual budget when information about the actual budget was provided [*Blomquist et al.*, 1999].

As shown in Table 8, the variable no category headings was used in the regression analysis for the Statewide Water Quality Budget to test if people read only the headings. This variable was not found to be significant at the 0.95 level across categories. Respondents are not terribly influenced by the "labels" applied to budget categories.

5. Reliability: Comparing MWTTO and Effectiveness

One way to test reliability of the elicited amounts is to ask a closely related question and check for similarity of results. In the mail survey, people were asked to rate the effectiveness of each program category in the Statewide Water Quality Budget.

Table 7. Significant Differences Between Allocations for North Fork and Statewide Programs: North Fork Respondents

	Allocations Among Statewide Water Quality Programs, thousands of dollars	Rescaled Allocations Among North Fork Watershed Programs, thousands of dollars
Illegal dumping	94.4 [1]	112.1 [1]
Hazardous materials disposal	47.7 [5]	38.5 [5]
Farming erosion and runoff	25.1 [10]	21.1 [11]

North Fork sample $n = 62$. North Fork respondents' allocations among North Fork Watershed Budget programs were rescaled by a multiple of 5 and compared against the allocations among Statewide Water Quality programs using t tests. Significant differences, at the 0.95 level, were found for these three programs. Allocation rank is shown in brackets.

Table 8. Effects of Socioeconomic Characteristics and Survey Format on Allocations

Change in Socioeconomic Variables	Resulting Change in Each Budget Category, %				
	Hazardous Materials	Untreated Sewage	Municipal Wastewater	Illegal Dumping	Spills and Releases
Age, 10% increase in years	−1.7	0.5	0.9	−2.3	1.2
Sex (male, 1)	−13.4	8.0	13.7	−7.0	−7.4
Race (nonwhite, 1)	22.4	12.2	10.9	−15.6	3.6
Marital status (married, 1)	17.6	4.1	−12.0	12.7	7.7
Children (do have, 1)	0.6	−0.9	15.6	−8.0	−3.7
Education, 10% increase in years	−0.6	0.3	−2.8	−3.2	1.1
Income, 10% increase in dollars	−0.3	0.1	0.7	0.7	−1.7*
Physiographic region (Base, bluegrass)					
Eastern coal fields	−31.8[a]	4.3	−3.8	−8.9	−2.2
Embayment	−11.3	−4.9	−3.8	−21.2	−13.8
Plateau	−8.0	11.9	29.7	0.4	−6.3
Western coal fields	−10.4	9.5	5.4	−15.1	1.5
Residence (Base, Nonfarm Rural)					
Farm	2.8	−7.5	−7.8	8.3	8.6
Urban	−5.2	−11.5	23.8	2.3	−1.7
Lifelong state resident (yes, 1)	1.3	−35.0[a]	−1.1	4.4	−23.8[a]
Environmental health concern (Base, low)					
Medium	0.4	−4.1	1.9	−18.4[a]	−1.5
High	−22.7	2.1	34.9	21.0	1.7
Live in North Fork[b] (yes, 1)	−0.2	38.3[a]	−28.1	44.1[a]	−32.5
No category heading used	1.6	3.2	16.3	27.1	21.8
R^2	0.07	0.07	0.08	0.10	0.06

Change in Variable	Resulting Change in Each Budget Category, %					
	Industrial Wastewater	Mining	Farming	Logging	Runoff	Construction
Age, 10% increase in years	−0.2	2.5	−0.8	0.8	0.7	0.8
Sex (male, 1)	15.9	3.8	1.7	17.1	−12.3	−20.2
Race (nonwhite, 1)	−1.3	−21.6	−22.8	−15.1	23.9	−0.2
Marital status (married, 1)	−10.9	−14.6	−38.7[a]	−1.2	5.7	7.8
Children (do have, 1)	−1.3	0.0	−11.4	14.4	6.3	−6.9
Education, 10% increase	2.4	5.6[a]	−0.9	1.0	−0.1	−0.4
Income, 10% increase in dollars	0.6	0.2	−0.0	−0.4	0.0	−0.7
Physiographic region (Base, bluegrass)						
Eastern coal fields	37.1[a]	14.9	−2.5	35.8[a]	−14.7	−20.4
Embayment	−2.3	12.3	34.2	77.2[a]	3.7	−39.7
Plateau	0.2	−10.9	0.6	22.3	−23.4	−27.6
Western coal fields	27.4	−3.9	31.4	11.9	−20.8	−31.0
Residence (Base, nonfarm rural)						
Farm	17.9	−17.8	−10.1	10.3	0.8	−15.2
Urban	13.8	6.4	−1.5	−4.4	−8.0	−16.2
Lifelong state resident (yes, 1)	11.8	17.2	16.2	9.0	20.9[a]	−5.6
Environmental health concern (Base, low)						
Medium	−3.9	−5.3	31.5[a]	−5.3	13.4	19.4
High	−41.7[a]	−33.4	48.0[a]	−25.3	−16.8	39.8
Live in North Fork[b] (yes, 1)	−75.1[a]	23.4	−16.2	23.2	−25.0	1.1
No category heading used	−19.3	−19.7	−31.0	−13.3	−2.4	−13.8
R^2	0.11	0.09	0.10	0.10	0.05	0.06

Here $n = 324$. Table 8 provides the results of a seemingly unrelated regression analysis. In each individual regression, allocation is regressed on several socioeconomic characteristics and one survey characteristic (no category headings used). Elasticities, and not coefficients, are presented in Table 8 to simplify result comparison. The elasticities are evaluated at the mean allocation for each program area and at the mean value for each continuous socioeconomic variable.

[a]The elasticity value is significant at the 0.95 level in an individual regression on a single budget category.

[b]The socioeconomic variable is significant at the 0.95 level in the seemingly unrelated regression over all budget categories.

Effectiveness was defined in the survey instrument to as follows: "How well a task or goal is accomplished."

On the basis of their own experiences, individuals could rate each category as "not effective," "somewhat effective," or "very effective." A program that has not accomplished as much as people want will be rated as "not effective." In the budget survey technique, individuals would be expected to direct more resources to such a program. They want more money devoted

Table 9. Effectiveness Ratings for the Statewide Water Quality Budget Programs

Budget Category	Not Effective, %	Somewhat Effective, %	Very Effective, %	Average Effectiveness Rating
Spills and releases	17.1	59.9	23.0	2.06
Municipal wastewater	17.2	66.9	16.0	1.99
Hazardous materials	26.5	57.9	15.6	1.89
Industrial wastewater	23.9	63.4	12.8	1.89
Farming	23.5	66.5	10.0	1.87
Construction	22.8	68.3	8.9	1.86
Runoff	24.7	65.2	10.1	1.85
Mining	28.5	61.9	9.6	1.81
Untreated sewage	34.7	51.8	13.5	1.79
Logging	33.4	56.8	9.8	1.76
Illegal dumping	54.6	36.9	8.6	1.54

The categories are ranked by the average effectiveness rating (not, 1; somewhat, 2; and very, 3). Effectiveness categories that are significantly different from each other at the 0.95 level are set apart. The t test is conducted for equality between each category and the next higher category.

to the program because they want more progress toward the policy goal.

It should be noted that "effectiveness" has at least two definitions. If "effectiveness" means "satisfaction with the current program level," then we would expect to see a negative correlation between effectiveness and allocation. If, however, "effectiveness" means "productivity or ability to convert program dollars into goals," then we would expect to see a positive correlation between effectiveness and allocation. We intended the respondents to use the "satisfaction" definition, and initial focus groups indicated that this was, indeed, the definition being used. Our test of reliability described below uses this "satisfaction" definition.

Table 9 shows the effectiveness ratings for the Statewide Water Quality Budget. Illegal dumping received a 1.54 effectiveness rating, which was the lowest for any category. In the budget allocation, illegal dumping was given $69,100 thousand of the $500,000, the largest amount given to any category. Overall, for water quality programs the correlation between the allocated amounts and the effectiveness ratings was −0.45.

The negative correlation between allocations and effectiveness ratings is an indication that the budget survey technique is reliable. If respondents believe a goal is met (highly effective), they allocate little additional money to it. A budget program for which additional resources are valued highly gets a low effectiveness rating because people want more progress.

6. Concluding Remarks

There is a growing interest in performance-based, result-oriented government. Citizens want more money directed into programs that achieve progress toward a desired goal. Agency professionals responsible for water quality must develop goals that are not only consistent with their legislative mandates but are also consistent with citizen preferences. Techniques that elicit information concerning the trade-offs citizens are willing to make between water resource programs can improve the public perception component of agency strategic plans and enrich the decision-making process. Budget values are relevant in pointing to the water quality programs to which people want more resources directed. Because a fixed increment to the budget is incorporated explicitly into the elicitation method, individuals are required to allocate funds across a realistic list of budget program categories. The allocations reveal information about the public's relative values of program funding changes or marginal willingness to trade off. MWTTOs among programs can be compared.

Two samples, Kentucky state residents and North Fork watershed residents, were surveyed in 1997. For the Statewide Water Quality Budget, individuals were asked to allocate an extra $500,000 over 11 budget categories. All Kentuckians were willing to trade off $69,100 of the extra budget for increases in programs reducing the problem of illegal dumping. In the North Fork Watershed Budget, North Fork residents also showed a high MWTTO for illegal dumping programs, allocating $22,200 of the extra $100,000 budget to such programs. Although the sample of North Fork residents was small, several differences between the two budgets were also found. For example, respondents in the North Fork watershed, a mountainous mining area with domestic wastewater problems, showed relatively higher MWTTO for programs reducing water quality problems associated with untreated sewage and mining drainage.

The responses to the budget survey did not appear biased when budget category headings were removed. This indicates respondents were paying particularly close attention to the program activities as described in the survey instrument. Using ratings of program effectiveness elicited in the budget surveys, we found respondents tended to allocate more money to those programs they feel have been less effective in the past. We use this as evidence of reliability. When decision makers are faced with the task of shifting resources from one water quality program to another, the results from this research indicate budget values can be useful information.

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