Tue 19/04/2011

Question on Notice - Willingness to Pay Studies

I am pleased to provide the following response to the question on notice with regard to 'willingness to pay' (WTP) studies resulting from my testimony before the Committee on 13 April 2011. Senator Ludlam asked,

> *"what evidence do you have that willingness-to-pay studies overstate the general public's willingness to pay?".*

The attached ABARE peer review of the report in question, PricewaterhouseCoopers 'Estimating consumers' willingness to pay for improvements to packaging and beverage container waste management' Final Draft Report', stated,

> *"ABARE does not consider that this report represents good choice modelling practice. More attention to the design, implementation, estimation and aggregation phases could have provided significantly greater precision in the estimates of Australians' willingness to pay (WTP) for increased recycling and litter reduction.*
>
> *The key qualifications relate to the aggregation factor and specification of the litter effect. Regarding the aggregation factor it must be noted that* ***surveys of this kind are subject to a selection bias because those with a lower WTP for increased recycling and litter reduction may be less likely to accept the invitation to participate in the survey*** *(emphasis added). It can be further argued that the study used a fairly aggressive test for protest responses which were then excluded from the analysis. Thus the aggregation factor of 80%, which indicates the proportion of the Australian population to which the sample estimates may be extrapolated, needs to be viewed, as stated in the report, as an upper bound with the most appropriate aggregation factor unknown and lower than 80%."*

Senator Ludlam's questioning, and my response, relate to the applicability of the PwC study specifically to container deposit legislation (CDL, otherwise known as CDS). The PwC study itself states (p.v),

> *"One of the limitations of the generic approach adopted in this study is that* ***impacts that are largely specific to one type of policy mechanism cannot be explored in any depth****. The generic approach was the right approach to take, given the terms of reference for this study called for the estimation of values that could be used to evaluate multiple policy options.* ***However, it does preclude a highly detailed analysis of the potential impacts associated with any one option — for example, inconvenience of participating in a CDS****."*

The ABARE peer review further states,

“ABARE agrees that the modelling was not successful in quantifying the inconvenience costs associated with a container-deposit scheme.”

I would also direct the Committee’s attention to the attached article by List and Shorgren in the *Journal of Environmental Economics and Management* which states,

“Some evidence suggests that ***people tend to overstate their real willingness-to-pay*** *(WTP) in hypothetical markets.”*

The article goes on to develop adjustment factors for such overstatement.

The attached article by Troske states,

“Aadland and Caplan (2003) recognize the possibility that ***individuals may overstate their willingness to pay in a hypothetical setting****, a phenomenon commonly referred to as hypothetical bias”.*

Additional attached research by Aadland funded by the National Science Foundation reinforces the point.

Other research suggests that environmental benefits accrue primarily to those in higher socioeconomic categories, as they regularly report a higher WTP in surveys on environmental matters.

I hope that this information addresses the question on notice. Please feel free to contact me with any questions.

Cheers,
Russ
President
Global Product Stewardship Council

ABARE review
of the
PricewaterhouseCoopers '*Estimating consumers' willingness to pay for improvements to packaging and beverage container waste management*' Final Draft Report

[prepared for the Environment Protection and Heritage Council – June 2010]

ABARE agrees that this report provides indicative values that may inform further policy development. The use of confidence intervals in preference to point estimates and the further qualifications included in the report will promote the appropriate interpretation of the results. However, ABARE does not consider that this report represents good choice modelling practice. More attention to the design, implementation, estimation and aggregation phases could have provided significantly greater precision in the estimates of Australians' willingness to pay (WTP) for increased recycling and litter reduction.

The key qualifications relate to the aggregation factor and specification of the litter effect. Regarding the aggregation factor it must be noted that surveys of this kind are subject to a selection bias because those with a lower WTP for increased recycling and litter reduction may be less likely to accept the invitation to participate in the survey. It can be further argued that the study used a fairly aggressive test for protest responses which were then excluded from the analysis. Thus the aggregation factor of 80%, which indicates the proportion of the Australian population to which the sample estimates may be extrapolated, needs to be viewed, as stated in the report, as an upper bound with the most appropriate aggregation factor unknown and lower than 80%. Further effort to elicit reasons for non-participation could have reduced this uncertainty.

The national model estimates a single litter parameter which relates to the *noticeable reduction* level. The model forces the *significant reduction* effect to be twice the *noticeable level* effect. Respondents may value these two levels with a different ratio and the survey design should accommodate this. However, the consultant reports that the specific experimental design used and the resulting data set do not allow any deviation from this assumption to be estimated with any precision. The use of these estimates is further complicated by the difficulty in determining how much litter needs to be reduced to achieve a *noticeable* or a *significant reduction*. On the other hand the report does indicate that Australians do have a significant WTP for litter reduction.

While ABARE does not consider that the best national model specification has been found, additional information provided to ABARE indicates that further refinements to the specification of the socioeconomic variables are unlikely to significantly improve the precision of the estimates. The most likely area for improvements would involve interacting the socio-economic or regional characteristics with the key effect variables. However this would necessitate a more sophisticated aggregation procedure that may raise other issues. Such models were not considered in the report.

The estimation methods and software used do not represent best practice for choice modelling. This factor has made the evaluation of the resulting models more difficult and is another area where some improvement in the precision of the estimates may be possible.

ABARE agrees that the modelling was not successful in quantifying the inconvenience costs associated with a container-deposit scheme (CDS). In order to quantify these costs and the level of participation in a particular CDS further analysis would be required. A more targeted analysis of a particular CDS may be able to make use of the data set collected in this study and as such ABARE recommends that a copy of the data be made available for this purpose.

INDUSTRY STUDIES ASSOCIATION
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Estimating Willingness of Citizens to Pay for Recycling

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Abstract

Previous studies estimating the willingness to pay for recycling focus exclusively on cities in the Western United States. Because of differences in citizens, population density, and waste management practices across regions, we might expect the benefits of curbside recycling to users to vary across regions. This paper estimates the willingness to pay for curbside recycling based on a contingent valuation survey of 600 residents in Lexington, KY in the Southeastern United States. Those most willing to pay for curbside recycling are young, highly educated individuals, women, those with higher income, and those feeling an ethical duty to recycle. We estimate willingness to pay for curbside recycling for Lexington residents is between $1.27 and $3.31 per month with a mean of $2.29 per month after using certainty statements to adjust for hypothetical bias. Our results are remarkably similar to those from the West. Our estimate can be compared with the costs of curbside recycling to determine if curbside recycling provides positive net social benefits in Lexington. They can also be compared to the willingness to supply when citizens are offered compensation to recycle.

*For cooperation and support we thank Steve Feese and the employees of the Lexington-Fayette Urban County Government Division of Solid Waste Management. We would also like to acknowledge the Center for a Sustainable Aluminum Industry for funding. The authors alone are responsible for the views expressed in this paper.

1. Introduction

Research on recycling programs has focused two broad areas: (1) the role of recycling in the optimal mix of solid waste disposal policies; and (2) the benefits households receive from recycling. This paper contributes to both areas by examining the willingness to pay for curbside recycling in a region of the country where the willingness to pay for curbside recycling has received little attention. The paper will also explores a new policy to influence the amount of materials households recycle. Namely an experiment is being conducted in which households receive explicit monetary incentives to increase curbside recycling.

Willingness to pay for curbside recycling has been studied extensively in the literature, but predominantly in the western United States. Aadland and Caplan (1999) survey residents of Ogden, Utah and find that residents are willing to pay $2.65[1] per month for curbside recycling. Aadland and Caplan (2006) investigate the benefits and costs of curbside recycling. On the costs side the authors consider both the explicit fixed and variable costs of curbside recycling programs as well as the opportunity cost of diverting resources away from their next most valuable resource. To estimate the benefits the Aadland and Caplan use survey households in 40 cities in across the western United States. They find an average willingness to pay of $3.42, and net social benefits of curbside recycling almost exactly equal to zero. Additionally, Aadland and Caplan (2003) recognize the possibility that individuals may overstate their willingness to pay in a hypothetical setting, a phenomenon commonly referred to as hypothetical bias. The authors use three methods to attempt to mitigate hypothetical bias. Two methods are

[1] All dollar amounts are converted to 2007 dollars using the Consumer Price Index.

based on their sampling strategy and one is based on *cheap talk* in which respondents are exhorted to avoid overstating their willingness to pay.

The current paper adds to studies on curbside recycling in two respects. First, most studies of willingness to pay for curbside recycling have been conducted in the western portion of the United States. Because of differences in citizens, population density, and waste practices, we might expect the benefits of curbside recycling to vary across regions. Second, our study represents the first use of “probably sure-definitely sure” certainty statements to mitigate potential hypothetical bias in the willingness to pay estimates. The results indicate that willingness to pay for curbside recycling, adjusting for hypothetical bias, is similar in the southeast as in the west.

The current work also explores household responses to municipal policies that encourage recycling. Optimal policy design for solid waste has been the focus of several studies. Kinnaman and Fullterton (1999) provide a comprehensive review of the economic literature regarding solid waste policies. Germane to the current work are policies that encourage household to recycle. One such policy believed to increase the amount of household recycling is the is the unit-pricing of waste in which households pay per unit for disposal of trash. The policy is expected to decrease the need for refuse collection and increase household recycling. Fullerton and Kinnaman (1996) show that some households respond to unit pricing by increase by “stomping” more garbage into each unit. Other studies have shown unit-pricing to have a positive impact on the quantity of materials recycled. Hong et al. (1993) find that the volume of a household’s recycling level is more responsive to price than is the volume of non-recyclabes.

Interestingly ordinances aimed specifically at making recycling mandatory have little significant impact on recycling or garbage quantities (Kinnaman and Fullerton 2000).

Economic factors such as tipping fee for waste disposal and population density also play a role in the quantity of materials recycled. Using data collected during the mid-1990s on 959 communities in the United States Kinnaman and Fullerton (2000) find that a $15 increase in the tipping fee increases the likelihood of a community adopting a curbside recycling program by 7.8%. A 1000-person per square mile increase in the population density increases the likelihood of curbside adoption by 3.9%.

Our study differs from the existing literature in that we will examine the effect of an explicit, direct incentive for households to recycle. Specifically, we examine the impact of offering households various dollar amounts ($0, $1, or $2) to increase the quantity of materials they recycle through curbside collection.

2. Survey and Sample

In order to examine household recycling behavior, a survey was administered to a representative sample of households in Lexington, Kentucky. The sample was subdivided into two distinct divisions based on whether the participating household were to receive incentives to encourage recycling (*experimental sample)* or if the household were to be part of the assessment of willingness to pay for curbside recycling (*WTP sample*). The experimental sample consisted of 1,000 households in a representative neighborhood in the city of Lexington. Households in this portion of the sample were further distinguished by their treatment under city tax code. Residents in the experimental sample are part of a city tax district in which residents receive city-provided refuse and recycling collection services. In addition, the experimental sample was chosen in conjunction with the solid waste manager for the city of Lexington to correspond with a single garbage collection route. This feature of the sample facilitated household level data collection.

The WTP sample was drawn from Fayette County's Property Value Assessment database and consisted of a total of 600 additional households. Five hundred were randomly selected from households in tax districts that did not receive city provided refuse and recycling collection. Instead, households in this portion of the sample contracted with private firms for curbside collection services. The remaining 100 were households in tax districts receiving city provided collection services. Sampling in this fashion allows for a comparison of the recycling behavior across service types as well as experimental treatments.

The survey instrument was designed to be administered by mail to the sample of Lexington residents. It consisted of three main sections. In the first section, respondents were asked about their knowledge of current recycling programs and their use of recycling services throughout the city. The second section provided a description of a hypothetical curbside recycling service. Households in the WTP sample were then asked to indicate their willingness to pay for the service. The willingness to pay question used a dichotomous choice format and was followed by a question asking respondents to their certainty of willingness to pay. The use of certainty statements in contingent valuation survey been shown to reduce hypothetical bias (Blumenschein et al. 2008, Champ and Bishop 2001, Little and Berrens 2004, Poe et al. 2002). Households in the experimental sample also read a description of a curbside recycling program. In contrast to the willingness to pay format, they were asked how much they would *accept* in payment in return for their participation in the program. The final section collected standard demographic information along with information on recycling behavior with respect to specific materials such as aluminum, newspaper and plastics.

Three professionally moderated focus groups were performed to ensure respondents understanding of the questionnaire. The first two groups consisted of eight faculty and staff members of the Gatton College of Business & Economics at the University of Kentucky. These groups were distinguished by their self-reported recycling behavior, with one group being recyclers and the other group being non-recyclers. The third focus group of 7 individuals consisted of members of a local neighborhood association in the Lexington area, with no distinction made for recycler status.

The survey was sent out in June-August 2007. Following Dillman (2007), implementation of the survey included up to five separate mail contacts. The contacts included an introductory letter, the survey itself with a $1 token of appreciation for (hopefully) completing the survey, a reminder postcard, a second mailing of the survey instrument, and final mailing of the survey sent by Priority Mail. A total of 1600 surveys were sent with 31 surveys being returned as undeliverable. Nine hundred and ninety six surveys were returned for a response rate of 63 percent (996 / 1569).

Table 1 reports demographic information from survey respondents and corresponding information for the Fayette County portion of the Census Bureau's American Community Survey 2007. Overall, respondents to the Recycling Survey tend to be more educated, earn more income, and are predominantly female.

3. Results

Figure 1 compares drop-off and curbside recycling behavior by tax district. Households in tax districts which receive city service are more likely to have a recycling container and are more likely to use curbside recycling. They are less likely to know about substitutes to curbside recycling such as drop-off recycling centers. Households on in tax districts that do not receive city service are more like to know about alternatives to curbside recycling and less likely use curbside recycling services. These results are consistent with expectation.

Residents on city service pay for refuse collection through a combination of property taxes and monthly fees levied through residents' water bills. In Lexington, the 2003 tax rate associated with refuse collection was $0.17 per $100 paid in property tax. For the average house in our sample the attributable amount would be approximately $21 per month. In addition, the city charges each household $4.50 per month for each 90 gallon container it uses. In contrast to garbage collection, there is no cost specifically attributed to recycling. Residents desiring to recycle are not required to pay additional taxes or fees for curbside recycling containers or service. From the perspective of the household, the monetary cost of using the city provided curbside recycling service is zero. Similarly, residents on city service cannot save money by opting out of participation in the curbside recycling service. There is one indirect monetary component to curbside recycling. If a household is on the margin of ordering another garbage can from the city, rather than incurring the additional $4.50 per month, the household could order a recycling container and alleviate the garbage capacity constraint.

Households on private service, in contrast, face an explicit cost related to their curbside recycling behavior. Currently, the private provider in Lexington charges $6 dollars per month to provide curbside recycling. This monthly charge appears as a line-item on the collection bill and can be discontinued at any time at the choosing of the resident. The differences in the cost structure of recycling for private and city service households help to explain differences in the observed recycling behavior. Those on private service face a higher marginal cost for curbside recycling and thus have an incentive to look for other ways to recycle. They are both more knowledgeable about the alternatives and are more likely to seek them out. In addition, these results provide initial evidence that the monetary price is an important component of the decision to recycle.

Figure 2 reports results on the self-reported factors that would most encourage people to recycle. Respondents were asked to select among three options: (1) An ethical duty to help the environment; (2) Saving money, (3) Being paid to recycle. Most households (63 percent) see recycling as an ethical duty; however, evidence indicates that money is a motivating factor for recycling behavior. Forty-three percent of households indicate money, either saving it or earning it, would encourage them to recycle.

3.1 Willingness to Pay

Individuals in the WTP sample were asked if they would be willing to pay for curbside recycling. Table 2 presents the responses for two definitions of yes. The first definition of yes, Baseline (All) includes all yes responses. The second definition of yes, Definitely Sure, separates responses based on respondent certainty. Respondents indicating a yes to the willingness to pay question and who were “definitely sure” of their response were treated as yes, while all remaining responses were treated as no.[2] Empirical evidence suggests that accounting for respondent certainty in this fashion is a reliable way to obtain accurate valuations from hypothetical surveys (Blumenschein et al. 2008, Blumenschein et al. 1998).

Consistent with expectation, the proportion of yes responses declines as the amount the respondent is asked to pay increases. Under the Baseline definition of yes, a high of 84 percent of respondents were willing to pay $1 per month for curbside recycling, while only 17 percent were willing to pay $12 per month. Fewer survey participants were Definitely Sure of their willingness to pay response; 61 percent were willing to pay $1 per month decreasing to a low of 17 percent at price of $12 per month.

3.1.1 Turnbull Estimate.

Two methods are used for calculating willingness to pay for curbside recycling based on survey responses. The first is the Turnbull nonparametric estimator. The advantage of the Turnbull estimator is that it makes no assumptions about the shape of the underlying willingness to pay distribution. Instead, the fraction of the empirical distribution falling into each price interval is used to calculate mean willingness to pay for the sample. Figure 3 plots the empirical distribution of willingness to pay for curbside recycling in Lexington. The Turnbull estimate of willingness to pay using the

[2] For each model, the final sample has been adjusted for respondents identified as protestors. The term, "protester" refers to someone who rejects the survey valuation scenario and therefore does not give responses that reflect their true preference for curbside recycling. To identify protesters, those individuals answering no to the willingness to pay question were asked to identify the reason why. Individuals responding, "My household should not have to pay for curbside recycling," were considered protesters as this response indicates a rejection of the hypothetical market rather than a low or nonexistent value of curbside recycling. Individuals who answered that they could not afford to pay, that curbside recycling had no value to their household, that there were suitable alternatives to curbside recycling, or that drop-off recycling is adequate were not considered protesters. Out of 200 'no' responses, 97 were identified as protesters. Running a logistic regression with a protester indicator as the dependent variable the variables in Table 4 as independent variables yields only one significant predictor, Ethical Duty. T he variable is positive and significant at the 5% level.

Baseline definition of yes is $5.46 per household per month (95% confidence interval = (4.28, 6.65)). Using the more conservative definition of yes, Definitely Sure, produces a Turnbull estimate of willingness to pay of $2.76 (95% confidence interval = (2.13, 3.38))

3.1.2 Parametric Estimate

While the Turnbull estimator makes no assumption about the underlying distribution of willingness to pay, its main disadvantage is its inability to control for household characteristics that may influence willingness to pay. To control for influential household characteristics, a parametric approach is used. The parametric approach follows Cameron (1988) and uses logistic regression to control for observable respondent characteristics. Table 3 presents the definitions of the control variables used in the logistic regression analysis along with their descriptive statistics. The main variables of interest can be divided into two groups. The first group relates to standard demographic characteristics of the household, things such as income, education, sex, and race. The second group can be related to current recycling behavior and personal motivations for recycling. For example, individuals who are currently using or are aware of drop-off recycling centers might be willing to pay less for curbside recycling because of drop-off being an adequate substitute for them. On the other hand, individuals motivated by an ethical duty may be willing to pay more for curbside recycling.

Table 4 presents the results of the logistic regression with controls for household characteristics. The two specifications presented are distinguished by the dependent variable used. The dependent variable for the Baseline specification is the yes/no response to the willingness to pay question. For the Definitely Sure specification, the dependent variable is the response to the willingness to pay question after adjusting for respondents who were definitely sure of their willingness to pay response.

The coefficients of the logistic regression indicate whether the independent variable has a positive or negative influence on the probability of responding yes to the willingness to pay question. The regression results indicate those with higher income, the young, and those that feel an ethical duty to recycle are most likely to respond affirmatively to the willingness to pay question. Table 4 also shows the mean willingness to pay for the WTP sample. Accounting for certainty, the best estimate of mean willingness to pay is $2.29 with a 95 percent confidence interval of $1.27 - $3.31[3]

4. Paid to Recycle: An Experiment in Progress

The main focus of the experiment is to understand how households respond to different incentives to increase their level of household recycling. In particular the experiment is designed to assess the impact of monetary and communication incentives given to households over a period of time. The field experiment is a 3 price incentive ($0, $1, $2) x 4 communication appeal (None, Guilt, Feel Good, Informational) between subjects design encompassing 12 experimental conditions. To establish a baseline level of recycling before the experiment begins, the weight of household recycled materials will be recorded once a week for four weeks. Experimental conditions will then proceed for six months. The price incentives will be offered at the end of each month and were generated after considering the potential revenue increases from the increase aluminum and other recyclable materials which may occur. Additionally, whole dollar values were chosen as $1 bills will be sent as incentives. The communication appeals were chosen as

[3] The ratio of the mean of uncalibrated to mean willingness to pay to calibrated by certainty statements in our study is (6.18/2.29) or 2.7. The ratio for Aadland and Caplan (2006) calibrated by revealed participation in voluntary recycling programs is (6.47/3.42) or 1.9

they have been shown in prior research to be potentially effective. The appeals were developed and tested using the focus groups.

In order to understand the behavior of households under a recycling incentive program, it is necessary to obtain the weight of materials that households recycle on a weekly basis. To this end a garbage truck in Lexington was retrofitted with a scale and radio frequency identification (RFID) reader. The scale and reader allow the weight of household recyclable material to be automatically measured for each household at each pickup.

Currently, the RFID tags are in place and baseline data collection began November 6th. Experimental conditions will begin in December. After six months of experimental conditions, an exit survey will be sent to experiment participants to judge attitudes toward recycling. Attitudes will be compared to actual recycling data to determine how important attitude is in prompting recycling behavior. Finally, recycling data will continue to be collected for 3 months after experimental conditions end to assess the longevity of any behavior changes brought about through the recycling incentives.

5. Conclusion

To be written

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Table 1. Demographics of Recycling Survey vs. American Community Survey 2005 for Fayette County Kentucky†

		WTP Sample (n=225)	City Service (n=577)	No City Service (n=210)	Overall (n=862)	American Community Survey 2005
Gender	Female	58.93%	60.83%	59.52%	59.40%	52.39%
Age	18-29	4.46%	25.48%	5.24%	18.79%	19.76%
	30-39	16.96%	33.10%	12.38%	26.68%	18.89%
	40-49	22.32%	19.58%	20.00%	19.84%	21.50%
	50-64	35.71%	14.04%	36.67%	20.77%	24.92%
	65 or over	20.54%	6.93%	23.33%	12.65%	14.94%
Race	White	97.32%	79.55%	98.57%	85.73%	84.10%
Education	Less than High School Diploma	0.45%	2.77%	0.48%	2.32%	11.73%
	High School Diploma or Equivalent	4.91%	6.24%	6.19%	6.73%	20.81%
	Some College	16.07%	16.12%	15.24%	16.82%	21.83%
	Associate Degree	8.04%	9.71%	8.57%	9.63%	7.50%
	Bachelor's Degree	35.27%	37.09%	30.00%	33.99%	22.48%
	Master's Degree or Beyond	31.25%	23.92%	34.29%	26.10%	15.67%
Household Income	Under $15,000	3.13%	2.25%	4.29%	2.55%	10.31%
	$15,000 - $39,999	14.29%	19.58%	14.29%	17.98%	25.05%
	$40,000 - $59,999	20.98%	24.09%	20.95%	23.09%	19.26%
	$60,000 - $99999	31.25%	38.99%	32.38%	37.70%	24.25%
	$100,000 or more	30.36%	15.08%	28.10%	18.68%	21.14%

†Both the Recycling Survey statistics and the American Community Survey statistics are for those individuals 18 years old or over living in a single family dwelling. The difference in the number of returned surveys (n=996) and number represented in the Overall column (n=862) is due to item nonresponse.

Table 2. Percent Yes Responses to Willingness to Pay for Two Definitions of Yes

Price	Baseline (All)		Definitely Sure	
	Yes/All	*Percent*	*Yes/All*	*Percent*
$1	32/38	84%	23/38	61%
$2	35/47	74%	26/47	55%
$3	33/44	75%	22/44	50%
$5	28/46	61%	10/46	22%
$7	13/35	37%	7/35	20%
$9	3/9	33%	1/9	11%
$12	1/6	17%	1/6	17%
Overall	145/225	64%	90/225	40%

Table 3. Definitions of Variables and Summary Statistics

Variables	Mean	Description
Price	3.96 [2.63]	Dollar amount individual would pay for Curbside Recycling Service in 2007 dollars. Amounts were one of the following: 1 (17%), 2 (21%), 3 (20%), 5 (20%), 7 (16%), 9 (4%), 12 (3%),
Income	86.42 [54.07]	Household Income in thousands of dollars
Employed	0.59	1 if employed full time, 0 otherwise
College Graduate	.74	1 if received Bachelor's Degree or higher, 0 otherwise
Age	52.41 [14.83]	Age of respondent
Female	0.59	1 if respondent if Female, 0 otherwise
White	0.97	1 if respondent is White, 0 otherwise
Number In Household	2.51 [1.16]	Number of individuals living in the household
City Service	0.18	1 if respondents receives city provided trash collection, 0 otherwise
Drop-off Know	0.48	1 if respondent knows of drop-off recycling center in the city, 0 otherwise
Drop-off User	0.20	1 if respondent uses drop-off recycling, 0 otherwise
Recycle at Work	0.45	1 if respondent recycles at work, 0 otherwise
Ethical Duty	0.83	1 if respondent feels an ethical duty to recycle, 0 otherwise
Money Motive	0.32	1 if saving money motivate respondent to recycle, 0 otherwise
Primary Ethics	0.66	1 if ethical duty would *most* encourage household to recycle, 0 otherwise
Primary Saving Money	0.16	1 if saving money would *most* encourage household to recycle, 0 otherwise
Member Envir. Org.	0.10	1 if someone in household is a member of an environmental organization, 0 otherwise

Standard deviations for non-categorical variables are in brackets. Means calculated using estimation sample, n = 225.

Table 4. Logistic Regression for Two Definitions of Yes

	Baseline	Baseline Marginal Effects	Definitely Sure	Definitely Sure Marginal Effects
Price	-0.4048***	-0.0833***	-0.3387***	-0.0782***
	[0.0762]	[0.0157]	[0.0742]	[0.0165]
Income	0.0101**	0.0021**	0.0062**	0.0014**
	[0.0043]	[0.0009]	[0.0032]	[0.0007]
Employed	0.1913	0.0396	-0.1272	-0.0295
	[0.4904]	[0.1023]	[0.4288]	[0.0996]
College Graduate	0.6413	0.1394	-0.06	-0.0139
	[0.4166]	[0.0945]	[0.3864]	[0.0899]
Age	-0.0425***	-0.0087***	-0.0204	-0.0047
	[0.0164]	[0.0033]	[0.0138]	[0.0032]
Female	0.6299	0.1321	0.2753	0.0631
	[0.4008]	[0.0845]	[0.3538]	[0.0802]
White	0.9722	0.228	1.0693	0.2016
	[1.1777]	[0.2931]	[1.2118]	[0.1709]
Number In Household	-0.0811	-0.0167	0.0615	0.0142
	[0.1777]	[0.0365]	[0.1487]	[0.0343]
City Service	-0.687	-0.1524	-0.393	-0.0872
	[0.4859]	[0.1132]	[0.4361]	[0.0923]
Drop-off Know	-0.3574	-0.0736	-0.3445	-0.0793
	[0.4259]	[0.0876]	[0.3767]	[0.0862]
Drop-off User	0.3809	0.0744	0.7746*	0.1862
	[0.5689]	[0.1048]	[0.4698]	[0.1146]
Recycle at Work	-0.3012	-0.0623	-0.1042	-0.024
	[0.4341]	[0.0902]	[0.3641]	[0.0838]
Ethical Duty	2.1964***	0.4968***	1.2089**	0.2388***
	[0.5760]	[0.1137]	[0.5393]	[0.0855]
Money Motive	-0.9106**	-0.1972**	-0.103	-0.0237
	[0.4028]	[0.0891]	[0.3485]	[0.0796]
Primary Ethics	0.8905*	0.1916*	0.5155	0.1158
	[0.5165]	[0.1135]	[0.4615]	[0.1003]
Primary Saving Money	0.3203	0.0627	0.4412	0.1053
	[0.6141]	[0.1138]	[0.5784]	[0.1413]
Member Enivr. Org.	1.4539*	0.2208***	0.5569	0.1344
	[0.7933]	[0.0794]	[0.5695]	[0.1410]
Constant	0.2143		-1.2322	
	[1.8096]		[1.6919]	
N	225		225	
Pseudo R-sq	0.334		0.177	
Proportion Yes	64%		40%	
Mean Willingness To Pay	$6.18		$2.29	
	[0.5631]		[0.5196]	

Standard Errors are in brackets. *, **, *** denote significance of 10%, 5% and 1% respectively.

Figure 1. Dropoff and Curbside Recycling Use by Service Type

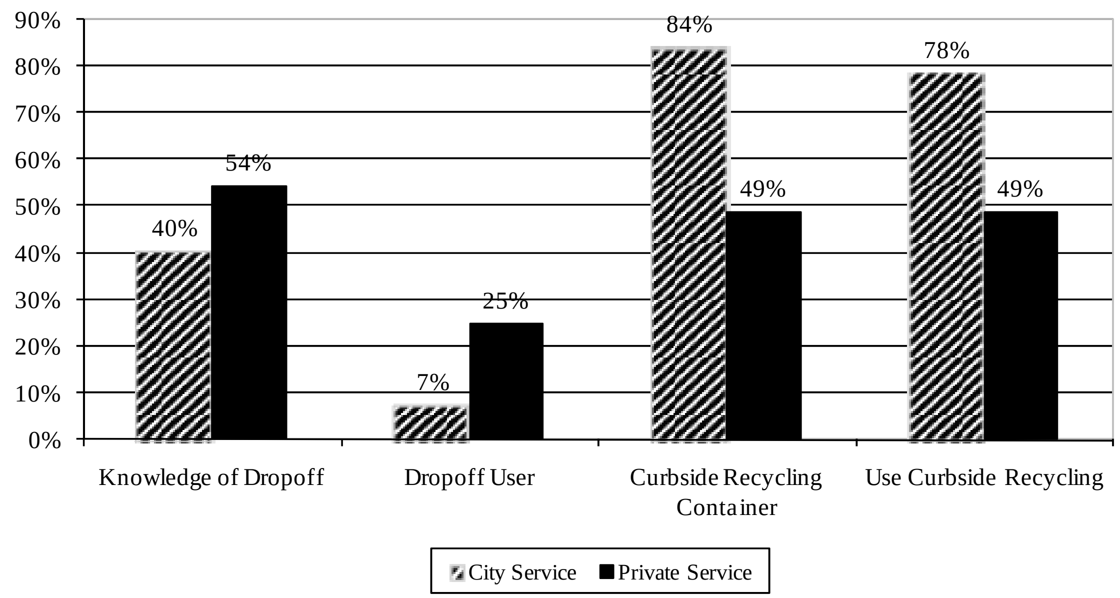
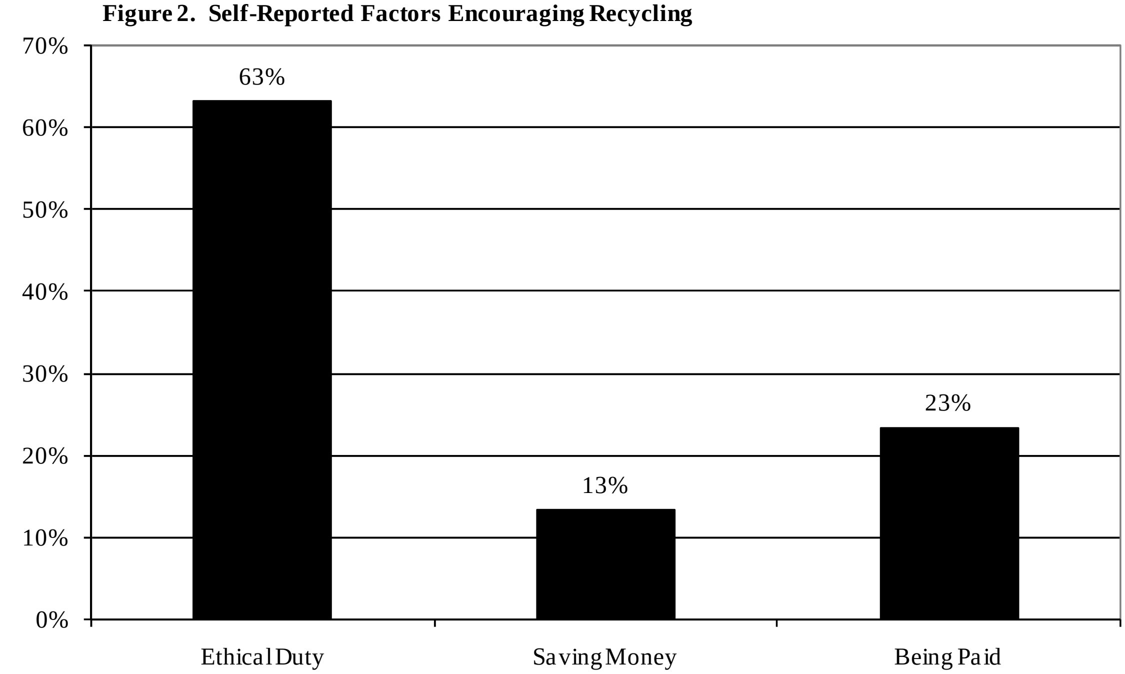


Figure 2. Self-Reported Factors Encouraging Recycling



The results in the figure pool observations across tax districts. Self-reported factors encouraging recycling are similar across both city-service and private-service districts. For city-service districts 65, 13, and 22 percent indicate Ethical Duty, Saving Money, and Being Paid, respectively, as the primary motivation for recycling while percentages for private-service districts are 67, 13, and 20 respectively.

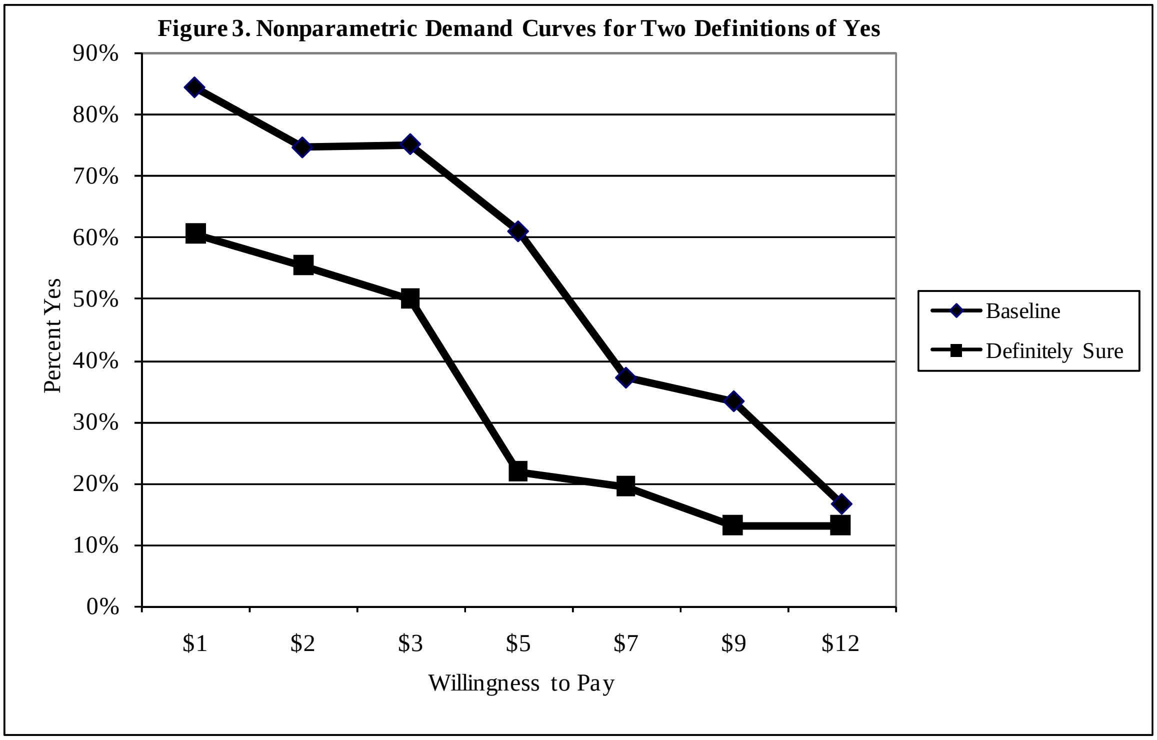


Figure 3. Nonparametric Demand Curves for Two Definitions of Yes
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent Yes
$1
$2
$3
$5
$7
$9
$12
Willingness to Pay
Baseline
Definitely Sure

Curbside Recycling:
Waste Resource or Waste of Resources?

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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.

JEL Classification: Q26, C25,

Keywords: curbside recycling, willingness to pay, social net benefits, hypothetical bias.

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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.

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% in 1999 to 26.7% 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.[1] One of our main contributions is the innovative way in which we use contingent valuation methods (CVM) to estimate willingness-to-pay (WTP) for CRPs. A common criticism of CVM is that respondents tend to overstate their true WTP due to the hypothetical nature of the good. Unlike previous CVM studies, we address this problem by estimating the magnitude of the potential hypothetical bias in our WTP data. The unique nature

[1] 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

of our dataset allows us to estimate this magnitude by contrasting stated-preference information (from CVM) with revealed-preference information from actual decisions made by households in communities with voluntary CRPs.[2] Using this estimate of hypothetical bias, we then calibrate the corresponding WTP estimates to the decisions made by households in a real market setting.[3]

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 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.

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and extension of these existing case studies. In particular, our study enables inference to a wider population of CRPs.

[2] "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.

[3] 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.

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. 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.[4]

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

[4] 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.

“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.[5]

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[6]

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

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

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[5] 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).

[6] 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 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 observation.

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.

CRP Condition I. 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.

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 $\overline{WTP}^V - ATC(n^*, V)$ is greater (less) than $\overline{WTP}^M - ATC(n, M)$ 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.[7] 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

[7] 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.

basis in order to be directly comparable with our benefit information.[8] 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%, 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 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.[9]

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[8] 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.

[9] 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.

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.[10] 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.

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

[10] 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% and 49%, 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.

questions.[11] 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.[12] 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 McConnell, 1997; Aadland and Caplan, 2003). As a result, our survey generates five rather than four valuation regions with $(-\infty, 0.5\nu)$ being replaced by $(-\infty, 0)$ and $(0, 0.5\nu)$.[13]

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,[14]

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[11] 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).

[12] 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.

[13] 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 $(0.5\nu, \infty)$. The likelihood function is adjusted accordingly.

[14] 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.

> "*……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).[15]

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 stochastic error term ε_i is added to capture the portion of WTP_i unexplained by $\mathbf{X}_i$, implying

$$\mathrm{WTP}_i = \mathbf{X}_i \boldsymbol{\beta} + \varepsilon_i \,, \tag{2}$$

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

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

where $\mathbf{Z}_i$ is a vector of variables (possibly intersecting with $\mathbf{X}_i$) and γ is a vector of parameters.

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[15] 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.

We further assume that the error terms are mutually independent and normally distributed. Letting $P_{i,j}$ indicate the probability that household *i*'s true WTP falls in the j^{th} region, the (log) likelihood function conditional on (2), (3), and the observed data is

$$\ln(L) = \sum_{i=1}^{N}\sum_{j=1}^{5}\omega_{i,j}\ln(P_{i,j}), \tag{4}$$

where $\omega_{i,j} = 1$ if the stated WTP value falls in the j^{th} region and 0 otherwise. See Aadland and Caplan (2003) for additional details on the specification of the probabilities and likelihood function in (4). 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 from maximizing (4) across all (N = 4012) households in our sample. First, note that the estimated WTP, averaged across cities, is $5.61 per month.[16] 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 Caplan et al. (2003); but smaller than those in Aadland and Caplan (2003), Kinnaman (2000), and Jakus et al. (1996).[17]

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

[16]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.

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

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 statistic used to test for overall goodness of fit is 886.54 with a 1% critical value equal to 156.65. Therefore, we reject the null hypothesis in favor of 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% level. Furthermore, the likelihood ratio statistic used to test the null hypothesis that $\gamma = 0$ in (3) is 512.52 with a 1% critical value equal to 6.63. Therefore, we reject the null hypothesis in favor of heteroscedastic errors.

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 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.[18]

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).[19]

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 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

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

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 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

[19] 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.

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.[20]

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). Furthermore, Tempe's approach of dividing the collection and processing components 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

[20] The community dummy variables for Tempe and Palo Alto (not shown in Table 3) account for $2.15 of the total difference in WTP across these two cities.

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. 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. 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.

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Figure 1. CRP Conditions I and II.

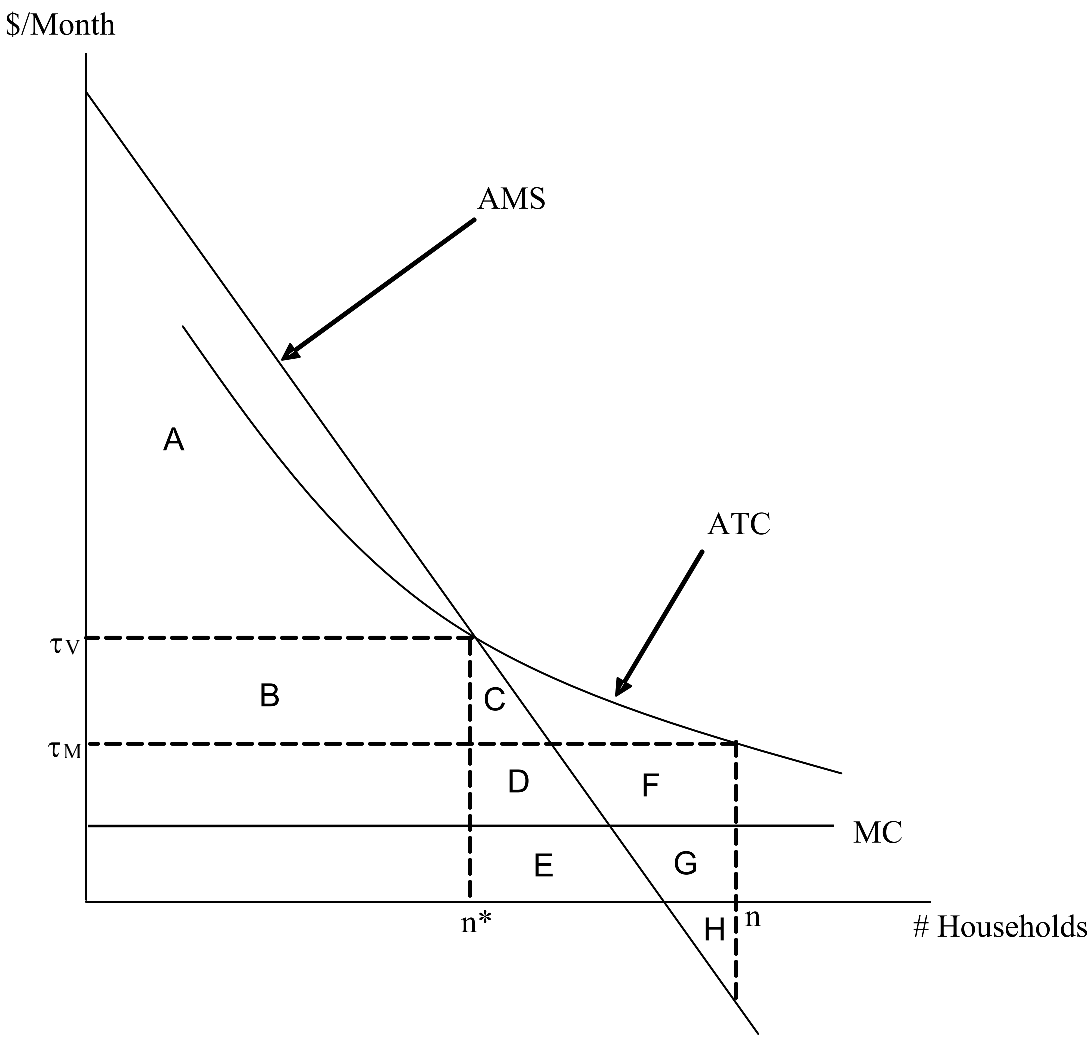

Table 1. Costs per Household and Other Characteristics for CRPs

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 υ

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	
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.