Curbside Recycling:
Waste Resource or Waste of Resources?

David Aadland
Department of Economics and Finance
1000 E. University Avenue
University of Wyoming
Laramie, WY 82071-3985

Arthur J. Caplan·
Department of Economics
Utah State University
3530 Old Main Hill
Logan, UT 84322-3530

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Abstract: In this paper, we address the often contentious debate over state and local recycling policy by carefully estimating the social net benefit of curbside recycling. Benefits are estimated using household survey data from over 4,000 households across 40 western U.S. cities. We calibrate household willingness-to-pay for hypothetical bias using an innovative experimental design that contrasts stated and revealed preferences. Cost estimates are compiled from previous studies by the U.S. Environmental Protection Agency and the Institute for Local Self Reliance, and from in-depth interviews with recycling coordinators in our sampled cities. Across our sample of cities, we find that the estimated mean social net benefit of curbside recycling is almost exactly zero. On a city-by-city basis, however, our social net-benefit analysis often makes clear predictions about whether a curbside recycling program is an efficient use of resources. Surprisingly, several existing curbside recycling programs in our sample are inefficient.

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Abstract: In this paper, we address the often contentious debate over state and local recycling policy by carefully estimating the social net benefit of curbside recycling. Benefits are estimated using household survey data from over 4,000 households across 40 western U.S. cities. We calibrate household willingness-to-pay for hypothetical bias using an innovative experimental design that contrasts stated and revealed preferences. Cost estimates are compiled from previous studies by the U.S. Environmental Protection Agency and the Institute for Local Self Reliance, and from in-depth interviews with recycling coordinators in our sampled cities. Across our sample of cities, we find that the estimated mean social net benefit of curbside recycling is almost exactly zero. On a city-by-city basis, however, our social net-benefit analysis often makes clear predictions about whether a curbside recycling program is an efficient use of resources. Surprisingly, several curbside recycling programs in our sample appear to be inefficient.

1. Introduction

One of society's greatest challenges is determining optimal allocations for environmental goods, such as old-growth forests, wetlands, spotted owls, wolf habitat, clean air, etc. The primary difficulty with this type of problem is accurately measuring the social benefits accruing from the provision of these goods. Due to the potential for free-riding behavior and the absence of well-developed markets, it is often necessary to estimate the benefits through non-market valuation methods, such as contingent valuation.

In this paper, we focus on one such environmental good – curbside recycling. Recycling is typically thought to benefit the environment by diverting solid waste from landfills, which can pollute groundwater, produce airborne pollutants, and compete for open space [U.S. EPA, 1992]. However, recycling programs also require households to clean, sort, store and deliver recyclables. Furthermore, curbside recycling programs (CRPs) divert resources from other public services such as education, highway maintenance, welfare programs, etc. Our goal in this paper is to provide a comprehensive measure of the social net benefit of curbside recycling, in order to help answer the often contentious question: "Should we be recycling?"

To date, answers to this question have been contentious and, in some cases contradictory. Take, for example, New York City's decision in the summer of 2002 to temporarily suspend collection of plastics and glass [Johnson, 2002]. Less than two years later, however, the city completely reversed its decision, choosing instead to invest $20 million in a new Brooklyn waterfront recycling plant [Urbina, 2004]. The primary basis for both the initial decision to suspend recycling and the subsequent reversal of that decision was cost effectiveness. While cost effectiveness may be an understandable criterion for municipalities that operate under tight fiscal budgets and lack reliable estimates of the social benefits of recycling, we are left to wonder whether the city's policymakers have made socially efficient decisions by failing to assess both the social costs *and* benefits of curbside recycling.[1]

New York City is not alone. Recent trends suggest that recycling rates are falling nationwide, provoking many communities to reconsider whether they should continue providing curbside recycling. In its most recent annual report, "State of Garbage in America", *Biocycle* magazine finds that although the per-capita generation of solid waste continues to grow nationwide, the overall recycling rate is down from 33 percent in 1999 to 26.7 percent in 2002 and the number of CRPs is similarly down from 9,709 to 8,875 [Kaufman, et al., 2004]. Cities big and small have either dropped their CRPs completely or are scaling them back to meet budget shortfalls [Seibert, 2002]. Also, several cities that have traditionally provided curbside recycling without directly charging for the service are now considering levying a household fee [Ibid]. Unfortunately, these decisions are being made similarly to New York City's. They are based exclusively on the criterion of cost effectiveness, rather than on the social net benefits of curbside recycling.

This paper represents a first attempt at establishing a sound economic basis for making such public policy decisions by estimating *both* the benefits and costs of curbside recycling for a wide range of communities.[2] One of our main contributions is the innovative way in which we use the contingent valuation method (CVM) to estimate willingness-to-pay (WTP) for CRPs. The innovation stems from a common criticism of previous CVM studies – that respondents tend to

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[1] We thank an anonymous reviewer for pointing out that social efficiency is not the only issue driving the debate about recycling. Questions related to the moral and ethical obligations of recycling are also likely at play.

[2] Previous studies have also looked at the net benefits of curbside recycling (e.g., Hanley and Slark, 1994; SWANA, 1995; Kinnaman, 2000). However, these studies use more of a case-study approach focusing on individual communities. We consider our study, which covers a wide variety of communities and CRPs, to be a complement to and extension of these existing case studies. In particular, our study enables inference to a wider population of CRPs.

overstate their true WTP due to the hypothetical nature of the good. Unlike these previous studies, we are able to estimate the magnitude of the potential hypothetical bias in our WTP data by contrasting stated-preference information (from CVM) with revealed-preference information (from actual decisions made by households in communities with voluntary CRPs).[3] Using this estimate of hypothetical bias, we then calibrate the corresponding WTP estimates to the decisions made by households in a real market setting.[4] To our knowledge, this is the first time that stated- and revealed-preference information from the same dataset has been used to directly estimate hypothetical bias in WTP and subsequently calibrate the welfare estimates.[5]

On the cost side, we utilize information from a wide array of communities to obtain an estimated per-household economic cost of providing curbside recycling services. In calculating the costs of curbside recycling, we include both explicit variable and fixed costs, as well as the opportunity costs associated with diverting public resources away from their next most productive use.

Across our sample of cities, we find that the estimated mean social net benefit of curbside recycling is almost exactly zero. However, on a city-by-city basis, our analysis often makes clear predictions about whether a CRP is an efficient use of resources. The results from our econometric and calibration exercise can also be used as a practical tool by local policy makers to obtain estimates of their community's WTP for curbside recycling. This is accomplished by

[3] "Voluntary" CRPs require households to pay only if they have signed up for the program while "mandatory" CRPs require all households to pay, irrespective of whether they have signed up or not.

[4] We use CVM to estimate benefits (rather than derive such measures using market prices and aggregate participation levels) because much of the data from established markets for voluntary curbside recycling are proprietary and also would not generally include information at the household level.

[5] Cameron [1992], Adamowicz, et al. [1994], Huang, et al. [1997], and Whitehead, et al. [2000] combine stated and revealed preference data to enhance the efficiency of their welfare estimates. Cummings and Taylor [1999] use responses from stated- and revealed-preference laboratory experiments to estimate the magnitude of hypothetical bias in students' valuations of a series of public goods.

substituting the relevant community and socio-demographic characteristics into the right-hand-side of our econometric equation. The resulting estimate of household benefits can then be weighed against the economic costs to determine whether establishing or maintaining a CRP is socially efficient.

The next section presents a simple theoretical framework that describes the management of solid waste at the household and community levels. This framework guides our ensuing empirical analysis. In section three, we introduce the data sources used in developing measures of economic costs and benefits. In section four, we present our econometric model for estimating WTP, including the methods used to mitigate hypothetical bias, and discuss our empirical results. In section five, we discuss the policy implications of our empirical findings and suggest some possible avenues for future research.

2. Theoretical Model

Our model involves an equilibrium relationship between households and a community planner, whereby households make utility-maximizing decisions in response to the planner's policies and the planner sets public policy to maximize the well-being of the households. As shown in the Appendix, household *i*, i = 1,…,n, is assumed to maximize an Andreoni (1990) impure-public-good utility function by choosing recycling effort subject to a budget constraint.[6] This creates a potential externality since households have no apparent incentive to fully internalize the marginal effect of their private recycling effort on the aggregate amount of recyclable material generated at the community level.[7]

[6] The appendix can be found at www.uwyo.edu/aadland/research/recycle/.

[7] See Fullerton and Wu [1998] and Kinnaman and Fullerton [2000] for alternative general equilibrium models of recycling and other "green policies" at the household level.

The impure-public-good assumption is supported by our survey results showing that both ethics (i.e., "an ethical duty to help the environment") and the potential generation of income (through the sale of recyclable material to governmental or private entities) motivate many of the sampled households to recycle. These two motivations suggest that households are indeed motivated by what Andreoni has labeled the "egoistic" component of preferences. The "altruistic" component of preferences is then represented by the potential for households to at least partially internalize the effect of their private recycling effort on the community's aggregate amount of recycling.[8]

WTP for curbside recycling is ultimately derived by subtracting the household's minimum expenditure given that it participates in the CRP from its minimum expenditure given that it does not. In other words, WTP_i is defined by the amount of income household *i* would willingly forego so as to participate in a CRP and maintain its original (pre-CRP) utility level. The household's WTP for curbside recycling may be negative if the disutility of foregone leisure is sufficiently large relative to the utility gained from recycling.

The community planner is responsible for managing municipal solid waste G by (i) selecting a type of CRP indexed by $j \in \{N,M,V\}$, where N, M and V refer to no, mandatory and voluntary curbside recycling respectively; and (ii) selecting the household curbside recycling fee, τ. The planner is assumed to face a balanced-budget constraint[9]

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[8] For an alternative interpretation of altruism and its effect on the efficient distribution of public goods, see Bergstrom [1982], Jones-Lee [1991,1992], and Flores [2002].

[9] We recognize that economic efficiency requires that households be serviced up to the point where price equals marginal, rather than average, costs. We have chosen to focus on balance-budget pricing, however, for two reasons. First, municipal CRPs are commonly expected to be self-sustaining and thus not dip continuously into general tax revenues to cover costs (based on our own personal interviews of community recycling coordinators and private contractors for this study). Note that for mandatory programs, where all households are required to pay for the service, the CRP fee is simply a de facto form of lump-sum taxation and the natural fee is the one causing revenues to just match total costs. Second, we observe several communities without mandated recycling goals choosing mandatory CRPs. Since we know there are households with WTP less than marginal costs, this suggests an

$$n_j \tau = C(n_j, j) \quad (1)$$

where n_j represents the number of participants for CRP type *j* and C is the total economic cost of providing curbside recycling. The number of participants are $n_N = 0$, $n_M = n$, and $n_V = n^*$, where *n* is the number of households participating in the mandatory CRP and n* is defined by the number of households that satisfy $WTP_i \geq \tau$ under a voluntary program. C includes both explicit fixed and variable components, as well as the implicit costs associated with the foregone use of resources allocated toward a CRP (further discussion of these costs is provided in the next section). Based on interviews with community recycling coordinators and private contractors (discussed further in Section 3), we also assume that marginal cost (MC) is positive and constant across n_j. Thus, average total cost (ATC) is asymptotically coincident with MC.

The community planner then uses this benefit and cost information, along with budget-balance condition (1), to simultaneously determine whether to establish a CRP, and if so, which type and at what fee level. We begin by stating the condition required for the community planner to offer a CRP of either type M or V.

<u>CRP Condition I</u>. Given (1) and WTP_i, the community planner will offer a CRP of either type M or V, if and only if $\sum_{i=1}^{n} WTP_i \geq C(n, M) \Rightarrow \overline{WTP}^M \geq ATC(n, M)$ or $\sum_{i=1}^{n^*} WTP_i \geq C(n^*, V) \Rightarrow \overline{WTP}^V \geq ATC(n^*, V)$, where $\overline{WTP}^M$ and $\overline{WTP}^V$ denote the mean WTP for mandatory and voluntary communities, respectively.

objective other than economic efficiency (e.g., a balanced-budget criterion). Nevertheless, implementing a mandatory program in cases where the average household's net benefit is positive is suggestive of a potential Pareto improvement (with appropriate inter-household transfers), while implementing a voluntary program suggests an actual Pareto improvement. We thank an anonymous reviewer for this last observation.

In other words, the community planner will offer a CRP of either type M or V if the mean WTP exceeds the ATC (evaluated at the number of participating households) for that program type. Figure 1 depicts the geometry for CRP Condition I. The aggregate marginal surplus (AMS) curve, drawn linear for simplification, depicts the change in aggregate WTP as the number of households increases, beginning with the household with the largest WTP and ending with the household whose WTP is lowest.

The household fee for the voluntary program, τ_V, is determined by budget balance at the intersection between the AMS and ATC curves, which also determines the number of participating households, n*, and the total net community surplus, area A. In this case, the voluntary program passes CRP Condition I. A mandatory program charges a household fee of τ_M, which by the budget-balance condition is consistent with *n* participating households. The mandatory program also passes CRP Condition I if area A+B+C exceeds area F+G +H. Conversely, both voluntary and mandatory programs would fail CRP Condition I if, for example, the AMS curve lied everywhere beneath the ATC curve. In this case, no τ could be found to satisfy (1), and thus a CRP of neither type would be offered.

If CRP Condition I is satisfied, the community planner then determines which type of program to offer. The following condition gives the condition required for choosing a voluntary or mandatory CRP.

<u>CRP Condition II</u>. Assume CRP Condition I is satisfied. The community planner chooses a voluntary (mandatory) CRP if $\overline{\text{WTP}}^{\text{V}} - \text{ATC}(n^*, \text{V})$ is greater (less) than $\overline{\text{WTP}}^{\text{M}} - \text{ATC}(n, \text{M})$ with corresponding household fee τ_V (τ_M) satisfying (1).

In other words, a voluntary program is chosen over a mandatory program whenever the household fees and participation levels for the two programs are such that the net community surplus from the voluntary program is greater than that from the mandatory program.

Figure 1 also depicts the geometry for CRP Condition II. Moving from a voluntary to a mandatory CRP, n* households obtain a net-surplus increase of area B, while n – n* households obtain a net-surplus change of area C – F – G – H. Therefore, if area B + C – F – G – H > 0, a mandatory program is chosen under CRP Condition II with fee τ_M; otherwise a voluntary program is chosen with fee τ_V. As shown in Figure 1, the probability that a voluntary CRP is chosen increases, all else equal, as the ATC curve becomes flatter. A flatter ATC curve, in turn, is consistent with a relatively low fixed-to-variable cost ratio. Alternatively, mandatory CRPs have a greater probability of being chosen at higher fixed-to-variable cost ratios.

In closing, our joint household-community planner model makes clear predictions about the social efficiency of various recycling options and enables us to predict which types of recycling programs should be observed in the different communities in our sample. Before making these predictions, however, we first introduce the data sources used to estimate the costs and benefits of the various CRPs sampled from our population.

3. Cost and Benefit Data

3.1. Cost Data

Our CRP cost data was obtained from two sources: (i) interviews with community recycling coordinators and private contractors located in our study area (discussed further in Section 3.2), and (ii) published studies by the Institute for Local Self-Reliance (ILSR) [1991] and Franklin Associates, Ltd [1997]. The ILSR study provides detailed cost information for Seattle, WA and

West Linn, OR, while the Franklin Associates study provides information for Olathe, KS. From the recycling coordinators and private contractors, we obtained cost information for eight cities – seven communities in our sample and Portland, OR.[10] This information is shown in Table 1.

The costs are based on explicit fixed and variable expenses for collection and processing incurred during the most recent year available. They are reported on a per-household per-month basis in order to be directly comparable with our benefit information.[11] The costs have also been adjusted for cost-of-living differences across communities [MSN, 2003], and in the case of Seattle, West Linn, and Olathe appropriate adjustments for inflation have been made using the consumer price index [Bureau of Labor Statistics, 2003]. In addition to the CRP costs, Table 1 also includes information on the number of participating households per year, percentage of the community's population participating, as well as indicators for whether the CRP is mandatory and whether household sorting of recyclables is required.

Several observations can be made from the information provided in Table 1. To begin, the estimated mean monthly cost per household across the eleven communities equals $2.93, with a coefficient of variation of 33 percent, implying a fairly tight distribution of cost estimates around the mean. Second, because each CRP in our sample is different in terms of items collected, collection frequency, whether it is a mandatory or voluntary program, degree of sorting required, etc., we are unable to identify a single underlying ATC curve. As a result, the numbers from Table 1 likely represent distinct points along several different ATC curves, rather than points

[10] Cost information was unavailable for many of our sampled communities because it does not exist, cannot be extracted from overall waste-disposal cost information, or is proprietary.

[11] Costs are reported as an average cost over the lifetime of the program. This reflects the fact that recycling coordinators and contractors are generally required to report on an annual basis and that CRPs are generally associated with relatively long planning horizons (e.g., 10-20 years) over which up-front capital costs are spread. As a result, we do not attempt to calculate net present value estimates based on the specific periods in which the costs are incurred. Rather, we presume that the monthly cost estimates provided by the recycling coordinators accurately reflect what a community can expect to incur during any given month of any given year.

along a single curve. Lastly, there seems to be a weak relationship between costs and whether the CRP is mandatory or voluntary. Five of the six least-costly CRPs are voluntary. This cost differential is apparently due to unobservable cost efficiencies rather than economies-of-scale effects.[12]

3.2. Survey Data and Design

Turning to the benefit data, we conducted a random-digit dialed telephone survey regarding recycling behavior during the winter of 2002 to over 4,000 households in 40 western U.S. cities with populations over 50,000.[13] We chose an approximately even three-way split between communities with a voluntary, a mandatory and no CRP. We purposefully over-sampled households in communities with voluntary CRPs to allow for the detection of any hypothetical bias in the data. To supplement the household data, we also conducted a telephone survey of the recycling coordinators (i.e., the public and private officials responsible for recycling services) in each of the 40 cities in order to provide specific information on the attributes and history of recycling in their respective communities.

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[12] Unobservable cost efficiencies may be related to the facts that (i) Seattle and West Linn were included in the ILSR [1991] study of the nation's most efficient CRPs, and (ii) recycling coordinators for the cities of Tempe, Fargo, Orem, and Portland were able to provide relatively detailed information about their respective programs. These facts suggest that these six programs may be more efficiently managed than the average program in our sample.

[13] Due to budget limitations, our population does not include the eastern U.S. The survey was administered by the survey research laboratory at Washington State University. The response and cooperation rates were 27 percent and 49 percent, respectively. The survey instrument, a list of the 40 cities in our sample, and information on the calculation of the response and cooperation rates are available at www.uwyo.edu/aadland/research/recycle/datareport.pdf.

4. Econometric Methodology and WTP Estimates

In this section, we discuss (i) the double-bounded dichotomous-choice (DBDC) model used to obtain our welfare estimates, (ii) the estimation results for overall WTP, (iii) the identification and estimation of hypothetical bias across the different program types (i.e., M, V, and N), and (iv) the calibration of the mean WTP estimates for a select group of cities.

4.1. Econometric Model

Our econometric approach follows Cameron and James [1987]. WTP questions are set in the DBDC format to elicit a household's WTP through a sequence of dichotomous-choice questions.[14] The first question is: "Would you be willing to pay \$ν for the service?" The opening bid ν is chosen randomly from a set of predetermined values.[15] Based on her response to the opening bid, the respondent is then asked a similar follow-up question, but with a larger bid value, 2ν, if she answered "yes" (i.e., she is willing to pay at least ν for the service) or a smaller bid, 0.5ν, if she answered "no" (i.e., she is unwilling to pay ν for the service).

Based on the responses to the opening bid and follow-up questions, the respondent's latent WTP may be placed in one of four regions: $(-\infty, 0.5\nu)$, $(0.5\nu, \nu)$, $(\nu, 2\nu)$ or $(2\nu, \infty)$. Unlike other CVM studies, we follow up with a third valuation question for those who respond "no" to the first two valuation questions: "Would you be willing to use the service if it were free of charge?" Previous experience with household recycling surveys suggests that some households have negative WTP values, or in other words need to be paid to participate in a CRP [Haab and

[14] The issue of optimal bid design is beyond the scope of this paper. For further discussion on bid design see Kanninen [1995] and Cameron, et al. [2002].

[15] The opening bids are chosen with equal probabilities from the set of integers two through 10. This set encompasses the range of household fees charged by the communities in our sample. As with the CRP cost data, the bids are adjusted so that our estimates of social net benefits accurately reflect real differences in cost-of-living across the communities in our sample.

McConnell, 1997; Aadland and Caplan, 2003]. As a result, our survey generates five rather than four valuation regions with (-∞,0.5ν) being replaced by (-∞, 0) and (0, 0.5ν).[16]

Households currently participating in their community's CRP were asked to value their existing program, while those households located in a community without a CRP were described the following hypothetical program,[17]

> "*……please imagine that you could have a curbside-recycling service that regularly collects aluminum cans, cardboard, glass, paper, plastic, and tin cans. Your household would/would not need to sort your recyclables into separate bins and would be required to pay a fee for the recycling service, in addition to your current monthly garbage collection fee. Now we are going to ask you some questions about your household's willingness to pay for this type of curbside recycling service.*"

This description was developed with input from the recycling coordinators. According to the coordinators, the primary factor distinguishing one CRP from another at the household level is the degree to which the household is required to sort its recyclable material, not the specific materials which are ultimately collected. By varying this description randomly across households – based on whether the household "would" or "would not" need to sort their recyclables – we are therefore able to make direct comparisons between WTP responses elicited for this hypothetical CRP and responses elicited for existing voluntary and mandatory CRPs. These responses, in turn, enable us to measure the magnitude of hypothetical bias in WTP estimates (discussed at length in Section 4.3).[18]

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[16] Some respondents answered "Don't Know" to one or more of the valuation questions. For these households, their unknown WTP does not fit into one of the five categories, but instead overlaps one or more of the intervals. For example, if a respondent answered "Don't Know" to whether they would be willing to pay $ν and "Yes" to whether they would be willing to pay $0.5ν, we assume that their unknown WTP falls in the region (0.5ν, ∞). The likelihood function is adjusted accordingly.

[17] Households located in communities with an existing CRP, and who know that the CRP exists, but who have chosen not to participate in the program were asked to value their community's existing program. Households located in communities with an existing CRP, but who are unaware that the program exists, were asked to value the hypothetical program described in quotations below.

[18] For further information on our survey design see Aadland and Caplan [2005]. A copy of the survey instrument is available at www.uwyo.edu/aadland/research/recycle.

Turning to our econometric model, we specify a reduced-form version of WTP_i, where the vector of explanatory variables $\mathbf{X}_i$ includes a host of household- and community-specific characteristics. A normally distributed random error term ε_i is added to capture the portion of WTP_i unexplained by $\mathbf{X}_i$, implying

$$WTP_i = \mathbf{X}_i\boldsymbol{\beta} + \varepsilon_i, \qquad (2)$$

where $\boldsymbol{\beta}$ is a vector of coefficients. The variance of the error terms is assumed to follow

$$\sigma_i^2 = \exp(\mathbf{Z}_i\boldsymbol{\gamma}), \qquad (3)$$

where $\mathbf{Z}_i$ is a vector of variables and $\boldsymbol{\gamma}$ is a vector of parameters. Using (2) and (3), we then form and maximize the log likelihood function (see Aadland and Caplan [2003] for additional details on the specification of the probabilities and likelihood function). The definitions of the explanatory variables used in equations (2) and (3), along with their sample means, are provided in Table 2.

4.2. Econometric Results

In columns two and three of Table 3, we report our DBDC estimates across all (N = 4012) households in our sample. First, note that the estimated WTP, averaged across cities, is $5.61 per month.[19] This estimate is larger than those reported in Aadland and Caplan [1999] and Tiller et al. [1997]; approximately the same as in Lake et al. [1996], Caplan and Grijalva [2003], and

[19]We have also tested for possible incentive incompatibility and starting-point bias using an approach originally suggested by Whitehead [2002] and later modified by Aadland and Caplan [2004]. We find evidence of starting-point bias but no incentive incompatibility. The mean WTP estimates for the two models (one controlling for starting-point bias and incentive incompatibility and one not) are very similar. As a result, we report the results from the latter model. The results from the former model are available from the authors upon request.

Caplan et al. [2003]; but smaller than those in Aadland and Caplan [2003], Kinnaman [2000], and Jakus et al. [1996].[20]

Second, we find several individual- and community-specific characteristics that are significantly related to WTP for curbside recycling. To highlight a few, those willing to pay the most are (a) young; (b) female; (c) highly educated; (d) motivated to recycle because of an ethical duty to help the environment; (e) members of an environmental organization; and (f) rated their current CRP as good or excellent. Many of these effects are similar to those found in the previously cited literature. The likelihood ratio test indicates that a significant amount of the variation in WTP being explained by household, community, and program attributes.

Third, we test for heteroscedasticity using (3). By construction of the bid design, BID is systematically related to the variance of the latent WTP errors. Recall that the opening bids are even integers between two and 10, with subsequent bids equal to either half or twice the opening amount. Therefore, the bid design generates larger WTP intervals (and thus more uncertainty regarding the true WTP) for higher opening bids. As expected, the coefficient on BID is positive and statistically significant at the 1 percent level.

4.3. Calibrating WTP for Hypothetical Bias

The potential for hypothetical bias arises whenever people are asked to provide a maximum amount they are willing to pay for a good or service, even though they will not have to actually pay for it [e.g., Hanemann, 1994; Diamond and Hausman, 1994]. We estimate the magnitude of the bias in each of our community types – voluntary, mandatory and no CRP – and calibrate the mean WTP estimates accordingly. In CVM it is typically not possible to estimate the magnitude

[20] Tiller et al. [1997] and Jakus et al. [1996] are concerned with dropoff (as opposed to curbside) recycling programs.

of hypothetical bias because the good under question is not typically traded in an established market. Even if the good is traded in an established market, one needs sufficient variation in the price of both the hypothetical and actual goods. With this in mind, our experiment was designed to include two different groups (one making stated decisions and the other making revealed decisions) and price variation across both hypothetical and actual CRPs. This feature of our data enables us to estimate the magnitude of hypothetical bias for each of our community types. We begin with voluntary CRP communities.

4.3.1. Estimating Hypothetical Bias: Communities with Voluntary CRPs

We first extract two non-overlapping subsamples of households from the dataset: (i) households residing in communities with voluntary CRPs that made a *hypothetical* decision about whether to participate in their existing CRP at a randomly assigned initial bid and (ii) households residing in communities with voluntary CRPs that have made an *actual* decision about whether to participate in their existing CRP. Households in the second subsample (N = 538) have revealed their preferences for curbside recycling, while households in the first subsample (N = 630) are simply stating their preferences for curbside recycling. The subsample of stated-preference households was restricted to those whose initial (cost-of-living adjusted) bids were between $1.30 and $4.94 per month in order to be directly comparable with the existing fees faced by the revealed-preference households.

Next, we pool these two groups together and estimate a probit model for the decision of whether to participate in a voluntary CRP, controlling for a host of household, program, and community attributes. We also allow the error variances to differ according to whether households are stating or revealing their preferences [Adamowicz et al., 1994]. Our null hypothesis of no hypothetical bias is tested by observing the statistical significance of the coefficient on the dummy variable for whether the participation decision is hypothetical or real. If this coefficient is positive and statistically significant, we conclude that the typical household in a community with a voluntary CRP will, all else equal, tend to overstate their WTP for curbside recycling by the value of the coefficient. The estimation results for this model, shown in columns four and five of Table 3, indicate that hypothetical bias for households in voluntary CRP communities is $2.30 per month.[21]

4.3.2. Estimating Hypothetical Bias: Communities with a Mandatory or No CRP

Next, we estimate hypothetical bias for households residing in communities with either a mandatory or no CRP, using methods similar to those described above. In this case, the revealed-preference group includes all households residing in voluntary CRP communities with existing (cost-of-living-adjusted) fees between $1.30 and $4.94 per month and that are aware of the program's existence, irrespective of the initial bid that they received (N = 994).[22]

There are two stated-preference groups in this case – those making hypothetical decisions about their mandatory CRP (N = 332) and those in communities without a CRP who are deciding about a hypothetical CRP described in the survey (N = 788). We then pool all three groups – the revealed-preference voluntary CRP group, the mandatory CRP group, and the hypothetical CRP group – and estimate a probit model to predict whether a household participates in a CRP. As before, we control for a wide variety of household, program and community attributes, and we allow error variances to differ by CRP type and whether the households are stating or revealing

[21] For more details about this method of detecting and estimating the magnitude of hypothetical bias see Aadland and Caplan [2005].

their preferences. Two variables of most interest are the binary ones for whether the stated-preference households are located in a community with either a mandatory or no CRP. If the coefficients on these dummy variables are positive and statistically significant, we interpret this as evidence of positive hypothetical bias. In other words, when faced with the decision of whether to sign up for a CRP, all else equal, households located in a mandatory or no CRP community that are making a hypothetical decision are more likely to do so (and consequently have a higher latent WTP) than those making an actual decision.

The results from this experiment, shown in columns six and seven of Table 3, indicate that hypothetical bias among households in mandatory and no CRP communities is $2.72 and $2.96 per month, respectively. As anticipated, the bias estimate for the typical household in a mandatory CRP community is lower (albeit slightly) than that for the no-CRP community, and both of these estimates are higher than that for the typical household in a voluntary CRP community. This ordering suggests that the experience associated with voluntarily signing up for and/or using a CRP enables households to more accurately determine their true WTP.

4.3.3. Calibrated WTP

Using the hypothetical bias estimates from the previous two sections, we can adjust the mean WTP estimates, conditional on whether the household resides in a voluntary, mandatory, or no CRP community. Also, using city-level U.S. Census Bureau data [2000] we are able to adjust the estimates to better represent population demographics. Making adjustments for hypothetical bias and sampling error, we find that the average calibrated WTP value across the 40 communities in our sample is $2.97 (see bottom of Table 3). Table 4 provides additional details

[22] We estimate hypothetical bias for the mandatory and no CRP households separately from the bias in the voluntary CRP households because the revealed-preference group in this section is larger than that in Section 4.3.1.

on the calibration process for the nine cities in our sample with available cost data and three randomly selected non-CRP cities. In terms of estimated WTP, these 12 cities are representative of our sample of 40 cities and highlight the diversity across communities. It is interesting to note that the estimated average monthly benefits per household from curbside recycling range from a high of over $5 in Tempe, AZ to a low of $1.40 in Newport Beach, CA.

5. Policy Analysis and Conclusions

Remarkably, by comparing our mean calibrated WTP and cost estimates, we conclude that the social net benefit of curbside recycling is almost exactly zero. As a result, to determine whether it is an efficient use of society's resources, we need to evaluate curbside recycling on a city-by-city basis.

In Table 5, we take a closer look at the 12 communities included in Table 4. Calibrated WTP values from Table 4 and per-household costs from Table 1 are provided in columns 2 and 3. Column 4 presents the corresponding social net benefits of curbside recycling, which vary greatly across the 12 communities. For example, monthly net benefits in Tempe, AZ are $3.50 per household, while in Palo Alto, CA they are -$2.85. At their current populations and rates of CRP participation, this amounts to an annualized net benefit gain of $1.5 million in Tempe and an annualized net benefit loss in Palo Alto of $1.0 million.

To shed some light on the variation in community net benefits noted above, we dig deeper into the two communities located on opposite ends of the net-benefit spectrum – Tempe, AZ (high end) and Palo Alto, CA (low end). As indicated by the information contained in columns two and three of Table 5, the net-benefit difference between these two communities is due to differences in both the costs and benefits of curbside recycling. On the benefits side, Tempe has a nearly $3 higher adjusted benefit per household than Palo Alto. The majority of this difference is unexplained variation captured by our city dummy variable, while the remainder appears to be due to the fact that, all else equal, Tempe has a younger population, higher employment rate, and respondents were less likely to give refusals on the first call attempt.[23]

Although we can only conjecture on what may be driving the unexplained difference in WTP across the two communities, one possibility is the residents' perceptions regarding landfill constraints. For example, Tempe is more actively informing residents of landfill issues than is Palo Alto. The Tempe Public Works Department (2006) writes on their website: "One thing is certain, in the next few years Tempe's residents and businesses will need to get involved in recycling if we are to solve the municipal solid waste problem." This, in turn, could help to raise the value of alternatives to landfilling waste (such as curbside or dropoff recycling) for the typical Tempe resident.[24]

On the cost side, Palo Alto's CRP costs approximately $3.50 more per household to operate than Tempe's program. The higher costs for Palo Alto appear to be driven by additional labor expense (due to the use of multiple bins rather than a single, automated co-mingled container) and relatively weaker enforcement of recycling standards (which may ultimately impact the quality of the recyclables collected). The problem with additional labor expense was noted by Brown, Vence, and Associates, Inc.(2001) in their final report to the Palo Alto Public Works Department, which suggested that the city's recycling collection process was inefficient (pages 2-9 and 2-10). Palo Alto subsequently switched from separate bin collection to their current co-mingled system, shortly after we completed our survey in the winter of 2002. To the contrary,

[23] The community dummy variables for Tempe and Palo Alto (not shown in Table 3) account for $2.15, or more than two-thirds of the total difference in WTP across these two cities.

Tempe's decade-old approach of dividing the collection and processing components of its co-mingled system between the city and a private company appears to have significantly reduced the costs associated with both components.

The last two columns of Table 5 compare existing CRPs with our theoretical/empirical predictions. The column entitled "CRP Predictions" shows that five of the 12 communities satisfy CRP Condition I (i.e., social net benefits of curbside recycling are positive). Of these five, two communities have mandatory CRPs (Tempe, AZ and Longmont, CO), while the remaining three have voluntary CRPs. CRP Condition II predicts that Tempe and Longmont may have mandatory CRPs because of high fixed-to-variable cost ratios (relative to Orem, Wichita and Fargo). Unfortunately, we cannot test this hypothesis since we were unable to obtain a breakdown of the fixed and variable cost information from the recycling coordinators in Tempe and Longmont.

Of the seven communities that we predict should not have a CRP, three (Abilene, Peoria and Inglewood) represent correct predictions and four (Escondido, Olathe, Newport Beach and Palo Alto) do not. The most probable explanation for why Escondido, Newport Beach, and Palo Alto have chosen mandatory CRPs (when our estimates suggest that their social net benefits are clearly negative) is that California has implemented a state-mandated recycling quota. Which naturally provokes the question: In the 20 or so states that have passed laws establishing mandatory recycling programs or quotas, how many communities are motivated by the recycling targets themselves rather than by locally-based economic rationalizations?

In sum, using our theoretical model and estimates of net social benefits, we have correctly predicted the choice of whether or not to implement a CRP for 8 of the 12 selected communities.

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[24] The recycling websites for Tempe and Palo Alto are www.tempe.gov/publicworks/fspage/curbside/crecycling.htm and www.cityofpaloalto.org/public-works/rec-index.html, respectively.

Furthermore, if Escondido, Newport Beach, and Palo Alto have in fact chosen mandatory CRPs in order to meet a state-mandated recycling quota, then we can explain all but one community's (Olathe, KS) choice of whether or not to provide a CRP.

Next, we highlight the main shortcomings of our approach. On the one hand, our mean WTP estimates may understate the social benefit of recycling if survey respondents are not fully internalizing the public benefits associated with recycling. As mentioned in Section 2, we have assumed that households are "impurely altruistic", in the sense that although they are motivated to recycle out of an "ethical responsibility to help the environment," they may not be fully internalizing the effects of their recycling effort on the welfare of other households located in their community. To the extent that each household values increased aggregate recycling, this may cause us to understate the social net benefit of recycling.

On the other hand, it is possible that we may be overstating the net benefits of curbside recycling. The issue of how to account for implicit opportunity costs through discounting is hotly debated [Hanley and Spash, 1993]. We have tacitly assumed that the opportunity cost associated with diverting resources toward curbside recycling is the foregone interest income at the market interest rate, which in turn is assumed to equal the social discount rate. As a result, discounting completely offsets any accumulated opportunity costs. To the degree that the market interest rate (or rate of return on the next best alternative) exceeds the social discount rate, the social net benefit of recycling will be overstated.

In sum, despite the shortcomings mentioned above, this is the most comprehensive study to-date of the social efficiency of curbside recycling. The study covers approximately 20 western U.S. states, surveying over 4,000 households and recycling coordinators in 40 different communities. The benefit measure generated from the household survey is carefully calibrated for hypothetical bias by contrasting with the actual decisions of households residing in communities with voluntary CRPs. The economic cost of providing curbside recycling services is estimated from direct interviews with the recycling coordinators from cities within our sample and from previous research compiled by the U.S. EPA and ISLR. Remarkably, we find that, on average, the benefits and costs per household are almost exactly identical.

Although this finding lends scientific credibility to an often contentious national recycling debate, it does little to guide national opinion regarding the efficiency of municipal recycling programs. At a local level, however, our research suggests that the public policy choices are often much more clear. Cities with significantly positive net social benefits should be supporting curbside recycling programs while cities with significantly negative net social benefits should consider other waste management options. Toward that end, our research provides local policymakers within our population of western U.S. states the additional tools necessary to decide whether to implement or maintain a CRP. Local policymakers can obtain WTP estimates for their respective communities by substituting community and socio-demographic characteristics into the right-hand-side of our econometric equation (i.e., equation (2)). Or, they might consider conducting their own surveys, in which case our survey design and econometric analysis might serve as a useful benchmark. Finally, regardless of how they estimate the benefits associated with curbside recycling, policymakers in communities with existing CRPs should maintain detailed cost information for their programs, preferably disaggregated from general refuse funds, as is currently done in the cities of Portland, OR and Seattle, WA.

A natural next step would be to extend our research to the eastern U.S. where the constraints on landfill space are more binding, and to obtain more precise CRP cost data across a wider variety of communities. To accomplish this, more case studies of existing CRPs are required (along the lines of ILSR, 1991; U.S. EPA, 1994; Hanley and Slark, 1994; SWANA, 1995; Franklin Associates, Ltd., 1997; and Kinnaman, 2000). This would enable us to more accurately estimate the marginal and average costs of providing curbside recycling and to identify programs that are the most cost effective.

References

Aadland, D. & Caplan, A.J. (1999). Household valuation of curbside recycling. Journal of Environmental Planning and Management, 42(6), 781–99.

Aadland, D. & Caplan, A.J. (2003). Willingness to pay for curbside recycling with detection and mitigation of hypothetical bias. American Journal of Agricultural Economics, 85(2), 492–502.

Aadland, D. & Caplan, A.J. (2004). Incentive incompatibility and starting-point bias in iterative valuation questions: Comment. Land Economics, 80(2), 312–315.

Aadland, D. & Caplan, A.J. (in press). Cheap talk revisited: New evidence from CVM. Journal of Economic Behavior and Organization.

Adamowicz, W., Louviere, J., & Williams, M. (1994). Combining revealed and stated preference methods for valuing environmental amenities. Journal of Environmental Economics and Management, 26(3), 271–292.

Andreoni, J. (1990). Impure altruism and donations to public goods: A theory of warm glow giving? Economic Journal, 100(401), 464–477.

Bergstrom, T. C. (1982). When is a man's life worth more than his human capital? In: Jones-Lee, M.W. (Ed.), The value of life and safety: Proceedings from a conference held by the Geneva Association (pp. 3-25). Amsterdam: North Holland Press.

Brovsky, C. & Larson, M. (2003, April 18). City may trash its recycling by July. Denver Post. Retrieved September 5, 2003, from http://www.denverpost.com/Stories/0,1413,36-53~1333448,00.html

Brown, Vence and Associates, Inc. (2001, September). Refuse fund cost of survey study: Final report to the city of Palo Alto Public Works Department. San Francisco: Author.

Bureau of Labor Statistics. (2003). Retrieved October 10, 2003, from http://www.bls.gov

Cameron, T.A. & James, M.D. (1987). Efficient estimation methods for 'close ended' contingent valuation surveys. Review of Economics and Statistics, 69, 269–76.

Cameron, T.A. (1992). Combining contingent valuation and travel cost data for the valuation of nonmarket goods. Land Economics, 68(3), 302–17.

Cameron, T.A., Poe, G.L., Ethier, R.G., & Schulze, W.D. (2002). Alternative non-market value-elicitation methods: Are the underlying preferences the same? Journal of Environmental Economics and Management, 44, 391–425.

Caplan, A.J., Grijalva, T. & Jakus,P. (2002). Waste not or want not? A contingent ranking analysis of curbside waste disposal options. Ecological Economics, 43, 185−197.

Caplan, A.J. & Grijalva, T. (2003). Household experience and valuation of a pilot curbside recycling program. Economic Research Institute Working Paper 2002-21, Utah State University.

Cummings, R.G., & Taylor, L.O. (1999). Unbiased value estimates for environmental goods: A cheap talk design for the contingent valuation method. American Economic Review, 89(3), 649−66.

Diamond, P.A. & Hausman, J.A. (1994). Contingent valuation: Is some number better than none? Journal of Economic Perspectives, 8(4), 45−64.

Flores, N.E. (2002). Non-paternalistic altruism and welfare economics. Journal of Public Economics, 83, 293−305.

Franklin Associates, Ltd. (1997, September). Solid waste management at the crossroads. Kansas City: Author.

Fullerton, D. & Wu,W. (1998). Policies for green design. Journal of Environmental Economics and Management, 36, 131−148.

Greene, W.H. (2000) Econometric analysis, 4th ed. Upper Saddle River, NJ: Prentice Hall.

Haab, T.C. & McConnell, K.E. (1997). Referendum models and negative willingness to pay: Alternative solutions. Journal of Environmental Economics and Management, 32, 251−70.

Hanley, N. & Spash, C.L. (1993). Cost-benefit analysis and the environment. United Kingdom: Edward Elgar Publishing.

Hanley, N. & Slark, R. (1994). Cost-benefit analysis of paper recycling: A case study and some general principles. Journal of Environmental Planning and Management, 37(2), 189−197.

Hanemann, W.M. (1994). Valuing the environment through contingent valuation. Journal of Economic Perspectives, 8(4), 19−43.

Huang, J.-C., Haab, T.C. & Whitehead, J.C. (1997). Willingness to pay for quality improvements: Should revealed and stated preference data be combined*?* Journal of Environmental Economics and Management, 34, 240−55.

Institute for Local Self-Reliance. (1991). Beyond 40 percent: Record-setting recycling and composting programs. Washington, D.C.: Island Press.

Jakus, P.M., Tiller, K.H. & Park, W.M. (1996). Generation of recyclables by rural households. Journal of Agricultural and Resource Economics, 21(1), 96–108.

Johnson, K. (2002, March 12). Is recycling's future behind it? New York Times. The Metro Section, pp. B1 and B4.

Jones-Lee, M.W. (1991). Altruism and the value of other people's safety. Journal of Risk and Uncertainty, 4, 213–219.

Jones-Lee, M.W. (1992). Paternalistic altruism and the value of statistical life. The Economic Journal, 102(410), 80–90.

Kanninen, B.J. (1995). Bias in discrete response contingent valuation. Journal of Environmental Economics and Management, 28, 114–125.

Kaufman, S.M., Goldstein, N., Millrath, K., & Themelis, N.J. (2004). The state of garbage in america. Biocycle, 45(1), 31–41.

Kinnaman, T. & Fullerton, D. (2000) Garbage and recycling with endogenous local policy. Journal of Urban Economics, 48, 419–442.

Kinnaman, T. (2000). Explaining the growth in municipal recycling programs: The role of market and nonmarket factors. Public Works Management and Policy, 5(1), 37–51.

Lake, I.R., Bateman, I.J. & Parfitt, J.P. (1996). Assessing a kerbside recycling scheme: A quantitative and willingness to pay case study. Journal of Environmental Economics and Management, 46, 239–54.

Li, C.-Z., & Mattsson, L. (1995). Discrete choice under preference uncertainty: An improved structural model for contingent valuation. Journal of Environmental Economics and Management, 28, 256–69.

MSN House and Home Compare Cities. (2003). Retrieved January 11, 2003, from http://houseandhome.msn.com

Seibert, T. (2002, September 1). Recycling programs may be headed for scrap heap. Denver Post. Denver Post. Retrieved November 3, 2003, from http://www.denverpost.com/Stories/0,1526,42-67~146789,00.html

Solid Waste Association of North America (SWANA). (1995). Integrated municipal solid waste management: Six case studies of system costs and energy use. Washington, DC: Author.

Tiller, K.H., Jakus, P.M., & Park, W.M. (1997). Household willingness to pay for dropoff recycling. Journal of Agricultural and Resource Economics, 22(2), 310–320.

Urbina, I. (2004, September 14). Mayor recommits to recycling with an ambitious 20-year pact. The New York Times. Retrieved July 22, from http://query.nytimes.com/gst/abstract.html?res=F10A15FE3A

Unitied States Environmental Protection Agency. (1992). Recycle – you can make a ton of difference. EPA 530-F-92-003. Washington, DC: Author.

United States Environmental Protection Agency. (1994). Waste prevention, recycling, and composting options: Lessons from 30 communities. EPA530-R-92-015. Washington, DC: Author.

Whitehead, J.C., Haab, T.C. & Huang, J.-C. (2000). Measuring recreation benefits of quality improvements with revealed and stated behavior data. Resource and Energy Economics, 22, 339–54.

Whitehead, J.C. (2002). Incentive incompatibility and starting-point bias in iterative valuation questions. Land Economics, 78(2), 285–297.

Figure 1. CRP Conditions I and II.

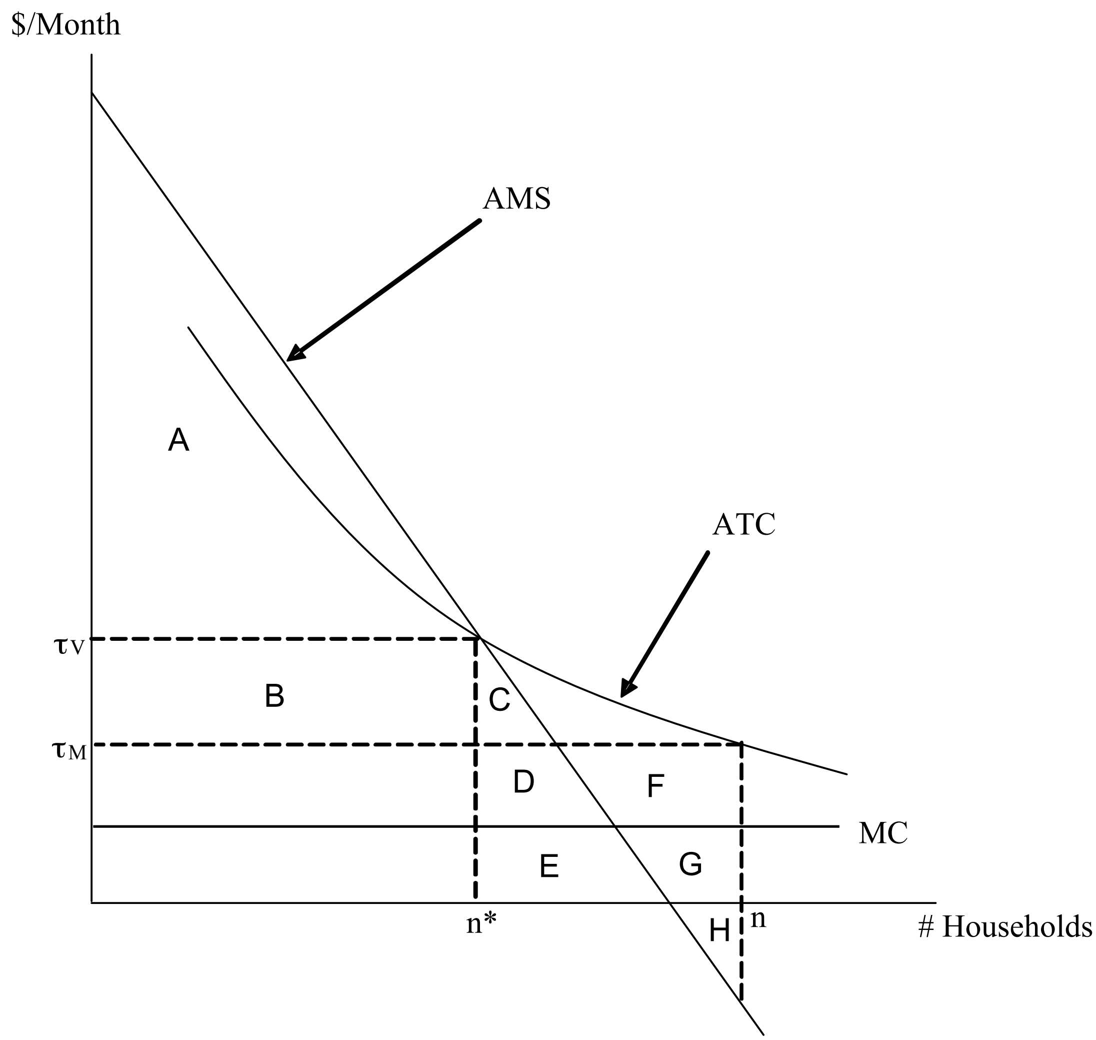

Table 1. Costs per Household and Other Characteristics for CRPs

City	Cost ($) per Household per Month	Number of Households Participating	Percent of Households Participating[h]	Mandatory Program?	Household Sorting Required?
Tempe, AZ	1.62	38,000	60	Yes	No
Seattle, WA[e]	1.71	113,484	44	No	No[f]
West Linn, OR[e]	2.21	4,956	61	No	Yes
Fargo, ND	2.68	1,452	4	No	Yes
Orem, UT	2.78[b]	5,400	23	No	No
Portland, OR[c]	2.89	139,431	62	Yes	Yes
Longmont, CO	3.03[g]	22,950	86	Yes	No
Escondido, CA	3.16[b]	NA	NA	Yes	No
Newport Beach, CA	3.42	27,700	84	Yes	No
Olathe, KS[a]	3.58[b]	30,000	93	No	Yes
Palo Alto, CA	5.10[d]	25,216	100	Yes	Yes
Mean	2.93	40,859	61.7	---	---
Coefficient of Var.	0.33	1.15	0.50	---	---

Notes. [a]Based on figures provided by Franklin Associates, Ltd., "Solid Waste Management at the Crossroads," December 1997. [b]Since the revenues from the sale of recyclable materials were unavailable, we used the average revenue (adjusted for location) across communities that reported revenue sales. This amounted to $0.44 per household per month. [c]Based on figures provided by Neal Johnson, Recycling Coordinator, December 2002. [d]Includes once-a-month curbside collection of household hazardous waste and green waste. [e]Based on figures provided by ILSR [1991]. [f]Approximately 56 percent of households (those located in the "north section" of the city) participate a commingled program, while the remaining 44 percent (located in the "south section") participate in a non-sorting program. [g]Processing costs are inferred using Franklin Associates, Ltd. [1997] at $1.53 per household per month (after adjusting for location and inflation). [h]Less than 100% participation in mandatory CRPs is common, since even though households are required to pay for the program they are typically under no obligation to actually participate. NA means "not available".

Table 2. Variable Definitions and Means

Variables	Mean	Description
Ethical Duty	0.87	Do you feel an ethical duty to recycle to help the environment? 1 = yes, 0 = no.
Monetary	0.47	Are you motivated to recycle in order to save money? 1= yes, 0 = no.
Primarily Ethics	0.56	Which most encourages your household to recycle? 1 = ethical duty, 0 = save money.
Dropoff Distance	1.31	Distance in miles to the nearest dropoff site.
Dropoff User	0.61	In the past 12 months has your household used dropoff recycling? 1 = yes, 0 = no.
Young	0.32	1 if 18<Age<35, 0 otherwise.
Old	0.12	1 if 65<Age, 0 otherwise.
Male	0.40	1 = male, 0 = female.
High School	0.13	Highest level of education in household? 1 = high school graduate, 0 = otherwise
Associates	0.09	1 = associates degree, 0 = otherwise
Bachelors	0.31	1 = bachelors degree, 0 = otherwise
Masters	0.17	1 = masters degree, 0 = otherwise
Ph.D.	0.08	1 = Ph.D. or equivalent professional degree, 0 = otherwise
Household Size	1.09	Number of adults in household, other than the respondent.
Environmental Org.	0.10	Anyone in your household belong to an environmental organization? 1 = yes, 0 = no.
Med Income	0.35	1 if $35K/yr<Household Income<$75K/yr, 0 otherwise
High Income	0.32	1 if $75K/yr<Household Income, 0 otherwise
Employed	0.80	Adult with the highest income currently employed? 1 = yes, 0 = no.
Retired	0.12	Adult with the highest income currently retired? 1 = yes, 0 = no.
Short Cheap Talk	0.34	1 = received short cheap-talk statement, 0 otherwise.
Longer Cheap Talk	0.34	1 = received longer cheap-talk statement, 0 otherwise.
Sorting Required	0.41	1 = CRP requires some sorting of recyclable materials, 0 otherwise.
Polite	0.10	1 if polite refusal for first call attempt, 0 otherwise.
Angry	0.01	1 if angry refusal for first call attempt, 0 otherwise.
Landfill Visit	0.53	Has anyone in your household visited your community's landfill? 1 = yes, 0 = no.
Landfill Distance	10.96	Distance to nearest landfill in miles.
Landfill Distance > 2	6.89	Distance above and beyond 2 miles to nearest landfill, 0 otherwise.
Hypothetical	0.47	1 = respondent valued a hypothetical CRP, 0 = otherwise.
Precision	84.24	On a scale of 0-100, how certain are you of the answers to your WTP questions?
English	0.98	Is English your first language? 1 = yes, 0 = no
Employer Recycle	0.50	Do you recycle at work? 1 = yes, 0 = no
Caucasian	0.78	What racial group best describes you? 1 = White or Caucasian, 0 otherwise
Hispanic	0.08	What racial group best describes you? 1 = Hispanic, 0 otherwise
African American	0.03	What racial group best describes you? 1 = Black or African American, 0 otherwise
Generation Link	0.38	Were you (or other adults in your house) raised in recycling households? 1 =yes, 0 = no
Neighbor Recycle	0.39	Do most of your neighbors currently recycle? 1 = yes, 0 = no.
Years in Community	15.80	How many years have you lived in your community?
Number of Children	0.85	How many children under the age of 18 currently live in your home?
Attempt 1	0.69	Respondent available for survey after first dialing attempt.
Attempt 2	0.14	Respondent available for survey after second dialing attempt.
Fee Known	0.49	Respondent offer answer to how much household pays for current CRP? 1 = yes, 0 = no
Fee Difference	4.54	Stated CRP fee minus actual CRP fee.
CRP Performance	0.89	Job performance of your current CRP? 1 = excellent or good, 0 = fair or poor
Bid	5.51	Opening Bid _

Notes. The description does not always exactly match the wording in the survey instrument. To see the exact wording and complete descriptive statistics for each variable, please refer to www.uwyo.edu/aadland/research/recycle/datareport.pdf. Further descriptions of the "Cheap Talk" variables can be found in Aadland and Caplan [2005]. In calculating the means, the relevant sample size is N = 4012. However, due to the nature of some variables (e.g., Dropoff Distance and Primarily Ethics) the mean is calculated using only the relevant subsample of respondents.

Table 3. Estimation Results for WTP and Participation Models

Explanatory Variables†	DBDC WTP Estimates		Voluntary CRP Participation Probit Estimates		Mandatory/No CRP Participation Probit Estimates	
	Coefficient	P –Value	Coefficient	P –Value	Coefficient	P –Value
Ethical Duty	2.801***	0.000	4.601***	0.002	4.671***	0.000
Monetary	0.289	0.244	1.113	0.188	-0.817	0.211
Primarily Ethics	1.147***	0.000	1.265**	0.012	1.357***	0.005
Dropoff Distance	0.021	0.197	0.049	0.182	0.061	0.126
Dropoff User	-0.040	0.427	-0.333	0.245	-0.437	0.171
Young	1.503***	0.000	-1.126**	0.011	0.122	0.393
Old	-0.220	0.221	-0.415	0.270	-0.883*	0.084
Male	-0.566***	0.000	-0.407	0.110	0.022	0.472
High School	0.470	0.159	-0.539	0.360	1.372	0.130
Some College	0.607*	0.100	-0.383	0.399	1.391	0.126
Associates	0.232	0.322	0.253	0.435	1.783*	0.080
Bachelors	0.775**	0.048	0.253	0.432	1.987*	0.053
Masters	0.782*	0.052	0.703	0.323	2.464**	0.027
Ph.D.	1.458***	0.003	-0.036	0.491	2.300*	0.043
Household Size	0.087	0.142	-0.023	0.451	0.052	0.378
Environmental Organization	1.305***	0.000	1.148**	0.022	1.545***	0.004
Med Income	0.007	0.487	0.255	0.307	0.107	0.406
High Income	0.182	0.219	0.025	0.482	0.376	0.222
Employed	3.610**	0.028	2.123**	0.012	0.288	0.347
Retired	0.136	0.356	2.046**	0.019	1.417**	0.049
English	0.770*	0.081	-1.836	0.175	-2.254*	0.079
Caucasian	0.688***	0.005	-0.315	0.293	-0.652	0.118
Hispanic	0.202	0.291	-1.133	0.112	-1.122*	0.091
African American	0.052	0.457	0.982	0.216	-0.141	0.448
Generational Link	0.180	0.122	0.377	0.148	0.528*	0.058
Neighbors Recycle	-0.281	0.096	---	---	---	---
Number of Children	-0.048	0.204	0.134	0.123	-0.028	0.401
Call Attempt #1	-0.182	0.182	0.793**	0.034	0.822**	0.023
Call Attempt #2	-0.477**	0.029	0.412	0.220	0.708*	0.079
Years in Community	-0.020***	0.000	-0.011	0.205	-0.010	0.199
Employer Recycle	-0.017	0.464	0.185	0.336	0.924**	0.016
Polite	-0.689***	0.002	-0.742**	0.050	-0.913**	0.025
Angry	-0.424	0.310	0.448	0.398	1.336	0.216
Precision	-0.013***	0.000	-0.003	0.353	-0.008	0.118

Table 3. Estimation Results for WTP and Participation Models (continued)

Fee Known		-0.512***	0.007	1.173***	0.002	---	---
Fee Difference		0.070***	0.000	-0.001	0.482	---	---
CRP Performance		1.339***	0.000	---	---	---	---
Sorting Required		-0.054	0.386	---	---	-1.127***	0.006
Landfill Visit		0.032	0.428	0.463	0.114	0.125	0.364
Landfill Distance		-1.750	0.115	1.135**	0.017	1.206***	0.008
Landfill Distance > 2 mi.		1.767	0.113	-1.208**	0.014	-1.317***	0.006
Short Cheap Talk		0.360**	0.018	2.023**	0.041	1.367**	0.042
Longer Cheap Talk		0.700***	0.000	2.737**	0.013	2.515***	0.003
CRP Community		-1.135***	0.000	---	---	---	---
Voluntary CRP Hypothetical Bias		---	---	2.306***	0.006	---	---
Mandatory CRP Hypothetical Bias		---	---	---	---	2.720**	0.040
No CRP Hypothetical Bias		---	---	---	---	2.957***	0.000
Hetero.	Constant	1.797***	0.000	0.937***	0.066	2.106***	0.000
	Bid	0.190***	0.000	0.373***	0.007	0.201**	0.027
	Voluntary SP	---	---	2.013***	0.000	---	---
	Mandatory SP	---	---	---	---	1.490**	0.011
	No CRP SP	---	---	---	---	1.192***	0.003
Sample Size		4012		1168		2114	
Likelihood Ratio Statistic		886.54***		226.25***		349.08***	
Mean WTP		5.61		---		---	
Calibrated Mean WTP		2.97		---		---	

Notes. (***), (**), and (*) refer to statistical significance at the 1, 5 and 10 percent levels respectively. The estimation was carried out using the Constrained Maximum Likelihood (CML 2.0) package in Gauss version 3.5. The nonlinear optimization routine was Newton-Raphson with a convergence criterion of 1×10^{-5} for the gradient of the coefficients. The estimates for the constant terms, community dummy variables, as well as the dummy variables for "don't know" and "missing responses" are not shown. †Although not explicitly listed as an explanatory variable, we control for BID in creating the probabilities that enter the likelihood function. See Cameron and James [1987] for further details.

Table 4. Calibrated WTP for Select Cities

City	CRP Type	Raw WTP Estimate	Hypothetical bias correction	Sample vs. population correction	Calibrated WTP Estimate
Tempe, AZ	M	7.89	-2.71	-0.06	5.12
Longmont, CO	M	7.52	-2.71	-0.05	4.75
Orem, UT	V	6.04	-2.31	+0.01	3.75
Wichita, KS	V	5.42	-2.31	+0.12	3.24
Fargo, ND	V	5.06	-2.31	+0.03	2.78
Abilene, TX	N	5.18	-2.96	+0.04	2.26
Palo Alto, CA	M	5.35	-2.71	-0.39	2.25
Escondido, CA	M	4.84	-2.71	+0.02	2.14
Peoria, AZ	N	5.13	-2.96	-0.05	2.13
Olathe, KS	V	4.41	-2.31	-0.11	1.99
Inglewood, CA	N	4.39	-2.96	+0.38	1.81
Newport Beach, CA	M	4.46	-2.71	-0.35	1.40

Notes: Mandatory and voluntary CRP cities were selected due to the availability of cost data. Three representative non-CRP cities were chosen at random. The correction for differences between the sample and population demographics includes the variables: gender, age, education, household size, income, primary language and race.

Table 5. City Comparisons of Net Benefits and Theoretical CRP Predictions

City	WTP	Cost	Net Benefit (WTP-Cost)	CRP Type	CRP Predictions
Tempe, AZ	5.12	1.62	3.50	M	CRP
Longmont, CO	4.75	3.03	1.72	M	CRP
Orem, UT	3.75	2.78	0.97	V	CRP
Wichita, KS	3.24	2.93[a]	0.31	V	CRP
Fargo, ND	2.78	2.68	0.10	V	CRP
Abilene, TX	2.26	2.93[a]	-0.67	N	No CRP
Peoria, AZ	2.13	2.93[a]	-0.70	N	No CRP
Escondido, CA	2.14	3.16	-1.02	M[b]	No CRP
Inglewood, CA	1.81	2.93[a]	-1.12	N	No CRP
Olathe, KS	1.99	3.58	-1.59	V	No CRP
Newport Beach, CA	1.40	3.42	-2.02	M[b]	No CRP
Palo Alto, CA	2.25	5.10	-2.85	M[b]	No CRP

Notes: (a) The overall mean cost estimate from Table 1. (b) Theoretical prediction does not account for state-mandated recycling goals.