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Household Willingness to Pay for Dropoff Recycling

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Increased landfilling costs and state-mandated reductions in municipal solid waste (MSW) disposal have combined to increase interest in recycling as an MSW management option. Most benefit-cost analyses, however, focus solely on urban curbside recycling programs and/or fail to include the benefits which accrue to households from the opportunity to recycle. This study focuses on the economic feasibility of dropoff recycling in rural areas, presenting estimates of household willingness to pay (WTP) for dropoff recycling in a rural/suburban area of Tennessee. Using contingent valuation, the most conservative mean household WTP is near $4.00 per household per month.

Key words: contingent valuation, dropoff recycling, recycling, rural waste management, willingness to pay

Introduction

New federal regulations affecting traditional methods of municipal solid waste (MSW) disposal are increasing waste disposal costs dramatically. Additionally, most states have passed recycling laws or adopted recycling, diversion, or waste reduction goals. These changes increase interest in recycling, since the relative cost of recycling and consumer demand for recycling opportunities increase its cost competitiveness.

Managers of MSW want to know if recycling is economically feasible. Benefit-cost analysis based solely on fiscal measures ignores the fact that many people derive utility from recycling. Such benefits should be included when evaluating the performance of recycling programs. Further, recycling studies have generally focused on curbside recycling in urban and suburban areas. In rural areas and communities with low population density, a dropoff recycling system appears to be the most fiscally feasible household recycling option.

This article measures households' willingness to pay (WTP) for a dropoff recycling program in a rural and a suburban area. Using contingent valuation, the lowest mean household willingness to pay for a dropoff program is near $4.00 per household per month. Other than three studies measuring WTP for curbside recycling and two voter referenda, we know of no other "direct" information on households' WTP for recycling opportunities (Stock; Kinnaman; Lake, Bateman, and Parfitt).

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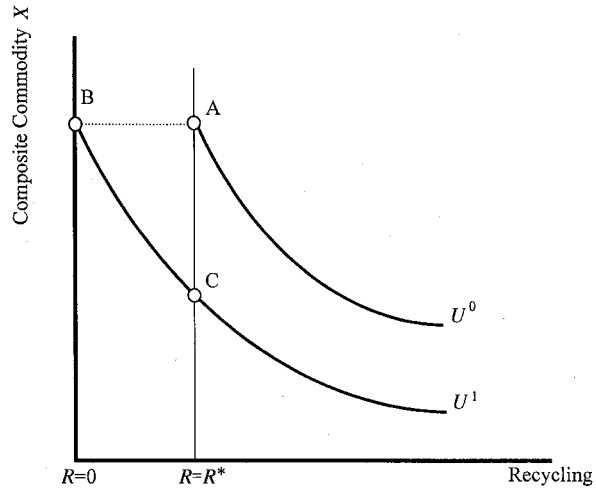

Figure 1. Measuring equivalent surplus

Theory and Methods

Garbage generation and opportunities to recycle will affect the utility of some households (recyclers) while not affecting others (some nonrecyclers, but not necessarily all). Recycling involves opportunity costs, but some households have an incentive to recycle to reduce the amount of garbage sent for disposal because (*a*) garbage disposal yields negative utility, (*b*) it reduces a unit disposal fee, or (*c*) recycling yields positive utility.

Measuring Household WTP for Recycling

Although the full details of the theoretical model are available elsewhere, we outline the basics of the theory in this section.[1] Assume that some level of recycling opportunity, R^*, is provided at no explicit charge (e.g., dropoff recycling funded by the local government through tax revenue), allowing a household to achieve utility level U^0, with expenditure level, e^0 (point A in fig. 1). Then take away the publicly provided recycling opportunity, ceteris paribus, leaving them at a lower utility level, U^1, and expenditure level e^1 (point B). WTP for the recycling opportunity may be measured by determining the amount that households are willing to pay to remain at this utility level, U^1, but enjoy the same recycling opportunity as was previously provided publicly (point C). At point C, expenditure level e^R is needed to reach U^1 with $R = R^*$. The difference between expenditure function e^1 and e^R is an equivalent surplus (*ES*) measure of WTP for the publicly provided recycling opportunity.[2] If nonrecyclers value recycling by others, *ES* can be greater than zero; if nonrecyclers do not value recycling by others, $ES = 0$ (the indifference curve is flat).

[1] The theory is developed from a household production model available in a staff paper by the authors (Tiller, Jakus, and Park). The staff paper also presents estimates of WTP obtained from interval data models (Hanemann, Loomis, and Kanninen) and unrestricted bivariate probit models (Cameron and Quiggin), which were rejected for statistical reasons.

[2] This equivalent surplus function is analogous to McConnell's variation function.

Using Contingent Valuation to Estimate WTP

The use of contingent valuation (CV) to estimate the magnitude of *ES* is widely accepted, provided that the commodity is well known and that appropriate elicitation and estimation methods are used (Arrow et al.). Recent research (e.g., Hanemann, Loomis, and Kanninen; Alberini) has shown that the variance of the WTP estimate will decrease by asking two referendum questions, where the value of the bid in the second question depends upon the answer to the previous question (a higher bid if the first response was "yes"; a lower bid if the first response was "no"). This "dichotomous-choice-with-follow-up" method, or DCF, decreases the variance of the WTP estimate but can bias the estimates.

The two responses elicited with DCF can be analyzed simultaneously using a bivariate probit model (Cameron and Quiggin) or an interval data model (Hanemann, Loomis, and Kanninen) or a mixture of the two (Alberini).[3] We use Alberini's bivariate probit model, which imposes a restriction on the parameters to ensure that the first and second WTP values are identical—that is, $\beta_1 = \beta_2$, as in the interval data model—but the error correlation is freely chosen by the maximization procedure.[4] If WTP is identical across the two questions, this method has lower mean-square error than the more general bivariate probit model. Mean WTP is computed according to Hanemann (1984).

Survey Setting and Data Collection

Survey Setting

The survey was conducted in Williamson County, Tennessee, in 1992. Williamson County established a voluntary dropoff program in 1989 and funded a full-time recycling coordinator and related expenses. The county has established seven attended dropoff "convenience center" sites at which garbage and recyclables are accepted, six nonattended recyclables (only) dropoff sites in public locations, and a material recovery facility where collected materials are delivered for intermediate processing. Plastic, paper, glass, aluminum, and tin are accepted. The dropoff recycling program is funded entirely by county general funds. Money from the sale of materials is donated to local schools, libraries, and not-for-profit groups.

The *suburban* area includes households whose garbage is collected curbside, but who must transport recyclables to a dropoff site. The *rural* area includes households disposing of garbage at convenience centers. Survey participants were intercepted as they entered a rural convenience center or suburban dropoff recycling site and were asked to participate in a personal interview survey as part of " . . . a study on what people think about Williamson County waste disposal issues." After completing one interview, the enu-

[3] The interval data model requires the error correlation (ρ) across the two questions to be strictly equal to one and constrains the WTP value to be identical across the two questions. Neither restriction is imposed in the bivariate probit model. Alberini's Monte Carlo study showed that interval data models result in biased parameter estimates when the true ρ is less than one. Mean-square error of WTP, however, is minimized with an interval data model even when ρ is as low as 0.9. Alberini's evidence suggests that when the correlation is less than 0.9, the bivariate probit model minimizes mean-square error. Cameron and Quiggin's bivariate probit model does not constrain WTP or ρ.

[4] The two WTP values are likely to be correlated, but they may not necessarily be equal. This can occur because the implied information about the program (contained in the bid value) may cause a respondent to revise his WTP, or because of uncertainty on the part of the individual regarding true WTP. An anonymous reviewer has noted that the second question could provide information on the researchers' intent.

merators attempted to interview the next person entering the site. Two hundred eighty-four rural residents and 197 suburban residents completed the survey, yielding 481 total responses. The refusal rate at rural sites was 29.9% and at suburban sites was 18.6%.[5]

Survey Design

Potential survey questions were tested in a focus group for their ability to obtain desired information, with particular attention given to the scenario designed to elicit WTP responses. After designing the initial survey, two pilot surveys were conducted (20 surveys each), one at a rural convenience center and one at a suburban recyclables dropoff site. Based on modifications resulting from the focus group and pilot surveys, the valuation question in the final survey described the Williamson County recycling program exactly as it existed at the time. The CV question was

> Williamson County currently operates a county-wide recycling program. This system consists of 7 drop-off sites at convenience centers and 6 sites at other public locations. The county delivers the recyclable material to the local processing center where it is processed and sold to area buyers. The revenues received from the sale of material collected at each site are then given to a community group located near the collection site. Public funds are needed to maintain and operate this program. One way a county might provide such public funds is through a surcharge on each household's monthly utility bill. If a surcharge of $X per month were added to your utility bill in order to continue the current program, would you support such a surcharge?

The follow-up question was, What if the cost were $Y per month? The initial question used bid values distributed uniformly among $3, $5, $10, $15, and $25, where the dichotomous choice bid levels were based on focus group and pilot survey results. Under the DCF format, if the first response was "yes," then the follow-up surcharge was 50% greater. If the first response was "no," then the follow-up surcharge was 50% less.[6]

While validity and reliability of WTP estimates has been questioned (Diamond and Hausman; Hanemann 1994), estimates can be valid and reliable if certain precautions are taken to minimize bias and increase statistical efficiency (Arrow et al.). The Williamson County survey was designed and conducted before the Arrow panel's report appearing in the *Federal Register,* however, the survey satisfied most of the panel's subsequent recommendations. Most important, the CV scenario described the exact program already in existence in Williamson County, establishing a perfect correspondence between the contingent commodity and respondents' experience.

The CV question contained no "service information" about the benefits of recycling because focus group and pilot survey participants knew the major benefits of recycling.[7] All participants considered extended landfill life and reduced resource extraction and harvest as benefits of recycling, and nearly all mentioned avoiding the political problems with landfill siting. Some benefits were missed; for example, no participant cited long-term tax benefits of extended landfill life. Evidence gained from focus group and pilot

[5] The 11% difference in refusal rates by rural (some recyclers, some not) and suburban households (all recyclers) raises concerns of selection bias in the data. If WTP is estimated for rural nonrecyclers and recyclers jointly, then one must consider whether recyclers and nonrecyclers were equally likely to refuse the interview. The most serious problems may be avoided by simply not combining population subsets and restricting our conclusions to specific populations, eliminating selection bias.

[6] Cameron and Quiggin term the first randomly assigned value the "exogenous threshold" and the second, follow-up value, the "endogenous threshold." It is endogenous because the value is contingent on the participant's first response.

[7] Bergstrom, Stoll, and Randall define "service information" as the possible uses or benefits of an environmental commodity. Failure to consider all services may underestimate WTP.

survey interviews, however, suggests the major benefits of recycling are easily recognized by the general public.

In addition to the utility bill payment vehicle ultimately selected, two other vehicles were initially considered. The first was an increase in property taxes, the current funding mechanism for solid waste management in Williamson County. This was not chosen because the question could not be asked of nonhomeowners and would be difficult to calculate during the interview. The second alternative vehicle was direct billing for recycling. This was rejected because focus groups considered the costs associated with billing to be too high relative to WTP, making the vehicle implausible.

Empirical Results

Based on the hypothesis that households may have a different WTP depending on their location (rural or suburban) and waste management preferences (recyclers or nonrecyclers), and that selection bias may be a problem, three distinct groups are identified. The first group, rural recyclers, includes those using a convenience center for garbage disposal who also indicated they regularly recycle at least one material. Approximately 75% of rural respondents categorized themselves as recyclers. The second group is rural nonrecyclers: convenience center users who do not regularly recycle at least one material. The third group is suburban recyclers: households with curbside collection of garbage which deliver recyclables to a dropoff location. Definitions of variables and their descriptive statistics by group are in table 1.[8]

Bivariate Probit Model Results

Estimates of the bivariate probit models, restricting WTP to be equal across the two CV questions, are in table 2. In responding to *BID PRICE,* the variable *INCOME* is positive and a significant determinant of WTP for rural recyclers and nonrecyclers, but insignificant for suburban recyclers. A respondent's education level (*EDUCATION*) is negative for rural respondents and positive for suburban respondents, but significant for rural nonrecyclers only. The *AGE* of the respondent is negative in all models and significant only in the rural recyclers model. This variable may capture some of the influence of the county's recycling promotional campaign, the core of which is an elementary and middle school curriculum administered by the recycling coordinator. Younger respondents are more likely to have school age children who are familiar with the recycling program and pass this information on to parents.

The variable *HELPS* measures the response to the statement "I feel recycling helps reduce the amount of waste entering landfills." For each group, the coefficient of *HELPS* is negative, as expected, since low values represent stronger agreement to the statement.

[8] Respondents were asked to indicate an income category for all household income in 1991. The midpoint of the income range is used for all categories, except the highest, which was, "greater than $80,000." All reported models use a Pareto-tail method to estimate the midpoint of this category (Smith). Rather than choosing an arbitrary figure for this midpoint, the Pareto-tail approach uses the slope from one income category to another to estimate the midpoint. Nearly one-third of the suburban respondents chose the highest category, with an estimated midpoint of $164,000. The sensitivity of the models to the Pareto method was assessed by arbitrarily assigning an income of $110,000 to these observations. All coefficients (except *INCOME*) retain the same magnitude, and all retain the same sign and statistical significance. Estimated mean WTP changed by less than $0.07 for all three of the reported WTP estimates.

Table 1. Descriptive Statistics for Respondents to Williamson County, TN, Recycling Survey

Variable	Description	Mean (SD)		
		Rural Recyclers	Rural Nonrecyclers	Suburban Recyclers
INCOME	Household gross annual income	45,125 (38,240)	39,820 (38,300)	86,825 (53,690)
EDUCATION	Respondent's highest level of education (12 = high school grad., 16 = college grad.)	12.85 (3.32)	11.49 (3.12)	15.54 (1.63)
AGE	Respondent's age in years	44.92 (14.97)	41.71 (14.69)	43.31 (11.10)
HELPS	Response to statement: "Recycling helps reduce the amount of waste entering landfills," where 1 = strongly agree, 2 = agree, 3 = disagree, 4 = strongly disagree	1.68 (0.59)	1.89 (0.60)	1.63 (0.57)
BID PRICE 1	Monthly bid amount of first WTP question (values were distributed among \$3, \$5, \$10, \$15, \$25)	11.78 (7.86)	10.17 (7.30)	11.31 (7.82)
BID PRICE 1 RESPONSE	0/1 response to *BID PRICE 1* where 0 = "no," 1 = "yes"	0.47 (0.50)	0.35 (0.48)	0.54 (0.50)
BID PRICE 2	Monthly bid amount of second WTP question (value was 1.5**BID PRICE 1* if *BID PRICE 1 RESPONSE* was "yes"; value was 0.5**BID PRICE 1* if *BID PRICE 1 RESPONSE* was "no")	10.08 (8.13)	7.04 (4.04)	10.74 (9.25)
BID PRICE 2 RESPONSE	0/1 response to *BID PRICE 2* where 0 = "no," 1 = "yes"	0.35 (0.48)	0.27 (0.45)	0.49 (0.50)

However, the variable is significant only with suburban recyclers. For each model, the response to the WTP questions is negative and significantly related to the bid value, *BID PRICE.*

While all but one of the 481 survey respondents combined dropoff of recyclables and/or garbage with other trip purposes, suburban households are likely to have a higher opportunity cost than rural households of participating in dropoff recycling. Rural households, by definition, must deliver garbage to a convenience center where recyclables are also collected, and so the marginal cost associated with delivering recyclables to the collection point is at or near zero. Suburban households, however, absorb the full cost of delivering recyclables since they have curbside garbage collection. They are essentially paying a higher cost already (just by participating, they incur a delivery cost that rural households do not incur), thus they likely value the recycling opportunity more. Consistent with a priori expectations, the group willing to pay the most for recycling is suburban recyclers, with a mean WTP point estimate of \$11.74 (median WTP and confidence

Table 2. WTP for Dropoff Recycling Estimation Results for Bivariate Probit Model Restricting WTP to Be Equal across Two WTP Bid Prices

	Rural Recyclers		Rural Nonrecyclers		Suburban Recyclers	
INTERCEPT	1.57**	(3.14)	3.59**	(2.46)	1.09	(1.28)
INCOME	0.003*	(1.71)	0.01**	(2.16)	−0.002	(−1.45)
EDUCATION	−0.02	(−0.72)	−0.16**	(−2.42)	0.03	(0.61)
AGE	−0.02**	(−3.80)	−0.02	(−1.44)	0.002	(0.30)
HELPS	−0.09	(−0.71)	−0.46	(−1.38)	−0.56**	(−3.84)
BID PRICE (1&2)	−0.06**	(−5.37)	−0.13**	(−2.29)	−0.05**	(−4.65)
ρ	0.32**	(2.29)	0.65**	(2.30)	0.48**	(3.45)
Log-likelihood	−231.57		−62.10		−205.81	
Mean WTP (median)	$7.07	($7.84)	$4.05	($3.47)	$11.74	($9.79)
95% C.I.	$4.22–9.93		$1.05–7.04		$8.24–15.24	
ICCC[a]	124/189	(65.6%)	48/62	(77.4%)	108/164	(65.9%)
FCCC[b]	86/189	(45.5%)	34/62	(54.8%)	41/164	(25.0%)
χ^2	49.60		27.60		37.48	
n	189		62		164	

Note: One asterisk indicates significance from zero at the 10% level and two asterisks indicate significance from zero at the 5% level. Numbers in parentheses are ratios of the coefficient to its asymptotic standard error.

[a] *ICCC* means initially correctly classified cases; number of correctly predicted responses to question 1.

[b] *FCCC* means fully correctly classified cases; number of correctly predicted responses for both questions.

intervals for all groups are reported in table 2).[9] They are followed by rural recyclers, with a mean WTP value of $7.07. Rural nonrecyclers are willing to pay an average of $4.05.

Estimated correlation coefficients ranged from 0.32 for rural recyclers to 0.65 for rural nonrecyclers and a 95% confidence interval (based on normality) does not include the value one. The prediction accuracy of each model is given by the percentage of initially correctly classified cases and the number of fully correctly classified cases, according to procedures described in Kanninen and Khawaja. The null hypothesis that all the nonintercept parameters are zero was rejected for all of the models.

The Role of Donated Revenue

A potentially important element of the Williamson County recycling program and our CV question is that revenues from the recyclables are donated to community groups near the collection site.[10] Households may be willing to pay for recycling sites so as to provide benefits to community groups, which would overstate the estimate of WTP *for recycling opportunities.* This effect can be manifest in two ways: if people are more likely to recycle because of the donation mechanism and if people are willing to pay greater amounts for recycling because revenues go to community groups.

Following the CV question all respondents were asked if they had known that revenues

[9] Confidence intervals are calculated following Cameron's procedure.

[10] All models in this section are available from the authors upon request.

were returned to a community group. A dummy variable was constructed and added to a probit model explaining the decision to recycle (rural residents only). In all specifications, the dummy variable for revenue donation was insignificant, indicating that donations are not an effective incentive to recycle. The dummy variable was also added to the DCF WTP models. The variable was insignificant in all models. The difference with WTP estimates in table 2 was insignificant. Statistically, it does not appear that the donation mechanism results in an overstatement of WTP.

Applying the WTP Estimate

Benefit-Cost Analysis

Point estimates of mean WTP for a dropoff recycling option range from $4.05 per month for nonrecyclers to $11.74 per month for suburban recycling households. Bearing in mind that these are point estimates of maximum WTP, such estimates can be useful to local MSW planners considering recycling programs. Providing recycling opportunities is costly and households must have a WTP in excess of the net operating cost for a recycling program to be rational. The Williamson County recycling program's net costs of collection, transportation, intermediate processing, and administration (net of benefits from extended landfill life) in the fiscal year before the survey period were approximately $0.63 per household per month.[11] Using the conservative point estimate of WTP from rural nonrecyclers, $4.05, program benefits exceeded 1991 program costs with a benefit-cost ratio of approximately 6.4.[12] Program costs decreased in 1992 because the county purchased its own collection bins and began transporting recyclables instead of contracting with a private firm, and because the location of a new material recovery facility significantly decreased transportation costs. County officials estimate these actions reduced the net operating cost to about $0.46 per household, for a benefit-cost ratio of 8.8.

Comparison with Other WTP Estimates

Stock estimates the WTP for a curbside recycling program in Ogden, Utah, to lie between $3.00 and $6.00 per household per month, with the estimate differing across subgroups of the sample based on their willingness to participate in a "free" program. However, Stock's working paper does not identify estimation techniques, making comparison of the results difficult. A CV study was conducted in the U.K. to estimate WTP for a curbside recycling pilot program (Lake, Bateman, and Parfitt). Mean WTP was estimated to be £35.69 per year, which is roughly equivalent to $53 per year, or $4.50 per household per month (adjusted to 1992 prices). Direct comparison of the results, however, is difficult since the study used a single dichotomous choice question (which increases variance) and because waste management is treated differently in the U.K. than in the U.S. (Waite). Further, the estimation method used to calculate WTP is not fully documented. Kinnaman has estimated the WTP for a curbside recycling program in a small town in Pennsylvania

[11] This is based on the total program costs and the number of households in the county. The 1991 average cost of recyclables collected was $69.94 per ton.

[12] This estimate is chosen because it is most conservative. While an estimate based on a representative sample for the entire county would have been desirable, the survey design did not include information from suburban nonrecyclers.

Table 3. Selected Recycling Programs and Their Financing Structure

City/State	Service Type	Payment Arrangement	Payment per Household ($/month)
City Referendum[a]			
Boulder, CO	Weekly curbside	Occupational tax on haulers and sales tax of $0.01/$10.00	Adds approximately 1.50 onto existing monthly recycling rate of 1.00
Omaha, NE	Weekly curbside	Charge added to utility bill (referendum failed)	Amount in referendum was unspecified, but expected to be approximately 4.00
City Resolution[b]			
Davenport, IA	Weekly curbside	Charge added to monthly garbage collection charge itemized on utility bill	2.87
Evansville, IN	Biweekly curbside	Charge added to monthly garbage collection charge itemized on utility bill	2.83
Edmonton, Alberta	Weekly curbside	Charge added to utility bill	5.00 ($CN)
City Contract[c]			
Clearwater, FL	Weekly curbside	Paid from general tax base	1.24
Tucson, AZ	Biweekly curbside	Paid from general tax base	1.21
Jefferson Parish, LA	Weekly curbside	Charge added to garbage bill	1.40
Lake County, OH	Curbside (weekly urban, biweekly rural)	Paid from general tax base	Urban: 1.71 Rural: 1.29

Note: Information obtained from recent issues of *Resource Recycling*.
[a] All eligible voters had an opportunity to "vote" on the proposed program and financing arrangement.
[b] An elected or appointed governing body voted for program adoption and financing arrangement.
[c] A local decision maker charged with solid waste management arranged the program contract and financing.

faced with mandatory recycling to be $15.60 per year. While the CV study uses an iterative bidding mechanism, it does not adjust for potential bias associated with the elicitation method.

It is also useful to compare our WTP point estimate for all rural respondents with explicit household recycling costs incurred in other communities (table 3).[13] If WTP values in these communities are similar to the $4.05 estimated here, it would appear that communities or community leaders have made economically sound decisions in nearly all cases. Because the voter referenda in Boulder, CO, and Omaha, NE, most closely match the dichotomous choice CVM format used in this study, these cases are worth

[13] This study has focused on a *dropoff* recycling program, whereas all of the programs reported in table 3 are for *curbside* recycling. Because dropoff imposes greater costs on participants, it is reasonable to presume that WTP for curbside service would be greater than for dropoff.

further examination. In Boulder, citizens voted to raise the monthly household charge for recyclables collection from $1.00 to $2.50 per household per month as the program expanded to include more materials. Given the range of WTP estimates from our study, support for the referendum is not surprising. Residents of Omaha, however, recently defeated a referendum which would have added a fee for curbside recycling to monthly waste disposal costs. The ballot measure was essentially a "blank check," as it did not state the recycling fee amount, although some publicity estimated a fee of approximately $4.00 per household per month. Though we could not obtain a WTP estimate for all suburban residents, our conservative estimate appears consistent with the Omaha referendum results.

Summary

The contingent valuation method was used to estimate WTP for a dropoff recycling option using DCF referendum data. Willingness-to-pay measures were estimated using a bivariate probit model, in which WTP values were restricted to be equal across the two bid questions and the error correlation was freely chosen across the two bid questions. Mean WTP for rural nonrecyclers (the most conservative of the rural recyclers, rural nonrecyclers, and suburban recyclers groups within the sample) was estimated to be near $4.00 per household per month. If this estimate is transferable to similar rural communities, benefits accruing to households exceed costs in situations where the operating cost of the recycling program is less than $4.00 per household per month. The WTP results are similar to unpublished and published estimates of WTP for curbside recycling and are consistent with recycling provision and publicly or privately determined prices of curbside recycling opportunities in other communities.

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