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Abstract

This article examines the effects of recycling and deposit laws on consumer recycling of plastic water bottles using a nationally representative sample of 2,550 bottled water users. Economic theory predicts individual behavior that gravitates toward extremes—either diligent recycling or no recycling at all. This pattern is borne out in actual recycling behavior. Both water bottle deposits and recycling laws foster recycling behavior through a discontinuous effect that converts reluctant recyclers into diligent recyclers. More stringent recycling laws have a greater effect on recycling rates. The efficacy of these interventions is greatest for those who would not already recycle and especially for those in lower income groups or who do not consider themselves to be environmentalists.

1. Introduction

The waste associated with plastic water bottles has become an issue of substantial national prominence. U.S. sales of bottled water for individual consumption increased from about 12 billion water bottles in 2000 to 36 billion bottles in 2006.[1] Bottled water typically comes in polyethylene terephthalate (PET) bottles. More than 2 million tons of PET bottles, including those for beverages other than water, were incinerated or reside in landfills in 2006. Plastic water bottles comprise almost half of the total PET bottle sales and represent a growing share of sales. However, bottle deposit laws in most states do not include these water bottles. This paper examines the efficacy and the heterogeneity of the economic incentives generated by policies pertaining to these plastic water bottles.

There are two principal policy instruments that can be utilized to promote water bottle recycling—bottle deposits and recycling laws. Bottle deposits for plastic water bottles establish a unit price and financial incentive to foster recycling through bottle returns to obtain reimbursement of the deposit value. Without specific deposits for water bottles, the presence of deposit requirements for other types of bottles may foster recycling of plastic water bottles insofar as they promote recycling behavior generally, such as by increasing the number of trips that are made to the recycling center. The other category of policy instruments—recycling laws—uses as the economic mechanism not a monetary price but a reduced time and convenience cost for recycling.[2] These laws exhibit a wide range of policy stringency, with the more ambitious laws generally requiring curbside recycling or provision of convenient recycling locations.

[1] Container Recycling Institute (2008).

[2] There may also be financial incentives through penalties imposed for noncompliance in areas where recycling is mandatory.

To analyze recycling behavior for plastic water bottles, we use an original national data set of 2,550 households, making this the only study using such a nationally representative sample. By contrasting individual recycling behavior across states, we can estimate the effects of different policy regimes of recycling laws and bottle deposit laws.

Data at the individual level make it possible to examine the determinants of household recycling decisions. Respondents estimate the proportion of bottles that they recycle and where they recycle. They can indicate that they recycle all of the time, never, or an intermediate amount. On a theoretical basis, we predict that people will gravitate toward one of the two extremes. Our empirical data support this assumption, showing that if policy interventions have any effect on a reluctant recycler, it has a discontinuous effect, converting the individual to an avid recycler.

Our analysis of individual household data also helps illuminate many ongoing economic controversies pertaining to recycling. Consumers often face a choice between returning bottles for deposit and using curbside recycling or choosing not to recycle at all. Do the available policy instruments cannibalize one another, so that there is no net benefit of having both bottle deposit laws and recycling laws? Fundamental concerns also have been raised as to whether unit pricing has a net positive effect on recycling, and particularly whether bottle deposits have any incremental benefit once other recycling policies are in place.

The heterogeneity of the recycling responses to the incentives created by the recycling laws and bottle deposit laws also is of substantial economic interest. Are some segments of the population motivated less by recycling policies and does their responsiveness hinge on the particular form of intervention? To what extent are those in upper income groups responsive to the economic incentives of bottle deposits and to time costs associated with recycling generally?

Differences in valuation of the environment may be consequential as well in that recycling laws may either bolster pro-environment efforts, increasing the amount of recycling by those who consider themselves to be environmentalists, or detract from their efforts by diluting the existing ethical motivation of environmentalists to recycle.

Although the economics literature on recycling behavior has been growing, this study is novel in several respects.[3] To date there have been no comprehensive studies of plastic water bottle recycling.[4] In particular, no previous studies have used nationally representative data at an individual level or have analyzed the effect of either water bottle deposit laws or the influence of the different forms of recycling laws enacted by the states.[5] Several studies have documented the positive effect of unit pricing policies on the amount of recycling. In addition, laws that have fostered curbside recycling likewise have had a positive effect on recycling, though the net effect of having both bottle deposit laws and curbside recycling remains a matter of debate. Most studies to date have focused on total recycling amounts, as measured by weight, while ignoring the specific materials recycled. Of these studies, many have not used data at the individual level and have focused on narrowly defined regions.[6] Some studies of material-specific recycling

[3] Jenkins et al. (2003) and Yang and Innes (2007) review previous empirical recycling studies. Most, but not all studies in the literature have analyzed recycling behavior on a regional basis. Studies of recycling amounts at the regional level have analyzed policies such as unit pricing or curbside recycling in the U.S. and abroad. These studies include Fullerton and Kinnaman (1996), Callan and Thomas (1997), Nester and Podolsky (1998), Hong and Adams (1999), Van Houtven and Morris (1999), and Suwa and Usui (2007). Kinnaman and Fullerton (2000) examine community-level recycling behavior using a national dataset, and Jenkins et al. (2003) analyze material specific recycling for a sample in 20 metropolitan statistical areas (MSAs) of middle and upper-middle income households who had curbside collection available. Ashenmiller (2009) used individual survey data from CA to examine the effect of bottle bills and concluded that they increase recycling.

[4] Jenkins et al. (2003) include plastic bottles among the specific recycling materials considered.

[5] Kinnaman (2006) provides a somewhat different characterization of the various state laws than that used here and also provides a recent review of the literature.

[6] Three such regional studies are Saltzman et al.'s (1993) analysis of glass and newspaper recycling (by quantity) in 53 communities in PA and NJ, Beatty et al.'s (2007) analysis of aluminum, glass, and plastic recycling (by quantity) in regional CA communities, and Yang and Innes's (2007) regional Taiwan analysis of paper, metal, plastic, and glass recycling (by weight).

have used individual data, but have not analyzed the different state law regimes, have not used nationally representative samples, and have not focused on plastic water bottles specifically.[7]

The next section of this paper presents a conceptual model of recycling behavior, focusing on various policy interventions generated by different recycling laws and bottle deposits. A central implication of this analysis is that once people begin to recycle they tend to become diligent recyclers so that successful policy interventions have a discontinuous effect on individual behavior. After describing the sample and the recycling policy regimes, Section 3 presents overview statistics indicating again a strong bimodal aspect to recycling behavior. Recycling laws tend to shift non-recyclers into becoming avid recyclers, with bottle deposit laws strengthening this effect on the distribution of bottles recycled. The regression analyses of the determinants of the fraction of bottles recycled in Section 4 and the use of curbside recycling and bottle returns in Section 5 provide estimates of the efficacy of the different recycling interventions. Section 6 concludes. Overall, we find that incentives matter in ways that are consistent with both economic theory and the hypothesized structure of the recycling decision.

2. The Consumer's Recycling Decision

Recycling decisions will, of course, depend on what items the consumer has purchased. Following the standard dynamic programming approach, we will assume that in the first stage the consumer chooses the consumption mix conditional on the optimal disposal and recycling decisions in the second stage. The consumer will make the purchase decisions in the initial

[7] Three studies using household-level data are Reschovsky and Stone's (1994) analysis of the proportion of many different materials recycled in an upstate NY county, Sterner and Bartelings' (1999) analysis of recycling (by weight) of materials other than plastic using regional data in Sweden, and Jenkins et al.'s (2003) analysis of the recycling (by proportion recycled) of newspaper, glass bottles, aluminum, plastic bottles, and yard waste by middle and upper income households in 20 major MSAs.

period anticipating optimal disposal thereafter so that it is appropriate to analyze the second stage disposal and recycling decision, taking as given the prior purchase decisions.[8]

Recycling Decision Notation and Framework

Although not all disposal options are available in every locale, if we abstract from littering there are three possible ways to dispose of plastic bottles: curb recycling, denoted by c, returning the bottle for deposits, d, and putting the bottles in the garbage, g. The total number of bottles as x then $x = c + d + g$. For each bottle returned for deposit, the consumer receives a unit price p.[9]

Let the utility for each disposal mode be represented by an additively separable function of the environmental benefit minus the net cost of disposal. The person's wage rate, w, reflects opportunity cost of time.[10] The warm glow environmental benefit e(w) that the consumer derives for each bottle recycled is assumed to be the same whether the bottle is recycled at the curb or returned for deposit. There is no warm glow benefit associated with garbage that is not recycled.

For each recycling mode, there is a fixed cost time component as well as a time cost component that increases linearly with the number of bottles recycled. Thus, the time commitment t_c for recycling c bottles with curbside recycling is

$$t_c = t_{c0} + t_{c1}c \,, \tag{1}$$

and for d bottles returned for deposit it is

$$t_d = t_{d0} + t_{d1}d \,, \tag{2}$$

[8] Similar formats that focus on the recycling stage decision are used by Kinnaman and Fullerton (2000), Jenkins et al. (2003), and Beatty et al. (2007).

[9] If the bottles are returned to a recycling center in a no deposit state, the price is zero.

[10] For simplicity, we abstract from the exogenous labor supply decision and focus on the wage rate w. Assuming a fixed predetermined number of hours worked, the wage rate also serves as a measure of the level of income.

and for g bottles put in the garbage it is

$$t_g = t_{g0} + t_{g1}g \ . \qquad (3)$$

The personal cost of this time commitment is $t_c w$, $t_d w$, and $t_g w$ for the three different types of bottle disposal. States that have effective recycling programs, such as those with convenient curbside recycling and accessible recycling centers, promote recycling by decreasing the recycling cost components. In some instances the cost structure may be different, as when drinking bottled water at a sporting event or while traveling, in which case even diligent recyclers may not find it desirable to recycle their bottles.

The attractiveness of any recycling option will depend on the other choices available and whether the particular recycling mode is already being used, in which case the fixed cost component of the time cost drops out. There are many commonalities across the different recycling options, and these general economic aspects of the decision will be our focus here rather than attempting to inventory results for every disposal combination.

Curbside Recycling Versus Garbage

Consider first a binary decision of whether to recycle n bottles curbside or to put the bottles in the garbage, where we assume that this is the initial disposal for each mode.[11] Curbside recycling will be more attractive if

$$e(w)n - (t_{c0} + t_{c1}n)w > -(t_{g0} + t_{g1}n)w \ . \qquad (4)$$

Recycling at the curbside is preferable if the environmental benefit exceeds any net cost in disposal time, or

$$e(w)n > [(t_{c0} - t_{g0}) + (t_{c1} - t_{g1})n]w \ . \qquad (5)$$

[11] If the consumer already uses the garbage disposal mode for other items, $t_{g0} = 0$.

The net marginal effect of higher wage rates on the components of inequality 5 hinges on whether the marginal increase in environmental benefits for recycling n units, e'(w)n, exceeds the increased time cost per unit wage given by $[(t_{c0} - t_{g0}) + (t_{c1} - t_{g1})n]$. Theoretically, the net effect of higher wage rates is ambiguous as higher wage rates boost the opportunity cost of time but also raise the environmental benefit value.

How much people will choose to recycle will depend on a succession of marginal choices, but it may be preferable to adopt a common recycling strategy for all bottles. Suppose that it is desirable for a consumer to recycle n bottles at the curb, and that the consumer already uses garbage disposal for other items so that $t_{g0} = 0$.[12] Then the overall comparison of the benefits of recycling these n bottles rather than putting them in the garbage is

$$e(w)n - (t_{c0} + t_{c1}n)w > -t_{g1}nw, \tag{6}$$

or

$$e(w) > \frac{t_{c0}}{n} + \left(t_{c1} - t_{g1}\right)w . \tag{7}$$

For the n + 1'st bottle, the use of curbside recycling will be preferred if

$$e(w) - t_{c1}w > -t_{g1}w , \tag{8}$$

which can be written as

$$e(w) > (t_{c1} - t_{g1})w . \tag{9}$$

But since

$$\frac{t_{c0}}{n} + \left(t_{c1} - t_{g1}\right)w > \left(t_{c1} - t_{g1}\right)w , \tag{10}$$

[12] The analysis if no garbage disposal is already being used is generally less realistic.

if inequality 7 is satisfied so that it is desirable to recycle n bottles, then it will also be desirable to recycle n + 1 bottles. Consumers will tend to gravitate to corner solutions of no recycling or complete recycling.

Returning Bottles for Deposit Versus Garbage

Returning bottles for deposit as opposed to disposing of the bottles in the garbage differs from the curbside analysis in that there is a deposit return amount of p per bottle. A consumer will return n bottles for deposit rather than disposing in the garbage if

$$e(w)n - (t_{d0} + t_{d1}n)w + pn > -(t_{g0} + t_{g1}n)w \,, \tag{11}$$

which can be rewritten as

$$e(w)n + pn > [(t_{d0} - t_{g0}) + (t_{d1} - t_{g1})n]w \,. \tag{12}$$

The presence of the deposit amount adds a deposit benefit term to the left side of inequality 12 as compared to the condition for curbside returns in inequality 5. The corner solution analysis for bottle returns follows the same approach as for curbside recycling and leads to the same result.

Returning Bottles for Deposit Versus Curbside Recycling

Finally, the decision to return bottles for deposit rather than to recycle them curbside is driven solely by the cost components, as the environmental benefits cancel and consequently will be netted out of the comparison below. It will be preferable to return n bottles for deposit if

$$e(w)n - (t_{d0} + t_{d1}n)w + pn > e(w)n - (t_{c0} + t_{c1}n)w \,, \tag{13}$$

or

$$p > (1/n)[(t_{d0} - t_{c0}) + (t_{d1} - t_{c1})n]w \,. \tag{14}$$

Increased bottle deposit amounts boost the relative attractiveness of bottle returns as a recycling option.

As with the previous analysis, corner solutions tend to dominate. If it is desirable to return n bottles for deposit as opposed to curbside recycling, it will also be desirable to return the next bottle for deposit. If the consumer already uses curbside recycling as well as returning bottles for deposit, the bottle return desirability condition for the next bottle returned for deposit is

$$p - t_{d1}w > -t_{c1}w , \quad (15)$$

or

$$p > (t_{d1} - t_{c1})w . \quad (16)$$

The condition that it is optimal to return the initial n bottles for deposit when curbside recycling is already used is

$$p > [(1/n)(t_{d0}) + (t_{d1} - t_{c1})]w , \quad (17)$$

which is a more stringent test than inequality 16.

If the consumer uses bottle returns for the n bottles but does not yet use curbside recycling, then if the consumer is engaged in a continuous decision of whether to recycle each incremental bottle, it would not be desirable to switch to curbside recycling and incur the fixed time costs of curbside recycling if it was not desirable for previous bottles. If we ignore the fixed cost component of both types of recycling, then the analysis follows the previous discussion of bottle returns versus curbside recycling when the consumer already does both. Once again consumers choose corner solutions.

Empirical Predictions

This exploration of recycling decisions has led to several empirical predictions. First, people will prefer discrete modal choices in their recycling behavior. Thus, to the extent that policies such as curbside recycling laws or bottle deposit laws are influential, people will switch

from doing little or no recycling of that type to using that mode almost exclusively. Because of this discontinuous response, there should be few individuals with intermediate levels of recycling for any particular recycling mode. Second, placing a high value on the warm glow effect increases the attractiveness of recycling by curbside or through bottle returns as compared to putting the bottles in the garbage. But if the environmental utility value is identical for both recycling and returns, this environmental benefit component will not have a differential effect across those domains. Third, bottle deposits increase the attractiveness of recycling bottles. Fourth, higher income levels have ambiguous effects on the impact of recycling laws, as income raises perceived environmental benefits, boosts the time costs of recycling, and may make deposits less consequential.

3. Sample Characteristics and Recycling Laws

The data set used in the empirical analysis is part of a larger 2008 national survey of households undertaken for this study by Knowledge Networks. The survey is Web-based, administered to a nationally representative sample, with a 71% response rate. While the entire survey took around 25 minutes, the sections on individual attitudes and practices related to drinking water and recycling took less than 10 minutes.

The focus of our analysis is on the recycling of plastic bottles for bottled water. As a result, we restrict the sample to the 2,550 people who indicated that they use bottled water.[13] All empirical analyses reported in this article include these 2,550 people in the sample. The recycling question for the plastic bottles was the following: "Out of every 10 plastic bottles, how

[13] The sample is restricted to the 2,550 respondents who indicated how often they recycle their bottles, which led to the exclusion of 23 observations. For many of the excluded respondents the disposal question was not pertinent. For example, the plastic jugs for water coolers may be collected on a regular basis by the supplier.

many would you say that you recycled or returned for reuse?" On average, the sample members indicated they recycled or returned a mean of 6.0 out of 10 plastic water bottles. This amount is greater than the U.S. Government Accountability Office's estimate of a 24% recycling rate constructed by combining aggregative data from multiple sources.[14] The main matter of interest is how the return rate varies with the different recycling and bottle deposit regimes and, in particular, whether the economic incentives created by these regimes influence recycling behavior.

Table 1 summarizes the sample characteristics of the variables used in the analysis. Bottled water drinkers tend to be relatively affluent, disproportionately female, and middle-aged. Over one-third of bottled water users consider themselves to be environmentalists, and 9 percent are members of national environmental groups.[15] On average, they spend just under $12 per month on bottled water.

The two types of legal contexts of interest are bottle deposit laws and state recycling policies. Bottle deposits create a direct financial incentive for recycling bottles for which deposits are required, which in most states does not include plastic water bottles. The deposit rate is 5 cents per bottle except in Michigan where the rate is 10 cents. The unit price deposit raises the price paid at the time of purchase, but for every bottle returned to a recycling location or to stores that accept recycled bottles, the recycler is paid the deposit amount. The bottle can

[14] The U.S. Government Accountability Office (2009), pp. 23-24, constructed this estimate using data for 2006 from beverage industry representatives and environmental nonprofit organizations, but does not provide the details of the data inputs or how the various components of the calculation obtained from these groups were combined. Our individual survey data is more comprehensive and precise than this approach and is based on the population of water bottle users, who tend to be more affluent with higher recycling rates. The main caveat with respect to our survey results is that recycling rates may not be revealed accurately. To the extent that the responses indicate the relative degree of recycling rather than the actual quantity of recycling, the statistical analysis below will account for that possibility.

[15] These groups included Environmental Defense Fund, Greenpeace, National Audubon Society, National Wildlife Federation, Nature Conservancy, Natural Resources Defense Council, and Sierra Club.

be recycled by anyone and need not be recycled by the original purchaser.[16] Non-water bottle deposit laws are common, as 28% of the sample members reside in the states with such laws, but only 13% of the sample reside in the four states (California, Hawaii, Maine, and Oregon) that had bottle deposit laws in 2008 that included plastic water bottles.

The survey inquired whether the respondent received payment for plastic bottle recycling. The survey responses follow the expected pattern given the bottle deposit regime in the respondent's state of residence. The theory developed earlier suggests that bottle deposit requirements for other types of bottles may increase the recycling of water bottles. Such bottle deposits may lead consumers to sort their garbage and bring the bottles for which there are deposits to a recycling center. To the extent that there are fixed costs associated with returning bottles to a recycling center, the additional costs of also bringing the plastic water bottles will be less than if there were no bottle deposit policies. Recycling centers in states with bottle deposit requirements often also include opportunities to recycle plastic water bottles even though there is no payment for such recycling.

There is considerably more diversity in the structure of recycling laws across states. State laws often include one or more regulatory components, which are summarized in the Appendix. For example, a state with mandatory recycling may also include recycling goals. For purposes of categorization, we treat states hierarchically in terms of the most stringent component in the state's recycling law. States are grouped into those that have mandatory recycling, those that provide an opportunity for recycling, those that establish a recycling plan, those that establish recycling goals but lack a specific plan, and those that have no recycling law.

[16] For example, homeless people and scavengers often collect bottles from curbside recycling bins and return the bottles for cash. This leeway no doubt contributes to the role of bottle deposits as an income supplement for the poor, which in turn decreases crime rates. See Ashenmiller (2006, 2008, 2009).

The subsequent empirical analysis indicates that recycling goals alone do not have a statistically significant effect on recycling whereas the other three recycling laws do. Thus, for purposes of our first two overview tables we refer to the states with mandatory recycling, opportunities for recycling, or regional waste management plans with recycling considerations as effective recycling laws.

Table 2 summarizes the recycling practices for water bottle users under different recycling regimes. The average number of bottles out of 10 that are recycled rises from 4.38 for states with no effective recycling law and no water bottle deposit law to 6.10 if the state also has an effective recycling law and to 8.34 if the state also has a water bottle deposit law. All states with a water deposit law also have an effective recycling law.

The most prevalent form of recycling is that of curb recycling. Almost half of all water bottle users use curb recycling for some of their bottles, but this percentage drops to under one-third if the state does not have an effective recycling law. Only one-fifth of the sample returns bottles for deposit or takes them to a recycling center. In states with water bottle deposit laws, almost half of the sample returns the bottles for deposit, and the percentage using curbside recycling is not substantially lower than in states without such bottle deposit laws. By far, the most prevalent form of recycling for deposit refunds is taking the bottles to a recycling center rather than returning the bottles to a store for deposit or having the bottles collected by the bottler (e.g., plastic water cooler bottles).

The distribution of the number of bottles recycled shown in Table 3 is consistent with the model of behavior in that recycling behavior is a discrete rather than a continuous decision. For all bottled water users, 29.6% recycle 0 bottles out of 10, while 40.9% recycle 10 out of 10. The next most prevalent levels of recycling are 9 and 8 bottles out of 10, as people attempt to recycle

most but not all of their bottles, perhaps because they are drinking the water in the car or at some other location. Interestingly, there is minimal clustering of responses at 5 out of 10, which one might have expected if respondents were focusing on salient numerical responses rather than attempting to assess their actual recycling amount.

Columns 2-4 in Table 3 break the sample by three recycling regime categories. The respondents in column 2 have no effective recycling law or water bottle deposit law, with the result that 46.3 percent of that group recycles 0 out of 10 bottles. Just over a quarter of respondents in this weak recycling policy regime indicate that they recycle all water bottles.

The first recycling policy shown in Table 3 is the presence of an effective recycling law but no water bottle deposit law. Such a law shifts the mass of the distribution, decreasing the percentage of respondents who indicate they do not recycle at all, and increases the percentage who indicate 100% recycling.[17] Column 5 presents the difference between columns 2 and 3, which is the average effect across states with no recycling laws and the effective recycling laws. Almost the entire mass shift is from 0 out of 10 bottles recycled to 9 or 10 bottles recycled. Because of the bimodal nature of recycling decisions, there is little effect on the intermediate recycling amounts.

The introduction of water bottle deposits shown in column 4 has an even greater additional effect than the incremental influence of effective recycling laws.[18] The percentage of

[17] For areas with curbside recycling, Jenkins et al. (2003) found that for plastic bottles generally, 54.2% recycled over 95% of the bottles, 28.0% recycled 11-95%, and 17.8% recycled 0-10%.

[18] This result is consistent with Ashenmiller's (2009) finding that bottle deposit laws increase the amount of material recycled at Santa Barbara, CA redemption centers. Beatty et al. (2007) find that curbside recycling largely cannibalizes the effect of drop-off recycling centers when incomes are high or unemployment is low. Their analysis is within state for California, but if the comparison instead is with states with no effective recycling law, then the incremental effect of such recycling policies potentially may be greater. Several previous studies focused on bag/tag programs and pricing by weight programs. Reschovsky and Stone (1994), Fullerton and Kinnaman (1996), Kinnaman and Fullerton (2000), and Jenkins et al. (2003) found no statistically significant effect of unit pricing on

respondents who do not recycle drops to 7.7%, and those who recycle 10 out of 10 rises to 62.8%. As the calculation of the differences in column 6 indicates, there is a negligible incremental effect of water bottle deposits except at the tails of the distribution, where the 0 recycling percentage drops by 20.5% and the 10 out of 10 group increases by 21.8%.

The consistent pattern across all these results is that most people tend to adopt a recycling strategy of either being a diligent recycler or not recycling at all. The introduction of effective recycling laws or water bottle deposit laws consequently has a discontinuous effect across the distribution of recycling patterns as they shift recycling levels through a transformative effect on behavior.

4. Determinants of the Total Recycling Amount

The first series of regression analyses focuses on the proportion of water bottles recycled. To examine robustness across analyses, three different estimation approaches are used. The first column in Table 4 presents ordinary least squares (OLS) estimates for which we report robust heteroskedasticity-corrected standard errors. To take into account the bounded nature of the responses that cluster at 0 and 10, the second column of Table 4 presents the two-sided Tobit regression estimates. Finally, one might hypothesize that respondents were not giving precise estimates of the actual number of bottles recycled but were simply indicating their relative degree of recycling and perhaps overstated the actual number of bottles recycled. The final column of Table 4 presents the ordered logit estimates for which the three ordered categories are

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recycling. Van Houtven and Morris (1999) found that unit pricing affected whether people recycle but not the amount of recycling.

0, 1-7, and 8-10.[19] This formulation of the model addresses the possibility that the responses have ordinal rather than cardinal significance.[20] Moreover, the categories reflect the different discontinuous recycling groupings of consumers. Because of the strong parallels across the three analyses, the discussion here focuses on the OLS estimates.

The first pair of policy variables pertains to the state's bottle deposit laws. The deposit state variable is a 0-1 indicator variable for whether the state has a bottle deposit law. A second 0-1 variable then indicates if the deposit law covers water bottles. Both of the deposit state variables raise the number of bottles recycled. The broad deposit variable raises the recycled number by 0.7 out of 10 bottles, while the presence of a water bottle deposit law increases plastic water bottle recycling by 1.2 out of 10 bottles. Together, consumers in states with both laws recycle an additional 1.9 out of 10 bottles, controlling for all other influences, including the recycling regime.

The next set of three variables pertains to the state recycling law. The two most stringent forms of laws—mandatory recycling and required opportunities for recycling—are combined into a single category of 10 states plus the District of Columbia because of the small size of the component groups for which it is not possible to reject the hypothesis that the coefficients for these two categories are equal.[21] These laws should have the greatest influence since they have the greatest effect on the costs of recycling as they make available low cost recycling options, and in the case of mandatory recycling, impose penalties on those who fail to recycle. Laws that

[19] Other ordered logit specifications yielded similar results. For example, treating each of the 0 to 10 responses as a separate ordered response leads to estimates that have the same signs and statistical significance as those reported here.

[20] Jenkins et al. (2003) also use an ordered logit approach to analyze categorical responses for recycling behavior that they collapsed into three gradations of recycling rates. Similarly, Halvorsen (2008) uses an ordered probit model.

[21] The F test had a value of 2.92 with a probability value of 0.09. Similarly, Jenkins et al. (2003) found that for plastic bottles generally, mandatory recycling had no additional effect when curbside recycling is already available.

require either mandatory recycling or the opportunity to recycle increase recycling by 1.6 out of every 10 bottles.

Laws that only require regional waste management plans with recycling considerations also have a significant positive effect on recycling, boosting the recycling out of 10 bottles by 1.1 bottles. This effect has a smaller point estimate than that of the more stringent mandatory/opportunity recycling laws, and it is possible to reject the hypothesis that the planning variable is of the same magnitude as the mandatory/opportunity variable.[22]

The weakest of the recycling law variables is that in which the state has a waste reduction goal, but no required action. This variable does not have a statistically significant effect compared to the no recycling law states.[23] The pattern of coefficient magnitudes is consistent with the relative stringency of the laws. Mandatory/opportunity laws have the greatest effect, followed by planning laws, with no statistically significant effect of the weakest laws that are limited to specifying a waste reduction goal. Because of the significant effects on recycling of mandatory/opportunity laws and planning regimes we refer to these as the effective recycling laws.

Higher income levels increase the time opportunity costs of recycling but may also increase the value the consumer places on recycling if environmental quality is a normal good. Although the direction of the effect is unclear theoretically, the net effect of income on the number of bottles recycled is positive, as is the effect of education, which serves as a measure of

[22] The pertinent F value is 5.97, with probability value 0.0146.

[23] Planning states are more effective than goals states. The F statistic for the test for whether the planning variable coefficient equals that of the goals variable is 10.08, with a probability value of 0.002.

lifetime wealth.[24] The analysis includes a coefficient for the highest income category (greater than $175,000/year) where the value of incentives should be the least strong. The coefficient was negative as expected, but did not approach significance (p>.20). Thus, it appears that for recycling, the impact of wealth in raising the opportunity costs of recycling is not as strong as its positive impact on the environmental utility from recycling.

The value that the respondents place on environmental quality is captured directly by whether the respondents consider themselves to be environmentalists as well as by whether the respondent is a member of a major national environmental organization.[25] Each of these variables has the expected positive effect, with people who consider themselves to be environmentalists recycling an additional 1.6 out of 10 bottles, and environmental organization members recycling an additional 0.5 bottles after taking into account the effect of being an environmentalist and other variables.

Several of the other personal characteristic variables are influential as well. Recycling rates increase with age, are lower for African Americans, and are higher for larger households. Recycling rates are higher for homeowners, which may reflect the greater availability of curbside recycling and recycling locations to this group. The volume of recycling as measured by the dollars spent on bottled water does not have a significant effect, but including this variable nevertheless serves an important role in the analysis to account for the volume of bottled water purchased. Otherwise, variables such as income might be capturing the quantity effect. Use of

[24] In contrast, income and education did not significantly affect plastic bottle recycling in Jenkins et al.'s (2003) study that was restricted to primarily middle and upper income groups. Collins et al. (2006) found that recycling rates increase with income in Scotland.

[25] Previous studies concerned with the household's pro-environment preferences include Halvorsen's (2008) study of recycling in Norway.

bottled water in the car does not significantly reduce recycling even though recycling may be more difficult for such users, and reusing water bottles does not affect the recycling rate.

The regional variables are influential and indicate the considerable geographic differences in recycling rates. Urban and suburban residents of metropolitan statistical areas (MSAs) recycle an additional 1.5 out of 10 additional bottles, a result consistent with the greater availability of curbside recycling and convenient recycling centers in such locales. Compared to the omitted regional category the Midwest, people recycle 1.3 more bottles out of 10 in the Northeast and 1.0 fewer bottles in the South.

The efficacy of the policy measures in promoting recycling behavior may vary across the populations and in different policy regimes. In regressions not reported, there are two interaction effects that are statistically significant—the effect of income and being an environmentalist on the effect of water bottle deposits. Higher income levels diminish the marginal effect of water bottle deposits to such an extent that in water bottle deposit states people with lower income levels recycle somewhat more, whereas in deposit states higher income is associated with lower levels of recycling. Put differently, deposit laws produce a greater change in recycling from lower compared with higher income residents.[26]

There is also a negative interaction effect of the deposit on water bottles with whether the respondent is an environmentalist.[27] While self described environmentalists exhibit greater recycling rates than non-environmentalists, the existence of the bottle return deposit policy

[26] The coefficient (std. error) for the income interaction with the state water bottle variable is -0.1330 (0.0406), and 0.0926 (0.0254) for the income variable. These estimates are drawn from an equation that also includes an interaction of the environmentalist variable with water bottle deposits. The income effect pattern is consistent with Ashenmiller's (2009) finding that bottle returns are a relatively more important income source for people in lower income groups.

[27] A comparable interaction with being a member of an environmental organization did not have a statistically significant effect.

narrows the gap.[28] Despite the weakening of the bottle deposit effect for environmentalists, on balance the self described environmentalists return 0.9 additional bottles out of 10 in states with bottled water deposit laws. The income and environmentalist interaction effects with the recycling law variables were not statistically significant, perhaps because the effect of the water bottle deposit variable on recycling exhibits more heterogeneity than does the recycling law variable.

5. Determinants of Curb Recycling and Returning Bottles for Deposit

While both recycling laws and bottle deposit laws should each increase the degree to which people recycle plastic water bottles, the composition of the recycling should differ. Laws that increase the availability of curb recycling reduce the costs of curb recycling relative to returning the bottles to a recycling center and should have a positive effect on curb recycling and a negative effect on returning bottles for deposit. Likewise, water bottle deposit laws increase the economic benefits of returning bottles for deposit, consequently increasing the likelihood of returning the bottles and decreasing the attractiveness of using curbside pickup for which there is no payment. The analysis below tests these propositions by focusing on respondent answers to a question regarding two forms of recycling behavior over the past month.[29]

The probit regression for whether the respondent used curbside recycling for plastic water bottles in the past month is reported in Table 5. For these and all subsequent probit estimates, all coefficients have been transformed to reflect marginal probabilities. If the state has a deposit

[28] The coefficient (std. error) is -0.8397 (0.3707) for the environmentalist-water bottle deposit interaction and 1.7396 (0.1805) for the environmentalist variable in that equation.

[29] The question wording (without the specific formatting on the respondent's screen) was as follows: "In the last month, have you recycled your empty plastic bottles using : Curbside recycling…1, Take recycling to a recycling station…2, Return bottles for deposit…3, Bottler collects empty bottles when new ones are delivered…4, I have not recycled plastic bottles…5."

policy for plastic water bottles, the probability that the respondent uses curbside recycling decreases by 0.13. There is clearly some partial substitution as water bottle deposits make curbside recycling less attractive. Residents of states that have mandatory recycling or opportunity for recycling laws have a 0.23 higher probability of using curbside recycling for plastic water bottles, while states with recycling plans have a 0.14 higher probability of using curbside recycling than residents of states with no recycling laws. By contrast, the presence of recycling goals has no statistically significant effect on use of curbside recycling.

Many of the other patterns shown in Table 5 parallel the earlier results with respect to the number of bottles recycled. The use of curbside recycling is an increasing function of income, education, age, whether the respondent is an environmentalist, and whether the respondent lives in a MSA or in the Northeast. Respondents who indicate that they reuse their water bottles are less likely to use curb recycling for these bottles, with the curbside recycling probability declining by 0.11 for each time the person reuses the bottle. However, as shown earlier, the lower use of curbside recycling does not reduce the overall percentage of bottles that they recycle.

The presence of bottle deposits for plastic water bottles should foster the returns of these bottles. Table 6 includes three sets of probit estimates for the probability that the respondent returns bottles to the recycling center or for deposit and for the two components of this probability—whether the respondent took the bottles to the recycling center or returned the bottles, presumably to a store where such bottles are purchased.[30]

[30] The return for deposit probit omits three variables included in the other equations: state requires a recycling goal, missing variable indicator for considers self environmentalist, and missing variable indicator for environmental organization member.

The overall return probability for plastic bottles increases by 0.25 if the state has a water bottle deposit law and by an additional 0.07 if it is a deposit state generally. Financial incentives to return bottles are effective, and the presence of other deposit requirements also boosts the return rate because there will be a greater total payoff to bottle returns. In terms of the composition of the influence, the bottle deposit variable has a much stronger influence on returning bottles to the recycling center than returning bottles for deposit. This greater marginal effect may be because returning bottles for deposit to the store does not involve additional fixed costs if a trip was already planned for shopping.

Bottles recycled at curbside will not give consumers a financial payoff, but the presence of curbside recycling in providing the environmental benefit may reduce the relative utility of returning the bottles. Indeed, for respondents in states with the strongest recycling laws that provide for mandatory recycling or the opportunity to recycle, there is a 0.07 lower probability of returning the bottles for a deposit. This effect reduces the benefit of water bottle deposits by about one-third. By contrast, neither of the other two recycling legal regime variables affects bottle returns.

The principal demographic factors that influence deposit returns are income and whether the respondent is an environmentalist. Income has a negative effect because the time cost of bottle returns is higher and the financial gains from returning bottles for money are less consequential for those in higher income groups. Environmentalists are more likely to return the bottles for deposit. However, in results not reported, the interaction of the environmentalist variable with the deposit on water bottles variable is negative, indicating, as one would expect, that financial incentives are less compelling for those with an avowed commitment to the environment.

6. Conclusion

Water bottle deposits and recycling laws foster recycling efforts in different ways. The bottle deposits provide a financial inducement to recycle, while the recycling laws reduce the time costs by providing curbside recycling and convenient recycling centers. Recycling laws also may include financial penalties for noncompliance. We find both water bottle deposits and recycling laws to be effective. Moreover, the pattern of effects for the recycling laws parallels the degree of stringency of these measures. And while there is clearly some substitution that takes place when both deposit laws and recycling laws are present, on balance there is a net beneficial effect of having both policy instruments in place.

The central role of economic analysis in predicting the consumer response manifests perhaps most clearly in the stark pattern of individual recycling activity. Given the high fixed cost associated with recycling efforts, the hypothesis generated from rational economic behavior theory is that people will tend to gravitate toward extremes in their efforts, recycling either a few or most of their bottles. Empirically, this prediction is borne out, as there are few intermediate recyclers. Both recycling laws and bottle deposit laws have discontinuous effects on recycling behavior. In each case, the measures have a transformative effect, shifting individual consumers from not recycling at all to becoming committed recyclers.

The heterogeneity of recycling behavior is also of economic interest. For people in upper income groups, the positive income elasticity of the valuation of environmental quality outweighs the influence of the greater opportunity costs of time. Similarly, self described environmentalists likewise tend to recycle more. However, for these two instances, bottle deposits are less effective in bolstering the incentives to recycle. As follows from the all or

nothing response to incentives, policies have their greatest effect among those who would not already choose to recycle.

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Appendix: Bottle Deposit Laws and State Recycling Laws

Concerns about diminishing landfill space have prompted many states to pass legislation encouraging recycling.[31] States with the highest disposal fees and limited amounts of disposal capacity remaining were the first to pass waste reduction legislation. Recycling was seen as a good waste management alternative to controversial methods such as incineration. The legislation has taken various forms in different states; states have set waste reduction goals, required comprehensive local planning, adopted disposal bans, enacted mandatory provisions for source separation and curbside recycling, and required refundable deposits on containers.

Bottle Deposit Laws

A bottle deposit bill, or container deposit law, requires a refundable deposit on beverage containers, usually about 5 to 10 cents, and encourages consumers to return these containers for recycling to receive their deposit back.[32] As of 2009, eleven states—California, Connecticut, Delaware, Hawaii, Iowa, Maine, Massachusetts, Michigan, New York, Oregon, and Vermont—have bottle deposit laws. These states represent 29 percent of the U.S. population and 28 percent of our sample. Five of these states—California, Connecticut, Hawaii, Maine, and Oregon—include deposits on bottled water in their regulatory scheme.[33] Most states have a modest 5 cent deposit on beverages; only Michigan has a 10 cent deposit on all covered beverages. Six states

[31] For discussion of the legal and policy context for the emergence of recycling laws see Tchobanoglous and Kreith (2002) and Gaba and Stever (2008).

[32] The exact deposit system can vary from state to state. The Bottle Bill Resource Guide, www.bottlebill.org/about.htm, provides information on each state's bottle bill.

[33] Connecticut's addition of bottled water to its bottle deposit scheme became effective April 1, 2009. New York has already passed a bill that would add bottled water, but a court order has delayed implementation of this bill until at least 2010.

retain the unredeemed deposits, which provide state revenue in the millions.[34] Many states without bottle deposit bills are contemplating such legislation. Seven states considered new deposit bills and three states considered updates to their existing deposit bills in 2009.[35] Connecticut and New York both passed updated bills allowing the state to retain unredeemed deposits.[36] While Connecticut's update has already been implemented, New York's update has been delayed by a court ruling.[37] The seven states with new deposit bill proposals were Florida, New Hampshire, New Jersey, New Mexico, North Carolina, Tennessee, and West Virginia. Most of these state bills proposed bottle deposits of at least 10 cents—with Florida's bill proposing 20 to 30 cent deposits.[38] Florida's bill is the only bill to propose that bottlers retain unclaimed deposits; the rest proposed that the state retains unredeemed deposits.[39] All proposed laws, except New Hampshire's, would cover water bottles.

State Recycling Laws

State laws that mandate source separation and recycling or ban disposal of certain materials in almost all municipalities were especially popular in the late 1980s and early 1990s. Many of these laws require all municipalities, counties, or cities to establish pick-up of separated materials at curbside or other convenient locations.[40] These kinds of programs are usually

[34] This statistic includes Michigan, which has a mixed system, but does not include New York, which passed a bill that would create a mixed system, but implementation of this bill has been delayed.
[35] Maryland only considered setting up a task force to study the possibility of a bottle deposit, so it was not included in this statistic.
[36] New York's bill would also add water bottles to its list of bottles covered by the deposit.
[37] Confessore, Nicholas. Bottle Bill, Bottled Up, City Room, *N.Y. Times* (May 27, 2009), available at http://cityroom.blogs.nytimes.com/2009/05/27/bottle-bill-bottled-up/?scp=1-b&sq=bottle+deposit+new+york&st=nyt.
[38] Only Tennessee and one West Virginia bill proposed 5 cent deposits.
[39] New Jersey's bill proposed a mixed retention plan, where the state retains 75 percent of the unredeemed deposits.
[40] Kinnaman (2005, 2006) finds that about 18 to 22 states mandate curbside recycling. Because we were unable to confirm this number for 2008, we group states with comprehensive statewide recycling provisions with those with mandatory curbside recycling programs.

implemented at the municipality or county level,[41] but statewide recycling initiatives are also possible. For example, Pennsylvania requires all municipalities with more than 5,000 people to offer curbside recycling. In 2004, there were 974 curbside recycling programs in Pennsylvania, serving roughly 80 percent of the population.[42] In addition to the curbside recycling requirement, Pennsylvania requires all citizens to separate at least three materials from their other waste and to store the materials until collection. Connecticut, the District of Columbia, West Virginia, and Wisconsin have passed similar "mandatory" recycling laws. Table A1 summarizes these laws and provides excerpts from key provisions of the laws.

Other states have required all municipalities to give residents an "opportunity to recycle." Minnesota, for example, requires all counties to make curbside pickup or collection centers for recyclable materials available at sites that are convenient for residents to use. In 2004, there were 730 curbside recycling programs in Minnesota, serving roughly 72 percent of the population.[43] Arizona, Arkansas, Florida, Oregon, and Washington have passed similar laws ensuring adequate recycling opportunities for their populations. These laws are grouped with mandatory recycling laws in Table A1.

[41] In 2007, more than 8,600 curbside recyclables collection programs were reported in the United States (EPA 2007). The EPA (2007) found that 84 percent, 76 percent, 61 percent, and 30 percent of the populations in the Northeast, West, Midwest, and South, respectively, were served by curbside recycling. These percentages are calculated based on the populations in states reporting data.

[42] The number of curbside recycling programs and the population with access to curbside collection (10,000,000) was taken from Simmons et al. (2006). The percentage of the population with access to curbside collection was calculated using Pennsylvania's estimated population in 2004, prepared by the State Data Center of the Pennsylvania State University (12,406,292), available at http://www.dsf.health.state.pa.us/health/lib/health/Vital_Stat/2004/2004_statepop.pdf.

[43] The number of curbside recycling programs and the population with access to curbside collection (3,750,000) is from Simmons et al. (2006). The percentage of the population with access to curbside collection was calculated using Minnesota's estimated population in 2005, prepared by the U.S. Census Bureau (5,174,743), available at http://www.census.gov/population/projections/SummaryTabA1.pdf.

Many states have sought to encourage recycling at the local level by either requiring local governments to consider recycling initiatives in their waste reduction plans or setting statewide recycling goals. The local planning requirements frequently force counties or municipalities to assess their current recycling programs and to consider more comprehensive programs in the future. All of the states that have mandatory recycling or opportunity to recycle programs have planning requirements and most have a statewide recycling goal. The remaining states that have a planning requirement are summarized in Table A2, which provides documentation of the applicable laws. Finally, the states that only have a statewide recycling goal are summarized in Table A3, which also lists the specified recycling goal amount. It is not clear whether such goals are followed by policies that are implemented in order to achieve these goals.

Appendix Table A1: States that either require recycling or an opportunity to recycle

State	Mandatory recycling (M) or opportunity to recycle (O)	Source	Notes	State recycling or waste reduction goal?
Arizona	O	Ariz. Rev. Stat. Ann. § 9-500.07.	"A city or town shall provide its residents with an opportunity to engage in recycling and waste reduction."	No
Arkansas	O	Ark. Code Ann. § 8-6-720.	"Each regional solid waste management board shall ensure that its residents have an opportunity to recycle."	Yes (40%)
Connecticut	M	Conn. Gen. Stat. § 22a-241b.	"The Commissioner of Environmental Protection shall adopt regulations... designating items that are required to be recycled.... Each person who generates solid waste from residential property shall… separate from other solid waste the items designated for recycling pursuant to subsection (a) of this section."	Yes (25%)
DC	M	D.C. Code § 8-1007.	"Occupants of residential property shall separate from their solid waste and separately bundle or containerize all yard waste and newspaper for recycling… [and] all metals and glass in 1 container."	Yes (45%)
Florida	O	Fla. Stat. § 403.706.	"A county with a population of 100,000 or less may provide its residents with the opportunity to recycle in lieu of achieving the goal set forth in paragraph (a)."	Yes (30%)
Minnesota	O	Minn. Stat. § 115A.552.	"Counties shall ensure that residents, including residents of single and multifamily dwellings, have an opportunity to recycle."	Yes (35%)
Oregon	O	Or. Rev. Stat. §§ 459A.005 to .010.	"The 'opportunity to recycle' means at least that the city, county or metropolitan service district responsible for solid waste management... [p]rovides a place for collecting source separated recyclable material located either at a disposal site or at another location more convenient to the population being served and, if a city has a population of 4,000 or more, collection at least once a month of source separated recyclable material from collection service customers within the city's urban growth boundary."	Yes (50%)

Appendix Table A1: States that either require recycling or an opportunity to recycle (cont'd.)

State	Mandatory recycling (M) or opportunity to recycle (O)	Source	Notes	State recycling or waste reduction goal?
Pennsylvania	M	53 Pa. Cons. Stat. Ann. § 4000.1501.	"The source-separation and collection program shall include... [a]n ordinance or regulation adopted by the governing body of the municipality, requiring... [p]ersons to separate at least three materials deemed appropriate by the municipality from other municipal waste generated at their homes, apartments and other residential establishments and to store such materials until collection."	No
Washington	O	Wash. Rev. Code Ann. § 70.95.090.	"In urban areas, these programs shall include collection of source separated recyclable materials from single and multiple family residences... In rural areas, these programs shall include but not be limited to drop-off boxes, buy-back centers, or a combination of both, at each solid waste transfer, processing, or disposal site, or at locations convenient to the residents of the county."	Yes (50%)
West Virginia	M	W. Va. Code Ann. § 22-15A-18.	"Each municipality with a population of ten thousand or more people… shall establish and commence implementation of a source separation and curbside collection program for recyclable materials."	Yes (50%)
Wisconsin	M	Wis. Stat. Ann. §§ 287.07 to .09.	"No person may dispose of in a solid waste disposal facility or burn without energy recovery in a solid waste treatment facility in this state any of the following: [e.g., aluminum cans, newspaper and other paper, foam packaging, glass bottles, magazines, plastic containers, etc.]."	No
Notes: All of these states have a planning requirement.				

Appendix Table A2: States that require regional waste management plans with recycling considerations

State	Source for plan requirements	State recycling or waste reduction goal?
Alabama	Ala. Code § 22-27-45.	Yes (25%)
California	Cal. Pub. Res. Code § 41821.	Yes (50%)
Hawaii	Haw. Rev. Stat. § 342G-26.	Yes (50%)
Illinois	415 Ill. Comp. Stat. Ann. 15/4.	Yes (25%)
Iowa	Iowa Code Ann. § 455B.306.	Yes (50%)
Maine	Me. Rev. Stat. Ann. tit. 38, § 2133.	Yes (50%)
Maryland	Md. Code Ann., Envir. § 9-505.	Yes (20%)
Michigan	Mich. Comp. Laws Ann. §§ 324.11533 to .11538.	No
Nebraska	Neb. Rev. Stat. §§ 13-2031 to 2032.	Yes (50%)
New Jersey	N.J. Stat. Ann. § 13:1E-99.13.	Yes (60%)
New York	N.Y. Envtl. Conserv. Law § 27-0103.	No
North Carolina	N.C. Gen. Stat. Ann. § 130A-309.03.	Yes (40%)
Ohio	Ohio Rev. Code Ann. § 3734.53.	No
South Carolina	S.C. Code Ann. § 44-96-80.	Yes (35%)
Tennessee	Tenn. Code Ann. § 68-211-813.	Yes (25%)
Texas	Tex. Health & Safety Code Ann. § 363.062.	Yes (40%)
Virginia	Va. Code Ann. § 10.1-1411.	Yes (25%)

Appendix Table A3: States that only have a recycling or waste reduction goal

State	Source	Goal amount
Louisiana	La. Rev. Stat. Ann. § 30:2413.	25%
Montana	Mont. Code Ann. § 75-10-803.	17%
Nevada	Nev. Rev. Stat. Ann. § 444A.020.	25%
New Hampshire	N.H. Rev. Stat. Ann. § 149-M:2.	40% (waste reduction)
Rhode Island	R.I. Gen. Laws §§ 23-18.8-2 to .12-3.	35% (recycling waste); 50% (recycling beverage containers)

Table 1: Sample Characteristics

	Mean	Std. Dev.
Dependent variables		
Number/10 plastic bottles recycled	6.0031	4.3940
Use curb recycling	0.4627	0.4987
Return to recycling station/for deposit	0.2071	0.4053
Return bottles for deposit	0.0380	0.1913
Return to recycling station	0.1773	0.3820
State law variables		
State with deposit law	0.2773	0.4477
State with deposit law covering water bottles	0.1275	0.3335
State requires recycling or provides an opportunity to recycle	0.2435	0.4293
State requires a regional recycling plan	0.5353	0.4989
State requires a recycling goal	0.0333	0.1795
Other controls		
Income/10,000	6.5281	4.2796
Top income category (over $175,000)	0.0333	0.1795
Years of education	13.8806	2.5069
Age	46.7533	15.4822
Considers self an environmentalist	0.3945	0.4879
Missing data for environmentalist	0.0039	0.0625
Environmental organization member	0.0861	0.2796
Missing data for env. org. membership	0.0075	0.0860
Gender: Female	0.5596	0.4965
Race: Black	0.1090	0.3117
Race: Asian	0.0220	0.1466
Race: American Indian	0.0149	0.1212
Race: Other	0.0549	0.2278
Hispanic	0.0922	0.2893
Household size	2.6294	1.4289
Homeowner	0.7686	0.4218
Married	0.6063	0.4887
Head of household	0.8110	0.3916
Urban (lives in a MSA)	0.8471	0.3600
Region: Northeast	0.1937	0.3953
Region: South	0.3635	0.4811
Region: West	0.2192	0.4138
$/month spent on bottled water	11.9084	9.8317
Use bottled water in car	0.5545	0.4971
Times reuse bottles	1.2265	0.2054
Missing data for times reuse bottles	0.0302	0.1712

Table 2: Recycling Practices by State Recycling Legal Regime[a]

Group	Mean number/10 bottles recycled (std. dev)	Percent of respondents who curb recycle	Percent of respondents who return for deposit or to recycling center	Percent of respondents who return to recycling center	Percent of respondents who return for deposit	Bottles collected by bottler
Full sample (N=2,250)	6.00 (4.39)	46.3	20.7	17.7	3.8	1.3
No effective recycling law and no water bottle deposit law (N=564)	4.38 (4.51)	31.6	17.9	15.1	3.4	0.2
Effective recycling law only (N=1,661)	6.10 (4.35)	51.1	16.3	14.3	2.4	1.7
Both effective recycling law and water bottle deposit law (N=325)	8.34 (3.06)	47.1	48.3	40.0	11.7	1.2

[a] Notes: "Effective recycling law" is either a mandatory recycling or opportunity to recycle law, or a planning law. All states with a water deposit law (CA, HI, ME, OR) have either a mandatory recycling or opportunity to recycle law or a planning law.

Table 3: Percentage Distribution of Number Recycled out of 10 Bottles by Recycling Legal Regime[a]

	1	2	3	4	5	6
Number/10 bottles recycled	**Full sample (%)**	**Neither recycling law nor water bottle deposit law (%)**	**Effective recycling law only (%)**	**Effective recycling law and water bottle deposit law (%) (CA,HI,ME,OR)**	**Difference between column 3 and column 2 (% points)**	**Difference between column 4 and column 3 (% points)**
Percent of sample	100	22.1	65.1	12.7		
0	29.6	46.3	28.2	7.7	-18.1	-20.5
1	1.7	2.0	1.6	1.8	-0.4	0.3
2	2.4	2.3	2.8	0.3	0.5	-2.5
3	1.2	0.7	1.3	1.5	0.6	0.3
4	1.4	1.4	1.5	0.6	0.1	-0.9
5	3.8	4.1	3.9	3.1	-0.2	-0.8
6	1.8	1.8	1.6	2.8	-0.1	1.1
7	1.7	1.8	1.7	1.5	0.0	-0.2
8	6.3	5.7	6.5	6.2	0.8	-0.3
9	9.3	5.7	10.0	11.7	4.3	1.7
10	40.9	28.4	40.9	62.8	12.6	21.8
Mean	6.00/10 bottles	4.38/10 bottles	6.10/10 bottles	8.34/10 bottles	1.72 additional/10 bottles	2.25 additional/10 bottles

[a] Notes: Sample size is 2,550 respondents. "Effective recycling law" is either a mandatory recycling or opportunity to recycle (M/O) law, or a planning law. All states with a water deposit law (CA, HI, ME, OR) have either a M/O law or a planning law.

Table 4: Regressions Predicting Number of Bottles Recycled out of 10 Bottles[a]

	Number out of 10 bottles		Ordered coding (0, 1-7, 8-10)
	OLS	**Tobit**	**Ordered Logit**
State with deposit law	0.6590	1.8896	0.3092
	(0.2705)**	(0.8949)**	(0.1592)*
State with deposit law covering water bottles	1.2229	4.2815	0.7639
	(0.3985)***	(1.3853)***	(0.2522)***
State has mandatory recycling or provides an opportunity to recycle	1.6428	4.9227	0.8771
	(0.2538)***	(0.7897)***	(0.1350)***
State requires a recycling plan	1.1263	3.5377	0.5939
	(0.2299)***	(0.7213)***	(0.1187)***
State requires a recycling goal (G)	-0.4303	-1.3529	-0.1736
	(0.5062)	(1.5124)	(0.2607)
Income/10,000	0.0721	0.1516	0.0331
	(0.0241)***	(0.0787)*	(0.0138)**
Highest income category	-0.5406	-1.0897	-0.2110
	(0.4311)	(1.6074)	(0.3017)
Years of education	0.1649	0.3934	0.1163
	(0.0326)***	(0.1107)***	(0.0192)***
Considers self environmentalist	1.6254	5.1064	0.8462
	(0.1636)***	(0.5535)***	(0.0931)***
Environmental organization member	0.4601	1.5388	0.4043
	(0.2564)*	(0.9532)	(0.1785)**
Age	0.0172	0.0583	0.0072
	(0.0061)***	(0.0195)***	(0.0034)**
Female	0.1060	0.6908	0.0448
	(0.1571)	(0.5027)	(0.0863)
Black	-1.0193	-3.1910	-0.5170
	(0.2756)***	(0.8606)***	(0.1416)***
Asian	0.1697	0.2177	0.1733
	(0.4429)	(1.7652)	(0.3316)
American Indian	-0.1785	-0.3349	-0.0503
	(0.5738)	(2.1176)	(0.3110)
Other	-0.0132	0.0780	0.0527
	(0.3468)	(1.1258)	(0.2032)
Hispanic	0.1572	0.1931	0.0432
	(0.2832)	(0.8939)	(0.1580)
Household size	0.1454	0.4233	0.0923
	(0.0642)**	(0.1999)**	(0.0363)**

Homeowner	0.6847	2.1324	0.3803
	(0.2082)***	(0.6665)***	(0.1134)***
Married	-0.1825	-0.5803	-0.0621
	(0.1852)	(0.5860)	(0.1012)
Household head	-0.1484	-0.5252	-0.0754
	(0.2289)	(0.7175)	(0.1204)
$/month spent on bottled water	0.0090	0.0321	0.0028
	(0.0085)	(0.0264)	(0.0046)
Use bottled water in car	-0.1513	-0.5062	-0.0487
	(0.1585)	(0.5102)	(0.0873)
Time reuse bottles	-0.3758	-1.8943	-0.1534
	(0.3917)	(1.2538)	(0.2116)
Urban (lives in a MSA)	1.4678	4.5481	0.7325
	(0.2325)***	(0.7239)***	(0.1206)***
Northeast	1.2997	4.2304	0.7724
	(0.2592)***	(0.8666)***	(0.1544)***
South	-0.9870	-2.9146	-0.4455
	(0.2252)***	(0.6867)***	(0.1125)***
West	0.1197	0.5581	0.0927
	(0.3253)	(1.0074)	(0.1678)
Constant	-0.9040	-11.5348	
	(0.8202)	(2.7069)***	

[a] Notes: * Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level; robust standard errors in parentheses for the OLS regression; standard errors in parentheses for the Tobit and Ordered Logit. R squared = 0.23 for OLS regression. Variables that were included in the equations but not reported here include whether variables were missing for environmentalist, environmental organization, or number of time reuse bottles. These variables were not significant in the equations. Sample size = 2,550.

Table 5: Probit Regression (Reporting Marginal Effects) Predicting Use of Curbside Recycling[a]

	Use curbside recycling
	Dprobit
State with deposit law	0.0523
	(0.0381)
State with deposit law covering water bottles	-0.1271
	(0.0536)**
State has mandatory recycling or provides an opportunity to recycle	0.2331
	(0.0327)***
State requires a recycling plan	0.1398
	(0.0307)***
State requires a recycling goal (G)	-0.0588
	(0.0665)
Income/10,000	0.0158
	(0.0033)***
Highest income category	-0.052
	-0.0674
Years of education	0.0257
	(0.0048)***
Considers self environmentalist	0.1261
	(0.0226)***
Environmental organization member	0.0294
	(0.0397)
Age	0.0019
	(0.0008)**
Female	-0.0282
	(0.0213)
Black	-0.1347
	(0.0350)***
Asian	-0.0726
	(0.0680)
American Indian	-0.0593
	(0.0785)
Other	0.0423
	(0.0464)
Hispanic	0.0310
	(0.0374)
Household size	0.0149
	(0.0086)*
Homeowner	0.0632
	(0.0277)**

Married	-0.0606
	(0.0249)**
Household head	-0.0182
	(0.0314)
$/month spent on bottled water	-0.0003
	(0.0011)
Use bottled water in car	-0.0170
	(0.0215)
Time reuse bottles	-0.1125
	(0.0526)**
Urban (lives in a MSA)	0.2912
	(0.0254)***
Northeast	0.1303
	(0.0360)***
South	-0.1183
	(0.0284)***
West	-0.0231
	(0.0423)

[a] Notes: * Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level; robust standard errors in parentheses. Variables that were included in the equations but not reported here include whether variables were missing for environmentalist, environmental organization, or number of time reuse bottles. These variables were not significant in the equation. Sample size = 2,550.

Table 6: Probit Regressions Predicting Recycling Behaviors[a]

	Return to recycling center or for deposit	Return for deposit[b]	Return to recycling center
State with deposit law	0.0661	0.0722	-0.0401
	(0.0301)**	(0.0173)***	(0.0258)
State with deposit law covering water bottles	0.2493	0.0761	0.2608
	(0.0579)***	(0.0459)*	(0.0582)***
State has mandatory recycling or provides an opportunity to recycle	-0.0662	-0.0101	-0.0427
	(0.0228)***	(0.0039)***	(0.0221)*
State requires a recycling plan	-0.0012	-0.0133	0.0248
	(0.0230)	(0.0052)**	(0.0219)
State requires a recycling goal (G)	-0.0299		-0.0108
	(0.0446)		(0.0435)
Income/10,000	-0.0076	-0.0007	-0.0057
	(0.0026)***	(0.0006)	(0.0024)**
Highest income category	-0.007	-0.0026	-0.0026
	(-0.052)	(-0.0096)	(-0.0495)
Years of education	-0.0005	-0.0015	0.0013
	(0.0035)	(0.0008)*	(0.0033)
Considers self environmentalist	0.0541	0.0010	0.0472
	(0.0170)***	(0.0035)	(0.0158)***
Environmental organization member	0.0360	0.0045	0.0440
	(0.0289)	(0.0055)	(0.0264)*
Age	-0.0008	-0.0003	-0.0004
	(0.0006)	(0.0001)**	(0.0006)
Female	-0.0022	-0.0047	0.0034
	(0.0160)	(0.0034)	(0.0149)
Black	-0.0350	0.0112	-0.0391
	(0.0257)	(0.0091)	(0.0236)*
Asian	0.0813	-0.0068	0.0957
	(0.0580)	(0.0052)	(0.0568)*
American Indian	-0.0329	0.0104	-0.0332
	(0.0544)	(0.0230)	(0.0468)

Other	0.0093	0.0183	-0.0055
	(0.0347)	(0.0127)	(0.0312)
Hispanic	-0.0102	-0.0061	0.0114
	(0.0263)	(0.0038)	(0.0256)
Household size	0.0021	0.0002	0.0015
	(0.0064)	(0.0014)	(0.0059)
Homeowner	0.0329	0.0029	0.0131
	(0.0197)*	(0.0035)	(0.0189)
Married	0.0144	-0.0017	0.0159
	(0.0187)	(0.0039)	(0.0175)
Household head	0.0013	-0.0005	0.0031
	(0.0231)	(0.0046)	(0.0215)
$/month spent on bottled water	4.63e-5	-0.0002	0.0003
	(0.0008)	(0.0002)	(0.0008)
Use bottled water in car	0.0196	0.0016	0.0224
	(0.0163)	(0.0033)	(0.0151)
Time reuse bottles	0.0022	0.0038	0.0020
	(0.0388)	(0.0079)	(0.0363)
Urban (lives in a MSA)	-0.0754	0.0054	-0.0928
	(0.0251)***	(0.0039)	(0.0245)***
Northeast	0.0248	0.0027	0.0080
	(0.0286)	(0.0058)	(0.0268)
South	-0.0043	-0.0099	-0.0025
	(0.0228)	(0.0049)**	(0.0212)
West	0.0033	-0.0179	0.0238
	(0.0348)	(0.0054)***	(0.0329)

[a] Notes: * Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level; robust standard errors in parentheses. Coefficients have been transformed to reflect the marginal effects on the probability of returns. Variables that were included in the equations but not reported here include whether variables were missing for environmentalist, environmental organization, or number of times reuse bottles. These variables were not significant in the equation. Sample size = 2,550.

[b] To achieve estimability, the return for deposit equation omits three variables—state requires a recycling goal, missing variable indicator for considers self environmentalist, and missing variable indicator for environmental organization member.