Journal of Agricultural and Applied Economics, 29,1(July 1997):141–148

Explaining Rural Household Participation in Recycling

Paul M. Jakus, Kelly H. Tiller, and William M. Park

ABSTRACT

Rising landfill costs have forced solid waste managers to consider waste stream reduction alternatives such as household recycling. Explaining the factors which motivate households to recycle is important to regions where households must bear a large portion of the recycling cost because unit-based garbage disposal fees and curbside recycling are not feasible options. Empirical results indicate that residents are responsive to constraints introduced by the household production technology, such as time costs and storage space, but are not responsive to variables measuring a recycling promotional program. Promotion efforts should switch focus from broader "public good" benefits of recycling to reducing household-level household production constraints.

Key Words: dropoff recycling, household recycling participation, rural regions.

Rural counties and small communities with low population densities throughout the United States face new constraints and pressures with regard to solid waste management. In addition to difficulties in siting new landfills, stricter landfill regulations issued in 1991 under Subtitle D of the Resource Conservation and Recovery Act are raising the cost of traditional solid waste disposal methods (Darcy; Malia and Morrissey). These changes have made it imperative that communities carefully allocate existing and future landfill space. In response to the regulations, by 1994, 42 states had mandated reductions in the amount of solid waste requiring disposal; 28 of these also require the provision of recycling programs (Steuteville). In most cases, rural communities are subject to the same federal regulations and state waste reduction mandates as urban communities. But given the significant economies of scale in the operation of a recycling program, a large volume of materials must be recovered for the program to be cost effective. Such economies are difficult to achieve in rural areas unless recycling participation rates are high.

Although information regarding participation rates is important in determining whether a recycling program can be economically efficient, there has been little research investigating the economic factors which influence household recycling participation. The literature by noneconomists is more extensive, but these studies have focused on psychological or sociological factors (Vining and Ebreo; Barker et al.; Oskamp et al.; Vining, Linn, and Burdge).[1] Economists have generally exam-

The authors are assistant professor, graduate research assistant, and professor, respectively, all in the Department of Agricultural Economics and Rural Sociology, The University of Tennessee.

Support for this research was provided by the University of Tennessee Agricultural Experiment Station and the Waste Management Research and Education Institute.

[1] Another segment of the literature examines "intervention" mechanisms, such as public commitment or monetary rewards, to increase recycling participa-

ined the effect of unit-based pricing for garbage disposal on the quantity of material recycled or the frequency of recycling in urban, curbside programs [Fullerton and Kinnaman; Hong, Adams, and Love; Morris and Holthausen (MH)]; however, curbside recycling and unit-based pricing often are not feasible options for rural communities. Jakus, Tiller, and Park (JTP) studied a dropoff system in a rural area, but they focused on generation of recyclables (pounds of material generated) rather than on the factors influencing participation.

This study examines household decisions to participate in a voluntary recycling program in a rural area of Williamson County, Tennessee. Not only are curbside recycling and unit-based pricing impractical policy options in this region, but the rural area is served by dropoff sites for garbage because even curbside garbage pickup is infeasible. Given that this region constitutes 46% of the county's households, the county must encourage waste reduction and recycling by rural households if state-mandated waste reduction goals are to be met. The county has aggressively promoted recycling in rural areas. We evaluate the effectiveness of this effort.

The empirical model draws upon existing theoretical models (especially those of MH and JTP) to identify the factors influencing the participation decision. In addition, our model incorporates variables measuring the effect of a county government's efforts to encourage recycling. Results indicate that while rural households are responsive to constraints associated with the household production technology and to other demographic effects, they are not responsive to variables measuring the impact of the local recycling program. Our results are applicable to other regions with large rural populations.

Data Collection

The Tennessee Solid Waste Management Act of 1991 mandates a 25% reduction in the per capita weight of solid waste burned or buried over a six-year period, and many counties are relying on household recycling to help achieve this goal. Located just south of Nashville, Williamson County has a well-developed dropoff recycling program. Approximately half the households in the county are rural, where "rural" households are defined as those not contracting for curbside garbage collection. The county has established a network of seven convenience (dropoff) centers in rural areas, where residents without house-to-house garbage collection can drop off their garbage and recyclables.

Williamson County employs a full-time program coordinator who disseminates promotional information to the public and oversees a recycling education program in elementary and middle schools. The promotional literature advocates recycling as "good" for the environment (e.g., "recycling X tons of paper saves Y trees"), and as an effective way to reduce solid waste and extend the life of landfills. The information does not describe efficient production and storage methods for recycling. As a participation incentive, revenue from the sale of the recycled material is donated to schools, libraries, and civic groups located in the vicinity of the convenience center.

The survey instrument was designed using a focus group and two pretests conducted at convenience centers in Knox County, Tennessee. During August and November 1992, 284 individuals were interviewed as they entered convenience centers.[2] Upon completion of one interview, enumerators attempted to interview the next person entering the convenience center. The response rate was 70.1%. Respondents were presented with a number of statements regarding issues associated with household recycling and rural solid waste management, and were asked to state the degree to which they agreed or disagreed with these statements. The statements and mean responses are reported in table 1, along with data establishing a statistical profile of respondents.

Overall, 75% of respondents stated they re-

tion (Porter, Leeming, and Dwyer). We do not address this literature because interventions are not employed in the study area.

[2] Respondents were interviewed at three of the seven rural convenience centers.

Table 1. Variable Means

Variable	Mean or %	Std. Dev.	n
INCOME (% of sample)			275
< $15,000	15.27	0.36	
$15,000–$35,000	37.09	0.48	
$35,000–$65,000	34.18	0.48	
> $65,000	13.46	0.34	
EDUCATION (years)	12.45	3.35	284
AGE (years)	44.38	14.89	283
HOUSEHOLD MEMBERS (no.)	3.08	1.39	284
HOMEOWNER (%)	85.56	0.35	283
FRIENDS: I have friends who recycle. (% yes)	74.32	0.44	257
DONATE: Before this interview, I knew that recycling revenue went to local groups. (% yes)	31.34	0.46	284
CHILDREN 6–14: My household has children aged 6-14. (% yes)	29.22	0.46	284
Other Variables (measured on 4-point scale*):			
TIME: It takes little time to recycle.	2.02	0.53	274
STORAGE: My house has adequate storage space for recyclables.	2.49	0.74	284
GENERATE: My household generates enough material to make recycling worthwhile.	2.14	0.69	281
INFORMATION: Information on recycling is readily available.	2.13	0.54	265

* Four-point scale is defined as follows: 1 = strongly agree, 2 = agree, 3 = disagree, and 4 = strongly disagree.

cycled at least one material, but only 31% actually brought any recyclables on the day of the interview. The disparity between these percentages is striking, but could exist for logical reasons. First, the average "accumulation interval" (the number of days between delivery to the convenience center) for recyclables is longer (16 days) than that for garbage (eight days). This may be because recyclables "keep" better than garbage, or that storage capacity and household size combine to determine frequency of recyclables dropoff. Thus, if garbage is delivered more frequently than recyclables, an intercept survey is more likely to interview someone on a "garbage-only" day rather than on a day when recyclables were also delivered. Second, households with relatively high recycling costs would accumulate recyclables at a slower rate than those with lower costs. Finally, 14% of recyclers said they recycled at the workplace or delivered recyclables to other sites, such as a commercial buyback center. An alternative hypothesis is that these individuals may have been trying to provide an "environmentally correct" response. This issue is evaluated with a likelihood ratio test in the next section.

Empirical Models

This section reports probit models used to gauge the factors determining whether a household recycles. Econometric specifications are chosen using the theoretical models of MH and JTP. Both theoretical models rely on a household production approach and have similar Kuhn-Tucker first-order conditions. In general, these conditions show that household participation is driven by a comparison of the marginal benefits of recycling and the marginal costs of recycling [equations (20c) in MH and (4c) in JTP]. For the MH model, the benefit of recycling includes avoided disposal costs (from volume-based pricing of garbage disposal) and the monetized positive impact on utility from the generation of recyclables. The JTP model is somewhat different in that benefits are derived not from generating recyclables, but from the monetized impact on utility of avoiding a larger volume of waste to be disposed.[3] The JTP model restricts costs of

[3] Thus, the JTP model does not imply that people purchase products for the added "goal" of generating a larger volume of recyclables, as is implied by the MH model.

recycling to the time associated with recyclables preparation, while the MH model includes additional out-of-pocket expenditures for storage and delivery of recyclables. In both models, the parameters of the household production technology affect the first-order conditions, and thus the decision to recycle.

Because unit-based garbage disposal pricing is not feasible in many rural regions, the benefits of recycling consist solely of the "warm glow" benefits of recyclables generated (MH) or garbage disposal avoided (JTP). It is precisely these benefit terms that the Williamson County recycling program has attempted to influence, to the exclusion of trying to help households lower the costs of recycling. Our empirical specifications include not only variables which measure the impact of the Williamson County recycling promotion and education program, but also variables which capture the cost side of the equation: the household production technology and time costs. The models will identify which factors exert a more important influence on the decision to recycle.

Full Sample Results

The full sample participation models are presented in table 2. In general, the models are consistent with theoretical expectations, with nearly all variables having the expected sign and most highly significant. Specification #1 includes all variables believed to influence the decision to recycle. *STORAGE, GENERATE,* and *TIME* were coded such that the expected sign on these variables was negative.

The most important factors affecting the decision to recycle are those which constrain the marginal benefits of recycling or raise the marginal cost of recycling. Households believing that they generate enough material to warrant recycling are more likely to recycle (*GENERATE*). This variable can be interpreted in two ways. First, it serves as a measure of returns to scale in recyclables production, and thus represents a production technology variable. Alternatively, it could represent the respondent's perception of the effectiveness of personal recycling efforts in dealing with solid waste. *STORAGE* captures an oft-cited production constraint in recycling by households. Households with adequate storage space are also more likely to recycle than those with inadequate storage.

Pre-survey activities revealed that nonrecyclers could not answer questions about how much time was required to recycle, say, a glass bottle—so we opted to ask a question nonrecyclers could answer. The variable *TIME* represents a rough measure of household perceptions of the amount of time needed to recycle. Household *perception* of the time cost is the appropriate measure in a model such as ours because it represents a major barrier to recycling. All else being equal, it is hypothesized that those with greater perceived time costs will be less likely to recycle. The empirical models support this hypothesis, where households believing that recycling takes little time are more likely to recycle than those disagreeing with this statement (*TIME*).

Household characteristics influence behavior as well. Households are more likely to recycle if they have friends who recycle (*FRIENDS*) or as the respondent's age increases (*AGE*).[4] Respondents who are college graduates (*COLLEGE GRADUATE*) are more likely to recycle than those who are not. Household income data were collected as a categorical variable; in the empirical models, those with household incomes of less than $15,000 represent the base case. Only respondents with incomes in the $35,000–$65,000 category are more likely to recycle than base case respondents. This provides some support for the hypothesis that income may have offsetting production and income effects in recycling behavior (Saltzman, Duggal, and Williams). As income increases, households purchase more marketed commodities, so they have more material available to recycle. At the same time, however, the opportunity cost of time increases, thereby increasing the net cost of recycling.

Specification #1 also includes variables de-

[4] The respondent may merely be hauling the recyclables, and may not be the household member responsible for recycling decisions. In this case, the respondent's characteristics act as proxy variables.

Table 2. Recycling Participation Models: Full Sample (N = 222)

	Econometric Specification	
Variable	#1	#2
Intercept	1.21 (1.21)	1.48 (1.61)
Household Production Technology and Characteristics Variables:		
STORAGE	−0.49** (−2.93)	−0.49** (−3.04)
GENERATE	−0.43** −(2.93)	−0.38** (−2.25)
TIME	−0.33 (−1.52)	−0.37* (−1.69)
FRIENDS	1.00** (3.78)	1.00** (3.89)
AGE	0.02** (2.28)	0.02** (2.70)
COLLEGE GRADUATE	1.02** (2.29)	0.99** (2.30)
INCOME $15,000–$35,000	0.23 (0.67)	0.28 (0.83)
INCOME $35,000–$65,000	0.71* (1.81)	0.75* (1.94)
INCOME > $65,000	−0.35 (−0.71)	−0.20 (−0.43)
HOUSEHOLD MEMBERS (no.)	0.07 (0.65)	0.01 (0.15)
HOMEOWNER	−0.10 (−0.29)	−0.11 (−0.34)
County Recycling Program Variables:		
CHILDREN 6–14	−0.37 (−1.26)	
DONATE	0.16 (0.62)	
INFORMATION	0.16 (0.79)	
χ^2	77.50**	74.86**
% Correct	82.4	83.3

Notes: Dependent variable: 1 = recycle, 0 = don't recycle. Numbers in parentheses are ratios of a coefficient to its asymptotic standard error. Single and double asterisks (*) denote significance at $\alpha = 0.10$ and $\alpha = 0.05$, respectively.

signed to capture the impact of the Williamson County information and education program. This program is explicitly designed to influence residents' sensitivity to solid waste issues. The variable *CHILDREN 6–14* attempts to capture the influence of the elementary and middle-school education program, while *DONATE* measures whether the respondent is aware that revenue went to community organizations. *INFORMATION* measures the ability of the program to reach the general public about recycling and solid waste issues. Individually, none of the program-specific variables are statistically significant. The hypothesis that the slopes of the program variables are jointly equal to zero is not rejected (i.e.,

from table 2, negative two times the difference in the log-likelihood values between specification #1 and specification #2 is 2.64).

Before concluding that the education program is ineffective, however, two caveats must be stated. First, the variables used to gauge the program are crude measures. In particular, *CHILDREN 6–14* may capture not only the impact of the school program, but also other factors associated with having school-aged children in the household. A better measure would differentiate between households with school-aged children whose children had or had not participated in the recycling education program. Second, the effectiveness of the recycling education program may best be evaluated by observing how the marginal effects change over time. For example, while having school-aged children in the household may limit recycling participation (i.e., give a negative sign in a probit participation model), a school recycling program may make this effect "less negative."

Dropping Potentially "Compliant" Observations

While economic reasoning and the sampling methodology may explain why some respondents claimed to recycle but did not have any recyclables in hand, other participants may have provided responses which they perceived to be socially responsible, or they may have been trying to comply with what they thought the interviewer wanted to hear. For example, a recent study of college students (Barker et al.) revealed little congruity between the students' stated recycling behavior and their actual recycling behavior. It is possible that the same behavior occurred in our sample. Such "yea-saying" has long been recognized in the contingent valuation literature (e.g., Mitchell and Carson, pp. 240–41). Relative to a contingent valuation study, however, we have the advantage of knowing exactly which respondents present potential problems. We test for the effect of the "compliant" population by eliminating them from the analysis. The remaining sample consists solely of those who are known (with certainty) to be recyclers and those who stated that they did not recycle. The estimated coefficients from the restricted sample can be compared with the unrestricted sample coefficients using a likelihood ratio test. The participation models for the restricted sample are reported in table 3.

For the restricted sample, the value of the likelihood function for each specification was calculated at the coefficients estimated for the full sample. A test statistic was formed using the set of coefficients which maximized the value of the likelihood function for the restricted sample. For specification #1, the null hypothesis of parameter equality is rejected at the $\alpha = 0.10$ level, while the null for specification #2 is rejected at the $\alpha = 0.05$ level. This suggests that some degree of compliance is present in the data. Despite potential compliance problems, however, the restricted sample models are qualitatively identical to the full sample models. Every statistically significant variable in the full sample models (table 2) retains the same sign and at least the same level of statistical significance in the restricted sample models (table 3). Thus, conclusions based on the models are insensitive to potential compliance effects.[5]

Discussion

In many ways, our findings corroborate those of the noneconomics literature. Similar to Vining and Ebreo, we found that older respondents are more likely to recycle than younger respondents. Second, recyclers had, on average, greater incomes than nonrecyclers (a finding supported by Vining and Ebreo, and by Oskamp et al.). Third, as in our study, previous studies have also noted the importance of the recycling behavior of friends and neighbors in determining behavior.

Conversely, our results also differ in many respects. The empirical models suggest that recycling behavior may be quadratic in income, rather than linear as implied by previous stud-

[5] Compliance problems appear to bias the parameter estimates in this case. While this is not a major problem in our application (i.e., we can still conduct informative policy analysis), welfare measures (willingness to pay or willingness to accept) derived from a CVM application would be incorrect.

Table 3. Recycling Participation Models: Drop "Complaint" Observations (N = 127)

	Econometric Specification	
Variable	#1	#2
Intercept	0.71 (1.42)	1.44 (1.12)
Household Production Technology and Characteristics Variables:		
STORAGE	−0.68** (−2.88)	−0.59** (−2.74)
GENERATE	−0.77** −(2.96)	−0.68** (−2.74)
TIME	−0.57* (−1.83)	−0.63** (−2.08)
FRIENDS	1.03** (2.80)	0.98** (2.79)
AGE	0.03** (2.28)	0.03** (2.91)
COLLEGE GRADUATE	1.20** (2.24)	1.15** (2.23)
INCOME $15,000–$35,000	0.38 (0.76)	0.46 (0.93)
INCOME $35,000–$65,000	1.06* (1.84)	1.21** (2.15)
INCOME > $65,000	−0.08 (−0.12)	0.26 (0.42)
HOUSEHOLD MEMBERS (no.)	0.14 (0.92)	0.05 (0.40)
HOMEOWNER	−0.08 (−0.15)	0.02 (0.04)
County Recycling Program Variables:		
CHILDREN 6–14	−0.42 (−0.98)	
DONATE	0.30 (0.85)	
INFORMATION	0.55 (1.56)	
χ^2	79.96**	75.67**
% Correct	82.7	81.1

Notes: Dependent variable: 1 = recycle, 0 = don't recycle. Numbers in parentheses are ratios of a coefficient to its asymptotic standard error. Single and double asterisks (*) denote significance at $\alpha = 0.10$ and $\alpha = 0.05$, respectively.

ies by noneconomists. The policy implication of home ownership is also different; e.g., Oskamp et al. suggest that because homeowners are more likely to recycle, promotional efforts should be aimed at those who rent, especially those who do not live in single-family homes. In contrast, our data indicate that recycling participation is not related to home ownership per se, but to the production constraints that may have been proxied by home ownership. The models presented here explicitly include this constraint (*STORAGE*), so it is not surprising that home ownership is insignificant. Finally, Vining and Ebreo focus on the *motivations* of recyclers to suggest that recycling information should "emphasize the role

played by recycling in protecting the environment" (p. 71). Our study indicates that household production constraints may be more important factors in determining household recycling behavior.[6]

Conclusions: Making the Results Useful to Policymakers

The empirical models describing participation in recycling are consistent with theoretical models developed elsewhere, and provide a number of insights into the design of recycling campaigns. A recycling program coordinator may have the greatest impact in modifying residents' perceptions of constraints to recycling. While nearly all of the recycling information in Williamson County promotes the public good aspects of recycling, none target the household production constraints to which respondents were sensitive (*STORAGE, GENERATE,* and *TIME*). Information focusing on ways to make the constraints less binding could increase participation rates. Informational brochures might well highlight (*a*) space-saving, convenient methods of recyclables storage in both homes and rental apartments; (*b*) efficient methods of recyclables preparation, thus reducing people's perception of the amount of time required to recycle; and (*c*) the amount of waste and potentially recyclable material generated by households of different sizes to emphasize the contribution that each household can make toward reducing solid waste.

At first glance, the participation models might lead one to conclude that promotional efforts are not effective in inducing households to recycle. The availability of information about recycling and making households aware that revenues from the sale of recyclable material are donated to local community groups do not influence participation. Educational programs aimed at school-aged children also do not appear to have impacted household participation rates. Our models, however, do not provide a clear assessment of the impact of these promotional efforts. A more powerful test of their effectiveness would employ variables specifically designed to capture the marginal effects of promotion efforts.

[6] Most of the studies cited, however, do emphasize the need to make recycling as "convenient" as possible.

References

Barker, K., L. Fong, S. Grossman, C. Quinn, and R. Reid. "Comparison of Self-Reported Recycling Attitudes and Behaviors with Actual Behavior." *Psychological Reports* 75(1994):571–77.

Darcy, S. "Landfill Crisis Prompts Action." *Manage. of World Wastes* 32(1991):28–55.

Fullerton, D., and T.C. Kinnaman. "Household Responses to Pricing Garbage by the Bag." *Amer. Econ. Rev.* 86(1996):971–84.

Hong, S., R.M. Adams, and H.A. Love. "An Economic Analysis of Household Recycling of Solid Wastes." *J. Environ. Econ. and Manage.* 25(1993):136–46.

Jakus, P.M., K.H. Tiller, and W.M. Park. "Generation of Recyclables by Rural Households." *J. Agr. and Resour. Econ.* 21(1996):96–108.

Malia, J.E., and J. Morrissey. "Rural Communities and Subtitle D: Problems and Solutions." Joint TVA/EPA project. Tennessee Valley Authority/ Center for Waste Management, and Environmental Protection Agency, Region IV, Atlanta GA, December 1994.

Mitchell, R.C., and R.T. Carson. *Using Surveys to Value Public Goods: The Contingent Valuation Method.* Washington DC: Resources for the Future, 1989.

Morris, G.E., and D.M. Holthausen. "The Economics of Household Solid Waste Generation and Disposal." *J. Environ. Econ. and Manage.* 26(1994):215–34.

Oskamp, S., M.J. Harrington, T.C. Edwards, D.L. Sherwood, S.M. Okuda, and D.C. Swanson. "Factors Influencing Household Recycling Behavior." *Environ. and Behavior* 23(1991):494–519.

Porter, B.E., F.C. Leeming, and W.O. Dwyer. "Solid Waste Recovery: A Review of Behavioral Programs to Increase Recycling." *Environ. and Behavior* 27(1995):122–52.

Saltzman, C., V.G. Duggal, and M.L. Williams. "Income and the Recycling Effort: A Maximization Problem." *Energy Econ.* 15(1993):33–38.

Steuteville, R. "The State of Garbage in America, Part II." *BioCycle* 36,5(May 1995):30–37.

Vining, J., and A. Ebreo. "What Makes a Recycler?" *Environ. and Behavior* 22(1990):55–73.

Vining, J., N. Linn, and R.J. Burdge. "Why Recycle? A Comparison of Recycling Motivations in Four Communities." *Environ. Manage.* 16(1992):785–97.