Discontinuous Behavioral Responses to Recycling Laws and Plastic Water Bottle Deposits

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Using a nationally representative sample of 3,158 bottled water users, this article finds that both water bottle deposits and recycling laws foster recycling through a discontinuous effect that converts reluctant recyclers into diligent recyclers. The impact of the warm glow from being an environmentalist and an environmental group member is about equal to that of a 5-cent bottle deposit. Respondents from states with stringent recycling laws and bottle deposits have greater recycling rates. The efficacy of these policy interventions is greater for those who do not already recycle, have lower income, and do not consider themselves to be environmentalists. (*JEL*: K32, Q28)

1. Introduction

Waste associated with plastic water bottles has become an issue of substantial national prominence. In 6 years, U.S. sales of bottled water for individual consumption tripled from about 12 billion water bottles in 2000 to 36 billion in 2006.[1] In 2008 alone, U.S. consumption of bottled water was more than 28 gallons per capita, resulting in industry wholesale dollar sales exceeding $11 billion (Rodwan, 2009). Bottled water typically comes in polyethylene terephthalate (PET) bottles. More than 2 million tons of PET

1. See the Container Recycling Institute (2008) for detailed statistics through 2006.

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bottles, including those for beverages other than water, were incinerated or left in landfills in 2006. The Container Recycling Institute estimates that increasing PET recycling rates to ~85% would save more than 60 trillion BTUs and avoid about a million metric tons of carbon equivalent greenhouse gas emissions. 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 of the economic incentives generated by policies that encourage the recycling of plastic water bottles.[2]

There are two principal policy instruments that promote water bottle recycling—bottle deposits and recycling laws. Bottle deposits for plastic water bottles establish a financial incentive to foster recycling, while recycling laws generally encourage that behavior by reducing the time cost and increasing the convenience of recycling. In some instances, recycling laws may impose monetary penalties on failure to recycle properly. Recycling laws exhibit a range of policy stringency, from requiring local recycling to merely defining it as a goal.

While the economics literature on recycling behavior has been growing, this study is novel in its focus on individual recycling behavior for a nationally representative sample that can be linked to different recycling law regimes in the fifty U.S. states.[3] To date, there have been no comprehensive

2. We do not analyze whether increased recycling of water bottles would pass a cost–benefit test. Such an analysis would need to consider the implementation and operating costs of the various policies against the benefits of reducing greenhouse gas emissions, increasing landfill space, saving natural resources through the possibility of reuse, and experiencing the warm glow benefits of recycling. See, e.g., Kinnaman (2006) and Morris et al. (2005). To the extent that a state or a municipality would like to increase its water bottle recycling through a bottle deposit bill or other recycling law, however, our analysis identifies the impact that each policy is likely to have on individual recycling behavior.

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. These studies include Fullerton and Kinnaman (1996), Callan and Thomas (1997), Nestor 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 data set, and Jenkins et al. (2003) analyze material-specific recycling for a sample in twenty 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.

studies of plastic water bottle recycling or national studies of individual recycling behavior. Most studies have focused on states or narrowly defined regions.[4] Some studies of material-specific recycling 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.[5]

Our study uses an original national data set of 3,158 households. Data at the individual level make it possible to examine the determinants of recycling decisions controlling for household characteristics and to examine the different levels of individual recycling rates. Many of the variables included in our analysis, such as whether the respondent is a member of an environmental organization, are unique to our recycling study. On a theoretical basis, we predict that people gravitate toward an extreme of either being a non-recycler or a diligent recycler, a mechanism which can only be revealed from an examination of individual rather than aggregate data.

The use of individual data also makes it possible to examine the heterogeneity of the recycling responses to the incentives created by the recycling laws and bottle deposit laws of different states. To capture the incentive effects of these laws, our study uses our own detailed categorization of state recycling statutes and bottle bills presented in Appendix B. The data set enables us to answer several kinds of questions. Are some segments of the population less motivated by recycling policies, and does their responsiveness hinge on the particular form of intervention? Will those in upper-income groups respond to the financial incentives of bottle deposits or be deterred by the time costs associated with recycling? Are

4. Three such regional studies are Saltzman et al.'s (1993) analysis of glass and newspaper recycling (by quantity) in fifty-three communities in Pennsylvania and New Jersey; Beatty et al.'s (2007) analysis of aluminum, glass, and plastic recycling (by quantity) in regional California communities; and Yang and Innes's (2007) regional Taiwan analysis of paper, metal, plastic, and glass recycling (by weight).

5. Three studies using household-level data are Reschovsky and Stone's (1994) analysis of the proportion of many different materials recycled in an upstate New York county; Sterner and Bartelings's (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 twenty major MSAs. Kinnaman (2005) examines the effect on curbside recycling of legal contexts categorized by a survey of state officials reported in *BioCycle* magazine by Kaufman et al. (2004).

differences in individuals' valuation of the environment consequential if environmentalists already recycle without additional financial incentives? Our results demonstrate a substantial muting of the financial incentives for recycling for those with higher income levels and strong environmental preferences.

The next section of this paper presents a conceptual model of recycling behavior, which predicts 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 a strong bimodal aspect to recycling behavior. 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 presents corroborative results on the effect of bottle deposit laws based on the natural experiments in Oregon and Connecticut during the course of survey administration. Section 7 concludes. These analyses demonstrate that incentives matter, consistent with both economic theory and the hypothesized discontinuous recycling decision.

2. The Consumer's Recycling Decision

Recycling decisions depend on the mix of items the consumer purchases. Following the standard dynamic programming approach, we assume that in the first stage, the consumer chooses the consumption mix conditional on the optimal disposal and recycling decisions in the second stage. Thus, the consumer makes the purchase decisions in the initial period anticipating optimal disposal thereafter. Consequently, it is appropriate to analyze the second-stage disposal and recycling decision, taking as given the prior purchase decisions.[6]

6. 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). Bohm (1981) considers a different model of the refund-disposal decision that involves the time decision of when to stop using the product and dispose of it. Our analysis assumes that individuals must choose a way to dispose of their water bottles once they are empty.

2.1. A Model of Individual Recycling Decisions

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: curbside recycling, denoted by c; returning the bottle for deposits, d; and putting the bottles in the garbage, g. If we denote 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.[7]

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 the opportunity cost of time.[8] We also assume that there is no warm glow, or environmental utility benefit, e, from bottles that are not recycled and that the warm glow environmental benefit e that the consumer derives for each bottle recycled is the same whether the bottle is recycled at the curbside or returned for deposit.[9]

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

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

and for g bottles put in the garbage it is

$$t_g = t_{g0} + t_{g1}g. \tag{3}$$

(The linearity assumption in this model is the key assumption leading to the corner solution outcome.)

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

8. 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.

9. This benefit term, e, may, of course, vary with demographic characteristics such as whether the person is a member of an environmental group. Kinnaman (2006) provides an overview of the literature on the utility benefit of recycling.

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. Even diligent recyclers drinking bottled water at a sporting event or traveling 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 rather than attempting to inventory results for every disposal combination, we focus on the general economic aspects of the decision.

2.2. Curbside Recycling Versus Garbage

The recycling decisions in different contexts involve similar economic issues that can be illustrated by considering the 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. Curbside recycling will be more attractive if

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

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

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

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 curbside, and that the consumer already uses garbage disposal mode for other items so that $t_{g0} = 0$.[10] Then the overall

10. The analysis if no garbage disposal is already being used is generally less realistic.

comparison of the benefits of recycling these n bottles rather than putting them in the garbage is

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

or

$$e > \frac{t_{c0W}}{n} + (t_{c1} - t_{g1})w. \tag{7}$$

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

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

which can be written as

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

But since

$$\frac{t_{c0W}}{n} + (t_{c1} - t_{g1})w > (t_{c1} - t_{g1})w, \tag{10}$$

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. Because of the small incremental cost of recycling an additional bottle, consumers will tend to gravitate to corner solutions of no recycling or complete recycling. Returning bottles for deposit as opposed to disposing of the bottles in the garbage also leads to a similar corner solution, as does the decision to use curbside recycling or to return the bottles for deposit.

2.3. Behavioral Hypotheses and Empirical Predictions

While these results pertaining to a discontinuous policy response are derived from an optimizing economic model, behavioral frameworks can generate similar patterns of behavior. Thus, if a consumer uses a decision heuristic by which the consumer recycles the next bottle if the previous recycling decision is viewed as providing a guide to appropriate behavior, there will be discontinuous responses to policy interventions that set people down the recycling path. It could also be the case that policies could provide people with a heuristic indicating the right recycling decision even though people do not make all the explicit benefit and cost assessments in the model. There could also be a virtuous reinforcement cycle where recycling increases the belief that one is environmentally conscious, and greater

environmental consciousness leads to an increased likelihood of recycling in the future.[11]

Both behavioral considerations and economic optimization predict a discontinuous response to a single recycling decision. Thus, we predict that the impact of policies such as curbside recycling laws or bottle deposit laws will lead individuals to 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.

Economic models also suggest that placing a high value on the warm glow effect increases the attractiveness of recycling by curbside or through bottle returns. 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. Likewise, other bottle deposits increase the likelihood of recycling water bottles, because consumers may bring their water bottles with them on trips to return other bottles to recycling centers for deposit. Hence, the other bottle deposits reduce the fixed time cost of recycling water bottles in addition to other bottles. The analyses below test these propositions.

3. Sample Characteristics and Recycling Laws

The data set used in the empirical analysis is from a national survey of households undertaken for this study by Knowledge Networks (KN) in 2008 and 2009. The KN panel is based on probability sampling of both online and offline populations. If a person does not have Internet access or a computer, KN provides the necessary hardware and Internet access. Our survey is web-based and was administered to a nationally representative sample with a 71% response rate.[12] The characteristics of the full sample,

11. There is also the potential for herd effects to the extent that recycling policies generate patterns of behavior that others adopt. However, Viscusi et al. (2011) found that concern with one's neighbors' attitudes toward recycling did not alter recycling behavior for plastic water bottles.

12. Our use of KN for our EPA-funded water surveys has been specifically reviewed and approved by the Office of Information and Regulatory Affairs, U.S. Office of Management and Budget (OMB). The KN panel also meets the U.S. government's quality standards for RDD surveys. For additional information on the characteristics

as reported in Appendix Table A1, closely parallel those of the adult U.S. population. Of the 5,213 survey participants, our analysis pertains primarily to 3,158 bottled water users.[13] On the basis of the summary of the sample characteristics in Table A1, bottled water consumption is quite widespread across the population. Compared with those who do not drink bottled water, bottled water drinkers are more likely to be female, younger, nonwhite, and have high income. While the entire survey took ~25 min, the sections on individual attitudes and practices related to bottled water and recycling took <10 min. Appendix Table A2 summarizes the pertinent survey questions.

In addition to the amounts of plastic water bottles recycled, the survey included a recycling question that asked respondents to compare their recycling of *all* recyclable materials relative to their neighbors. As indicated by the data in Supplementary Table S1, the self-assessed degree of recycling for bottled water users parallels those who do not drink bottled water, suggesting that an analysis of other recycling behaviors for, say, aluminum cans or newspapers would produce similar results.

The focus of our analysis is on the recycling of plastic bottles for bottled water restricted to the sample of 3,158 people who indicated that they use bottled water.[14] The recycling question asked to these respondents was the following: "Out of every 10 plastic bottles, how 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 (GAO) report of an estimate of total plastic bottle recycling rate of 24% in 2006 based on the data from the National Association of PET Container Resources, which reports a 27% estimate for 2008.[15] However, those statistics do not pertain to the household recycling rate of plastic water bottles, which is the focus of our

of the KN panel, see http://www.knowledgenetworks.com/knpanel/KNPanel-Design-Summary.pdf.

13. To be classified as a bottled water user, the person must have "bought water in plastic bottles in the past month."

14. The sample is restricted to the 3,158 respondents who indicated how often they recycle their bottles. Many of the excluded respondents used water cooler containers that were collected on a regular basis by the supplier and consequently did not involve the same kind of recycling decisions being analyzed here.

15. The U.S. Government Accountability Office (2009) indicated that it "did not independently verify the accuracy and completeness of the data provided by

study. The relatively low national recycling rate figures also include the 69.1% of all bottled water that is consumed away from home at restaurants, workplaces, hotels, sporting events, conventions, and other locales (http://www.ers.usda.gov/publications/err1/err1a.pdf). As indicated below, our household recycling patterns are comparable with those found by Jenkins et al. (2003) for areas with curbside recycling for some materials.[16] If, however, all sample respondents overstated their recycling rate relative to the GAO figure by a common factor, one would multiply all recycling rates by 0.45.

The matter of interest is less on the average recycling rates than on how reported bottle return rates vary with the different recycling and deposit regimes and, in particular, the extent to which the economic incentives created by these regimes influence recycling behavior. Consideration of relative gradations of recycling behavior in our empirical analysis should be less susceptible to reporting bias than statements of the absolute number of bottles recycled.

Table 1 summarizes the sample characteristics of the variables used in the analysis. In addition to data on recycling practices and state laws, the data include detailed personal characteristic information. Two-fifths of the sample consider themselves to be environmentalists, and 8% are members of national environmental groups.[17] This proportion is similar for both bottled water users and non-bottled water users. Bottled water users spend over $11 per month on bottled water.

States differ by the extent to which they encourage recycling either through bottle deposit laws or through their specific recycling policies. Bottle deposits create a direct financial incentive for recycling bottles for which

[the environmental nonprofit] organizations." The National Association of PET Container Resources report, which provides the details for the estimate, is available at http://www.napcor.com/pdf/RRate2008.pdf.

16. Jenkins et al. (2003) found that the majority of respondents recycled over 95% of plastic bottles. Our results similarly show that a majority of respondents recycle 9 or 10 out of 10 plastic bottles. Additionally, the findings of Jenkins et al. suggest a plastic bottle recycling rate of around 69% using the midpoints of their reported ranges, a number similar to our 60% result.

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

Table 1. Characteristics of 3,158 Bottled Water Users in Sample

	Mean	SD
Dependent variables		
Number/10 plastic bottles recycled	6.08	4.38
Use curbside recycling	0.46	0.50
Return bottles for a deposit	0.04	0.20
Return bottles to a recycling station	0.18	0.39
Return bottles to recycling station + for deposit	0.21	0.41
State law variables	0.28	0.45
State has deposit law	0.13	0.33
State has deposit law covering water bottles	0.36	0.48
State has mandatory recycling or provides an opportunity to recycle	0.44	0.50
State requires a regional recycling plan	0.04	0.19
State only has a recycling goal	6.56	4.28
Personal characteristics	0.03	0.18
Income/$10,000	13.89	2.52
Highest income category (over $175,000)	0.40	0.49
Years of education	0.01	0.07
Considers self an environmentalist	0.08	0.27
Missing data for environmentalist	0.01	0.08
Environmental organization member	46.99	15.49
Missing data for organization member	0.56	0.50
Age	0.11	0.32
Gender		
Female	0.02	0.14
Race		
Black	0.01	0.12
Asian	0.05	0.22
American Indian	0.10	0.30
Other	2.66	1.44
Hispanic	0.77	0.42
Household size	0.61	0.49
Homeowner	0.81	0.39
Married	0.85	0.36
Household head	0.19	0.39
Urban (lives in an MSA)	0.36	0.48
Northeast	0.22	0.42
South	11.71	9.81
West	0.56	0.50
Midwest	1.19	0.28
$/month spent on bottled water	0.03	0.16
Use bottled water in car	0.26	0.44
Times reuse bottles	6.08	4.38
Missing data for times reuse bottles	0.46	0.50
Year 2009	0.04	0.20

deposits are required, which in most states do not include plastic water bottles.[18] The deposit rate is 5 cents per bottle, except in Michigan where the rate is 10 cents.[19] 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 be recycled by anyone and need not be recycled by the original purchaser.[20] About 16% of the sample members reside in the states with nonwater bottle deposit laws, and only 13% of the sample resides in the five states (California, Connecticut, Hawaii, Maine, and Oregon) that had bottle deposit laws in 2009 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 will increase the recycling of water bottles. We will test whether bottle deposits 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 may be less than if there were no bottle deposit policies. Recycling centers in states with bottle deposit requirements may also include opportunities to recycle plastic water bottles even though there is no payment for such recycling.

There is substantial diversity in the structure of recycling laws across states. State laws often include one or more regulatory components, summarized in Appendix B. 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 or that require an opportunity for recycling for all citizens, those that require

18. See Bohm (1981) for an early detailed analysis of deposit-refund systems.

19. Separate analyses failed to demonstrate any differential effect of the higher bottle deposits in Michigan.

20. For example, homeless people and scavengers often collect bottles from litter, garbage, and 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, 2009, 2010).

local communities to have a recycling plan, those that have recycling goals but lack a specific plan, and finally, those that have no recycling law.

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

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 4.30 for states with no effective recycling law and no water bottle deposit law to 5.86 if the state also has an effective recycling law and to 8.59 if the state also has a water bottle deposit law. All states with a water bottle deposit law also have an effective recycling law.

The most prevalent form of recycling is at curbside. Almost half of all water bottle users use curbside recycling for some of their bottles, while only one-fifth of the sample returns bottles for deposit or takes them to a recycling center. In states with water bottle deposit laws, about half return the bottles for deposit, and the percentage using curbside recycling is not substantially lower than in states without such bottle deposit laws.

The distribution of the number of bottles recycled shown in Table 3 is consistent with the theoretical model in which individual recycling behavior follows a discrete threshold rather than a continuous process. For all bottled water users, 29.1% recycle zero bottles out of ten, while 42.0% recycle ten out of ten. The next most prevalent levels of recycling are nine and eight bottles out of ten, 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 five out of ten, which one might have expected if respondents were focusing on salient attitudinal responses rather than attempting to assess their actual recycling behavior.

Columns 2–4 in Table 3 break the sample by three recycling regime categories. The first recycling policy shown in column 3 of 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 that they do not recycle at all and increasing the percentage

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

Group	Mean number/10 bottles recycled (SD)	Percent of respondents who curbside 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 ($n = 3, 158$)	6.08 (4.38)	46.2	21.3	18.2	4.1	1.3
No effective recycling law and no water bottle deposit law ($n = 644$)	4.30 (4.47)	30.6	17.6	17.6	3.1	0.5
Effective recycling law only ($n = 1, 696$)	5.86 (4.43)	48.7	15.4	15.1	0.7	1.5
Both effective recycling law and water bottle deposit law ($n = 404$)	8.59 (2.82)	47.5	49.5	40.1	14.3	1.5

[a]Notes: "Effective recycling law" is either a mandatory recycling or opportunity to recycle law or a planning law. All states with a water bottle deposit law (California, Hawaii, Maine, Oregon, and Connecticut) 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,CT)	Difference between column 3 and column 2 (% points)	Difference between column 4 and column 3 (% points)
Percent of sample	100	20.4	53.7	12.8		
0	29.1	46.4	31.1	6.4	−15.3	−24.7
1	1.5	2.2	1.4	1.0	−0.8	−0.4
2	2.4	2.6	2.7	0.5	0.1	−2.2
3	1.2	0.6	1.4	1.5	0.8	0.1
4	1.3	1.2	1.4	0.5	0.2	−0.9
5	3.6	4.2	3.7	2.5	−0.5	−1.2
6	1.7	1.9	1.4	2.2	−0.5	0.8
7	1.7	2.2	1.5	1.5	−0.7	0
8	6.6	6.5	6.6	6.4	0.1	−0.2
9	8.9	5.6	9.3	11.6	3.7	2.3
10	42.0	26.6	39.6	65.8	13.0	26.2
Mean	6.00/10 bottles	4.30/10 bottles	5.86/10 bottles	8.59/10 bottles	1.56 additional/ 10 bottles	2.73 additional/ 10 bottles

[a]Notes: Sample size is 3,158 respondents. “Effective recycling law” is either a mandatory recycling or opportunity to recycle law or a planning law. All states with a water bottle deposit law (California (CA), Hawaii (HI), Maine (ME), Oregon (OR), and Connecticut (CT)) have either a mandatory recycling or opportunity to recycle law or a planning law.

who indicate 100% recycling. As column 5 indicates, almost the entire mass shift is from zero out of ten bottles recycled to nine or ten bottles recycled. The addition of water bottle deposits is shown in column 4. 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 percent of those indicating zero recycling drops by 24.7 percentage points and the percent indicating complete recycling increases by 26.2 points.[21]

The percentage of nonrecyclers drops from 46.4% in states with neither recycling laws nor water bottle deposit laws to 31.1% for states with effective recycling laws only and to 12.8% for states that also have water bottle deposit laws. Consequently, the introduction of effective recycling laws or water bottle deposit laws has a discontinuous effect across the distribution of recycling patterns as water bottle users shift recycling levels through a threshold transformation of behavior.

4. Determinants of the Total Recycling Amount

The first series of regression analyses focuses on the proportion of water bottles recycled. To demonstrate robustness across analyses, four 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 zero and ten, 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

21. This efficacy of water bottle deposits is consistent with Ashenmiller's (2009) finding that bottle deposit laws increase the amount of material recycled at Santa Barbara, California, 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 the state of California, but if the comparison instead is with states with no effective recycling law, then the incremental effect of such recycling policies 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 recycling. Van Houtven and Morris (1999) found that unit pricing affected whether people recycle but not the amount of recycling.

Table 4. Regressions of Number of Bottles Recycled[a]

	Number out of 10 bottles		Ordered coding (0, 1–7, 8–10)	Recycle at all (0, 1–10)
	OLS	Tobit	Ordered logit	Probit
State has deposit law	0.574	1.741	0.237	0.084
	(0.228)**	(0.747)**	(0.135)*	(0.026)***
State has deposit law covering water bottles	2.124	7.721	1.467	0.194
	(0.326)***	(1.199)***	(0.226)***	(0.028)***
State has mandatory recycling or provides an opportunity to recycle	1.907	5.919	1.033	0.169
	(0.223)***	(0.708)***	(0.116)***	(0.021)***
State requires a recycling plan	0.733	2.162	0.351	0.067
	(0.229)***	(0.699)***	(0.114)***	(0.023)***
State requires a recycling goal	−0.467	−1.644	−0.166	−0.040
	(0.402)	(1.307)	(0.217)	(0.046)
Income/10,000	0.075	0.187	0.039	0.010
	(0.021)***	(0.071)***	(0.012)***	(0.003)***
Years of education	0.149	0.360	0.106	0.024
	(0.029)***	(0.100)***	(0.017)***	(0.004)***
Considers self environmentalist	1.632	5.385	0.877	0.157
	(0.146)***	(0.502)***	(0.085)***	(0.016)***
Environmental organization member	0.456	1.253	0.380	0.061
	(0.232)**	(0.881)	(0.163)**	(0.032)*
Age	0.018	0.064	0.008	0.001
	(0.005)***	(0.018)***	(0.003)***	(0.001)
Black	−0.918	−2.772	−0.439	−0.070
	(0.242)***	(0.755)***	(0.127)***	(0.030)**

(*Continued*)

Table 4. Continued.

	Number out of 10 bottles		Ordered coding (0, 1–7, 8–10)	Recycle at all (0, 1–10)
	OLS	Tobit	Ordered logit	Probit
Household size	0.169	0.506	0.105	0.018
	(0.057)***	(0.182)***	(0.033)***	(0.007)***
Homeowner	0.616	1.921	0.339	0.062
	(0.187)***	(0.605)***	(0.104)***	(0.023)***
$/month spent on bottled water	0.004	0.020	0.001	−0.001
	(0.007)	(0.024)	(0.004)	(0.001)
Urban (lives in an MSA)	1.275	4.058	0.666	0.133
	(0.208)***	(0.649)***	(0.110)***	(0.026)***
Northeast	0.779	2.725	0.499	0.115
	(0.265)***	(0.880)***	(0.156)***	(0.026)***
South	−1.043	−3.069	−0.503	−0.082
	(0.199)***	(0.615)***	(0.100)***	(0.021)***
West	−0.402	−1.489	−0.271	−0.036
	(0.275)	(0.872)*	(0.148)*	(0.032)

[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, Ordered logit, and Probit regressions; standard errors in parentheses for the Tobit regression. $R^2 = 0.24$ for OLS regression. Probit coefficients have been transformed to correspond to marginal effects. The regressions also include variables for missing data for environmentalist, environmental organization membership, and times reuse bottles; variables for times reuse bottles, highest income category, gender, Asian, American Indian, other race, Hispanic, married, household head, bottled water use in car, whether the survey was administered in 2009, and a constant term for the OLS and Tobit. These variables were not statistically significant in the equations. Sample size = 3,158.

their relative degree of recycling and perhaps overstating the actual number of bottles recycled. We explore this possibility in two ways. The third column of results in Table 4 presents the ordered logit estimates, for which the three ordered categories are 0, 1–7, and 8–10 recycled out of 10 bottles. The final column of Table 4 reports probit estimates, for which the dependent binary variable is equal to 1 if the individual recycles 1–10 out of 10 bottles and 0 if the individual does not recycle any bottles.[22] These formulations of the model address the possibility that the responses have ordinal rather than cardinal significance or are binary, indicating only whether someone is a recycler or not.[23] Moreover, the categories reflect the different discontinuous recycling groupings of consumers. Because of the strong parallels across the four analyses, the discussion here focuses on the OLS and the probit 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 whether the deposit law covers water bottles. Both of the state deposit variables raise the number of bottles recycled. The broad deposit variable raises the number of water bottles recycled by 0.6 out of 10 bottles and increases the recycling probability by 0.08, while the presence of a specific water bottle deposit law increases plastic water bottle recycling by 2.1 out of 10 bottles and increases the recycling probability by 0.19. Together, consumers in states with both laws recycle an additional 2.7 out of 10 bottles and have a 0.28 higher recycling probability, controlling for other influences.

The next set of three variables pertains to the state recycling laws. The two most stringent forms of laws—mandatory recycling and required opportunities for recycling—are combined into a single category of 14 states plus the District of Columbia because the small number of the component groups makes it impossible to reject the hypothesis that the

22. 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.

23. 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.

coefficients for these two categories are equal.[24] 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 require either mandatory recycling or the opportunity to recycle increase recycling by 1.9 out of every 10 bottles and increase the recycling probability by 0.17.

Laws that require only regional waste management plans with recycling considerations also have a significant positive effect on recycling, boosting the recycling out of 10 bottles by 0.7 bottles and increasing the recycling probability by 0.07. This effect is less than half of the effect of the more stringent mandatory/opportunity recycling laws.[25]

The weakest of the recycling law conditions relates to states that have a waste reduction goal but no required action. This variable never has a statistically significant effect compared with the no recycling law states.[26] The pattern of coefficient magnitudes is consistent with the relative stringency of the laws. Mandatory recycling and required recycling 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.

Next we consider the effects of user demographics on recycling. Higher income levels increase the time opportunity costs of recycling. Income may also influence the value the consumer places on recycling. The effect of income on the number of bottles recycled is positive but small, suggesting that the increased opportunity costs are not sufficient to totally offset

24. The F-test for the OLS equation coefficients has a value of 1.66 with a probability value of 0.1977. Similarly, Jenkins et al. (2003) found that for plastic bottles generally, mandatory recycling had no additional effect when curbside recycling is already available.

25. The pertinent F-value for the OLS equation is 32.40 with a probability value of 0.0000.

26. Planning states are statistically more effective than goals states. The F-statistic for the test for whether the planning variable coefficient equals that of the goals variable is 9.81 with a probability value of 0.0017. The t-statistic for the goals variable relative to the omitted no law variable is -1.16 with a probability value of 0.245 in the OLS regression.

the higher amount of recycling among higher income respondents.[27] Individual education has a positive effect on recycling, which serves both as a measure of the respondent's knowledge of available recycling options as well as lifetime wealth.[28]

The value that a respondent places on environmental quality is captured directly by whether the respondent is a self-described environmentalist as well as by whether the respondent is a member of a major national environmental organization.[29] 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 members of environmental organizations recycling an additional 0.5 bottles after taking into account the effect of being an environmentalist and other variables.

To the extent that these environmental variables correspond to the warm glow benefit from recycling, then it is possible to monetize this effect. The water bottle deposit variable reflects the inducement of a 5 cent per bottle payment. Being a self-described environmentalist is 77% as influential, or equivalent to about a 4 cent per bottle value, while being a member of an environmental organization is 21% as effective, or a value of about 1 cent per bottle. Since environmental organization members are generally also self-described environmentalists, their combined warm glow benefit is 5 cents per bottle, or almost equivalent to the effect of the bottle deposit.

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 increase for homeowners, possibly a reflection of the greater availability of curbside recycling and convenient recycling locations for this group. The volume of bottled water purchased as measured by the dollars spent on bottled water does not have a significant effect on the percent of bottles recycled, but including this

27. Higher income respondents may also live in communities with more access to recycling options that minimize opportunity costs (income is positively correlated with curbside recycling).

28. 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. Kinnaman (2005) found no significant effect of the percent of state residents with a high school diploma on the percent of state waste that is recycled.

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

variable nevertheless serves an important role in the analysis.[30] Otherwise, variables such as income might be capturing the quantity effect.

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 1.3 out of 10 additional bottles, a result consistent with the greater availability of curbside recycling and convenient recycling centers in such locales. In addition, state laws generally exempt rural areas from recycling requirements.

To explore these differences further, Supplementary Table S2 reports separate regressions for the urban (MSA) and non-urban subsamples.[31] The principal differences are that state deposit laws and state recycling planning requirements significantly increase plastic water bottle recycling in urban areas but not outside of these areas. Plastic water bottle deposits are equally effective in each context.

The efficacy of the policy measures in promoting recycling behavior may also vary across the populations and in different policy regimes. Table 5 reports selected coefficients from additional regressions including interactions of the policy variables and both income and whether the respondent is an environmentalist. Given a threshold model, we expect negative interactions between positive factors, because either one can drive one over the threshold. The negative interactive effect of income and water bottle deposit laws implies bottle deposits are not a financial inducement for higher income people.[32] Likewise, a water bottle deposit law dampens the substantial additional inducement for environmentalists, who already tend to recycle.[33] All respondents recycle more when there is a plastic water bottle deposit law, and environmentalists are especially likely to recycle, but this additional effect is reduced when there is a plastic water bottle deposit

30. The dollars spent variable remains statistically insignificant if the income variable is omitted from the equation.

31. The estimated parameters from the two regressions differ statistically, with an F (32, 3094) statistic of 3.30 and a probability value of 0.0000.

32. 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.

33. A comparable interaction with being a member of an environmental organization did not have a statistically significant effect and is not included in Table 5's regressions.

Table 5. Regressions of Number of Bottles Recycled Including Interaction Effects[a]

	Number out of 10 bottles, OLS
State has deposit law	0.571
	(0.229)**
State has deposit law covering water bottles	3.638
	(0.489)***
State has mandatory recycling or provides an opportunity to recycle	2.345
	(0.410)***
State requires a recycling plan	0.589
	(0.416)
State requires a recycling goal	−0.431
	(0.407)
Income/10,000	0.110
	(0.040)***
Considers self environmentalist	1.825
	(0.349)***
State with deposit law covering water bottles × income/1,000	−0.137
	(0.042)***
State with deposit law covering water bottles × considers self environmentalist	−1.165
	(0.357)***
State has mandatory recycling or provides an opportunity to recycle × income/1,000	−0.045
	(0.044)
State has mandatory recycling or provides an opportunity to recycle × considers self environmentalist	−0.388
	(0.407)
State requires a recycling plan × income/1,000	0.005
	(0.048)
State requires a recycling plan × considers self environmentalist	0.226
	(0.430)

[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. $R^2 = 0.24$. The regression also includes all of the other variables listed in Table 4, as well as dummy variables for missing data for environmentalist, environmental organization membership, and times reuse bottles. These variables were not statistically significant in the equations. Sample size = 3,158.

law. The results are similar for the separate regressions for environmentalists and nonenvironmentalists shown in Supplementary Table S2.[34] Both environmentalists and nonenvironmentalists respond to bottle deposits, but the effects of bottle deposits are comparable even though environmentalists recycle more overall. The other interaction terms in Table 5 are

34. One can reject the hypothesis that the estimated parameters from the two regressions are the same, with an F (31, 3080) statistic of 6.21 and a probability value of 0.0000.

not statistically significant, as the effect of the water bottle deposit variable on recycling exhibits more individual heterogeneity than do the recycling law variables.

5. Determinants of Curbside 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 curbside pickups reduce the costs of curbside recycling relative to returning the bottles to a recycling center and should have a positive effect on curbside recycling and may have a negative effect on returning bottles for deposit. Likewise, water bottle deposit laws improve the economic benefits of returning bottles for deposit and consequently increase the likelihood of returning the bottles and decrease 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.[35]

Table 6 reports a probit regression for whether the respondent used curbside recycling for plastic water bottles in the past month, where all coefficients have been transformed to reflect marginal probabilities. State deposit laws generally do not significantly affect curbside recycling; state recycling laws, however, make a big difference. Residents of states with mandatory recycling or opportunity for recycling laws have a 0.26 higher probability of using curbside recycling for plastic water bottles, while states with recycling plans have a 0.07 higher probability of using curbside recycling than residents of states with no recycling laws. The presence of recycling goals has no statistically significant effect on the use of curbside recycling.[36]

35. See Appendix Table A2 for the survey question wording.

36. Kinnaman (2005) found that mandatory beverage container deposits and recycling goals do not significantly affect the availability of curbside recycling, while laws imposing curbside recycling requirements do increase the availability of curbside recycling. Additionally, he found no statistically significant effects on the availability of curbside recycling of several other laws: bans on yard waste from landfills, bans of recyclable materials from landfills, tax credits for facilities, or requirements that government agencies purchase recycled material.

Table 6. Probit Regressions of Use of Curbside Recycling[a]

	Use curbside recycling
State has deposit law	0.019
	(0.032)
State has deposit law covering water bottles	0.019
	(0.048)
State has mandatory recycling or provides an opportunity to recycle	0.257
	(0.029)***
State requires a recycling plan	0.068
	(0.030)**
State requires a recycling goal	−0.089
	(0.058)
Income/10,000	0.016
	(0.003)***
Years of education	0.026
	(0.004)***
Considers self environmentalist	0.120
	(0.020)***
Age	0.002
	(0.001)**
Black	−0.118
	(0.031)***
Homeowner	0.051
	(0.025)**
Urban (lives in an MSA)	0.295
	(0.023)***
Northeast	0.055
	(0.037)
South	−0.131
	(0.025)***
West	−0.130
	(0.035)***

[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 marginal effects. The regression also includes variables for missing data for environmentalist, environmental organization membership, and times reuse bottles; variables for environmental organization membership, times reuse bottles, highest income category, gender, Asian, American Indian, other race, Hispanic, married, household size, household head, money spent per month on bottled water, bottled water use in car, and whether the survey was administered in 2009. These variables were not statistically significant in the equation. Sample size = 3,158.

Many of the other patterns shown in Table 6 parallel the earlier results with respect to the number of bottles recycled. All recycling laws variables except for those restricted to recycling goals boost curbside recycling. 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 an MSA.[37]

The presence of bottle deposits for plastic water bottles should foster the returns of these bottles. Table 7 includes three sets of probit estimates for the probability that the respondent returns bottles for deposit or to a recycling center and for the two components of this probability—whether the respondent returned the bottles for deposit, presumably to a store where such bottles are purchased, and whether the respondent returned the bottles to a recycling center.

The overall return probability for plastic bottles increases by 0.10 if the state is a general bottle deposit state. Since all plastic water bottle states also require deposits for other bottles, the additional 0.15 probability of bottle returns in a water bottle deposit state implies an overall 0.25 probability of returning plastic water bottles in states with water bottle deposits. 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 water bottle deposit variable has a much stronger influence on returning bottles to the recycling center than it does on returning bottles to the store 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 0.04 lower probability of returning the bottles to a recycling center or for a deposit. This effect

37. We also interacted the various legal and policy regimes with income and whether the individual is an environmentalist. The mean interaction effect between mandatory or opportunity laws and whether the respondent is an environmentalist on curbside recycling is ∼0.01 with a standard error of 0.04 and *z*-statistic of 0.351. The interaction effect ranged, however, from a negative 0.04 to a positive 0.06, with the *z*-statistic as high as 2.429 for some probability levels of using curbside recycling. This analysis uses the Stata command "inteff" per Norton et al. (2004). The other interaction effects were never statistically significant.

Table 7. Probit Regressions of Recycling Behaviors[a]

	Return to recycling center or for deposit	Return for deposit	Return to recycling center
State has deposit law	0.102	0.104	−0.005
	(0.026)***	(0.019)***	(0.023)
State has deposit law covering water bottles	0.153	0.020	0.174
	(0.043)***	(0.014)	(0.043)***
State has mandatory recycling or provides an opportunity to recycle	−0.040	−0.008	−0.019
	(0.022)*	(0.005)	(0.021)
State requires a recycling plan	0.013	−0.012	0.028
	(0.023)	(0.006)*	(0.022)
State requires a recycling goal	−0.049	−0.006	−0.028
	(0.037)	(0.010)	(0.036)
Income/10,000	−0.006	−0.001	−0.004
	(0.002)***	(0.001)	(0.002)*
Considers self environmentalist	0.063	0.003	0.055
	(0.016)***	(0.004)	(0.015)***
Age	−0.001	−0.000	−0.000
	(0.001)	(0.000)**	(0.001)
Female	−0.015	−0.008	−0.008
	(0.015)	(0.004)**	(0.014)
Black	−0.046	0.009	−0.047
	(0.022)**	(0.009)	(0.020)**
Homeowner	0.037	0.001	0.018
	(0.018)**	(0.004)	(0.017)
Use bottled water in car	0.025	0.001	0.030
	(0.015)*	(0.004)	(0.014)**
Urban (lives in an MSA)	−0.108	0.004	−0.117
	(0.023)***	(0.005)	(0.022)***
Northeast	0.034	−0.001	0.018
	(0.031)	(0.008)	(0.029)
South	0.011	−0.004	0.009
	(0.021)	(0.007)	(0.020)
West	0.072	−0.006	0.069
	(0.031)**	(0.007)	(0.029)**

[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. The regressions also include variables for missing data for environmentalist, environmental organization membership, and times reuse bottles; variables for environmental organization membership, times reuse bottles, years of education, Asian, American Indian, other race, Hispanic, married, household size, household head, money spent per month on bottled water, and whether the survey was administered in 2009. These variables were not statistically significant in the equations. Sample size = 3,158.

reduces the benefit of water bottle deposits by about one-fourth. Recycling planning law states have a small significant negative effect on returns for deposit.

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. Finally, the interaction results indicate that being an environmentalist and having higher income reduces the average efficacy of water bottle deposits on returning bottles for deposit or returning bottles to a recycling center.[38]

6. Effects of Law Changes

To investigate the causal effect of recycling laws and deposit policies, we take advantage of two legal changes that occurred during the administration of the survey. Specifically, Oregon and Connecticut both added water bottles to their deposit bills in 2009.

Oregon implemented its bottle bill expansion on January 1, 2009. The sample includes thirty-eight individuals surveyed before the expansion and fourteen individuals surveyed in October 2009, nine months after the expansion.[39] Connecticut's bottle bill expansion was implemented on October 1, 2009. The sample includes information from Connecticut residents between October 16 and October 27, 2009, resulting in thirty individuals surveyed before the change and twenty-three individuals surveyed about two weeks after the enactment of plastic water bottle deposits.[40] Thus the sample from these states includes sixty-eight observations from 2008 and thirty-seven

38. The inteff command calculates the mean interaction effect of water bottle deposits and being an environmentalist as −0.084 with mean standard error 0.048 and mean z-statistic −1.730. The mean interaction effect of water bottle deposits and having higher income is −0.007 with mean standard error 0.005 and mean z-statistic −1.285. We also interacted water bottle deposits with mandatory/opportunity laws, but we do not report the results because the negative interaction coefficient was never statistically significant.

39. Analysis of differences in recycling rates within Oregon before and after the bottle deposit law, however, indicates that the changes are not statistically significant. The t-statistic is −1.08 with a one-sided test probability value of 0.1421.

40. Consequently, there may not have been sufficient time for the full effects of the policy change to be manifested, as thirteen of the twenty-three people were interviewed only two weeks after the change. Of the twenty-three individuals interviewed after the change, nine of these answered questions on their recycling behavior both before and

Table 8. Percentage Distribution of Number Recycled out of 10 Bottles for Oregon and Connecticut Before and After the Inclusion of Water Bottles to the Bottle Bills

	Number out of every 10 bottles recycled					Percent who return for deposit
	Raw #	0	1–7	8–10	Mean (SD)	
Full sample (%)	100	29.1	13.4	57.5	6.08 (4.38)	4.1
Oregon before water bottle deposits	38	15.8	18.4	65.8	7.24 (3.99)	15.8
Oregon after water bottle deposits	14	0	21.3	78.5	8.50 (2.88)	64.3
Connecticut before water bottle deposits	30	3.3	20	76.7	8.00 (3.05)	6.7
Connecticut after water bottle deposits	23	8.7	0	91.3	8.96 (2.88)	8.7
Connecticut and Oregon (pooled) before	68	10.3	19.1	70.6	7.57 (3.60)	11.8
Connecticut and Oregon (pooled) after	37	5.4	8.1	86.5	8.78 (2.85)	29.7

from 2009, providing data on recycling behavior for Oregon and Connecticut both before and after they each implemented their expanded bottle bills. Although the sample of households experiencing changes is modest, the findings are consistent with previous results.

Table 8 summarizes the bottle recycling breakdown for those two groups, and Table 9 reports the difference-in-differences regressions. After the expansion, mean water bottle recycling increased from 7.6 to 8.8 bottles out of 10, as over 20% more people became diligent recyclers.[41] The regressions for the number of bottles recycled out of 10 in Table 9 yield interaction effects that exceed the estimated standard errors, and recycling rates are

after the change. There is evidence of substantial awareness of the policy shift as twenty-one out of the twenty-three interviewed after the change indicated that they were aware that Connecticut recently included water bottles in its deposit bill. We also analyzed the Connecticut residents who were aware of the change and the nine individuals interviewed before and after the change. The composition of the results was similar to the composition for the overall sample from Connecticut and also not significant, so we do not report those in Table 8.

41. The *t*-statistic is 1.76 with a two-sided test probability value of 0.0806.

Table 9. Difference-in-Differences Regressions on Oregon or Connecticut Sample[a]

	Number out of 10 bottles recycled		Return for deposit
	OLS	Tobit	Probit
Oregon or Connecticut	1.684	6.023	0.084
	(0.444)***	(1.868)***	(0.040)***
Year 2009	0.227	0.694	0.001
	(0.183)	(0.610)	(0.008)
OR or CT × year 2009	0.763	5.446	0.085
	(0.669)	(3.397)	(0.063)**
Constant	5.958	7.373	
	(0.092)***	(0.308)***	

[a]Notes: **Significant at the 5% level; ***significant at the 1% level; robust standard errors in parentheses for the OLS regression. Probit coefficients have been transformed to reflect the marginal effects on the probability of returns. The mean inteff results are 0.169 (interaction), 0.084 (standard error), and 2.018 (z-statistic) for the Oregon and Connecticut (pooled) probit regression. Sample size = 3,158.

higher in CT and OR in 2009 in the Tobit results at just over the 0.10 level, one-sided test.[42] A stronger, statistically significant indication of the efficacy of the plastic water bottle deposits is the result for whether the respondent returned the bottles for deposit, presented in Table 9. The interaction of the 2009 variable with the two states that introduced this policy is positive and statistically significant at the usual level.

7. 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 may also include financial penalties for noncompliance. We find both water bottle deposits and recycling laws to be effective. Moreover, the strength of effects for the recycling laws follows the degree of stringency of these measures.

The analysis of the interaction between factors testifies to the diminishing marginal efficacy of recycling incentives as predicted by a threshold model of response at the individual level. Mandatory recycling laws offer

42. The probability value on the pooled Oregon and Connecticut interaction term in the reported Tobit regression is 0.109.

only modest recycling gains compared with planning laws. Self-described environmentalists are more likely to recycle without bottle deposits so that these interventions have less effect on their recycling behavior than on less environmentally-oriented respondents. For people in upper-income groups, the financial inducements provided by bottle deposits are less effective, and the time costs of taking bottles to recycling centers loom large.

The central role of economic analysis in predicting the consumer response manifests perhaps most clearly in the stark pattern of individual recycling activity. For most policy interventions, one would expect modest policy impacts throughout the range of behavior. Thus, nonrecyclers would become modest recyclers, and modest recyclers would become more diligent recyclers. This kind of continuous policy influence is not consistent with individual data. Instead, the observed shifts reflect starker changes in behavior that match the economic structure of the recycling decision and how policies will influence this decision. These come from the high fixed costs compared with low variable costs associated with recycling. 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. Consistent with our result that people respond in a discontinuous manner to recycling incentives, policies have their greatest effect among those who would not already choose to recycle.

Supplementary material

Supplementary tables are available at *American Law and Economics Review* online.

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Appendix A. Sample Characteristics and Survey Questions

Table A1. Comparison of KN Sample to the National Adult Population[a]

Demographic variable	U.S. adult population, %	Survey participants ($n = 5{,}213$), %	Bottled water users ($n = 3{,}158$), %	Do not use bottled water ($n = 2{,}055$), %
Gender				
Male	48.4	48.1	44.2	54.1
Female	51.6	51.9	55.8	45.9
Age, years				
18–24	12.6	7.9	8.7	6.7
25–34	17.9	13.6	14.9	11.5
35–44	18.8	19.1	21.0	16.2
45–54	19.6	21.1	22.1	19.6
55–64	14.8	20.6	19.7	22.0
64–74	8.7	12.0	10.3	14.6
⩾75	7.7	5.8	3.4	9.5
Educational attainment				
Less than HS	14.2	11.1	10.1	12.6
HS Diploma or higher	58.8	60.0	59.7	60.4
Bachelor or higher	26.9	29.0	30.2	27.0
Race/ethnicity				
White	81.3	81.9	79.6	85.3
Black/African-American	11.7	10.0	11.5	7.8
American Indian or Alaska Native	2.4	1.3	1.4	1.1
Asian/Pacific Islander/Other	4.6	6.6	7.4	5.6
Hispanic	13.5	9.5	10.3	8.3
Marital status				
Married	55.0	58.2	60.9	54.1
Single (never married)	26.0	21.4	20.9	22.2
Divorced	10.4	12.6	11.5	14.4
Widowed	6.4	5.5	4.5	7.0

(*Continued*)

Table A1. Continued

Demographic variable	U.S. adult population, %	Survey participants ($n = 5,213$), %	Bottled water users ($n = 3,158$), %	Do not use bottled water ($n = 2,055$), %
Household income, $				
<15,000	13.3	11.5	9.1	15.2
15,000–24,999	11.6	9.8	8.6	11.6
25,000–34,999	10.7	10.4	9.1	12.4
35,000–49,999	14.2	16.8	16.0	18.0
50,000–74,999	18.2	20.8	22.6	18.1
⩾75,000	32.0	30.8	34.8	24.6

[a]U.S. Census Bureau (http://www.census.gov/). 2008 adult population (18 years +).

Table A2. Survey Questions Pertaining to Bottled Water

WELCOME.
Welcome to our survey on the value of drinking water quality. This survey was put together by researchers at Vanderbilt and Duke Universities to help the government understand your views on the value of drinking water quality. The survey should take less than half an hour to complete, and you may stop at any time.

We hope that you will find this survey interesting. Thanks very much for your responses.

For most of the questions in this survey, there are no right or wrong answers. We are simply interested in your opinions.

HHSIZE.
How many members of your family (spouse, children, parents, or other relatives) currently live in your home, including yourself?

One 1
Two 2
Three 3
Four 4
Five 5
Six or more 6

[SHOW IF HHSIZE = 1 OR REFUSED]
FAM2A.
For the rest of this survey, when a question refers to your family or members of your family who live in your home, think of it as referring only to you.

[SHOW IF HHSIZE > 1]
FAM2B.
For the rest of this survey, when a question refers to you, think of it as referring to you and the members of your family who currently live in your home.

REMEDY4.
Do you use bottled water? (distilled, filtered, or spring water bought in small bottles, gallon jugs, or a water cooler)

Yes, in the home 1
Yes, at work 2
Yes, while exercising 3
Yes, in the car 4
Yes, other (specify)_____ 5

(*Continued*)

Table A2. Continued

No, I do not use bottled water
[SP] 6

[ASK IF REMEDY4 = 1 — 5: ANY YES ANSWER]
EXPENSE1.
How much would you estimate that your household spends each month on bottled water?
$1 or Less 1
More than $1 up to $5 2
More than $5 up to $10 3
More than $10 up to $25 4
More than $25 up to $40 5
Over $40 per month 6
Don't Know 7

[ASK IF REMEDY4 = 1 — 5: ANY YES ANSWER]
BOTKIND1.
When you drink bottled water, what kind do you most often use?
Filtered water
Spring water
Distilled water
Other (specify_____)
Don't know

[ASK IF REMEDY4 = 1 — 5: ANY YES ANSWER]
BOTKIND2.
How do you most often buy your bottled water?
Single serving bottles
Gallon jugs
Containers larger than one gallon

[ASK IF REMEDY4 = 1 — 5: ANY YES ANSWER]
BOTBUY.
In the last month, what kinds of bottled water have you purchased?
Plastic bottles 1
Glass bottles 2
Plastic gallon jugs 3
Water cooler containers 4
Other (specify)_____ 5

[ASK IF BOTBUY = 1]
BOTRECP.
In the last month, have you recycled your empty plastic water 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

[ASK IF BOTBUY = 2]
BOTRECG.
In the last month, have you recycled your empty glass 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 glass bottles 5

[ASK IF BOTBUY = 3]
BOTRECJ.
In the last month, have you recycled your empty plastic gallon jugs 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 gallon jugs 5

[ASK IF BOTBUY = 4]

(*Continued*)

Table A2. Continued

BOTRECW.
In the last month, have you recycled your empty water cooler containers 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 water cooler containers 5

[ASK IF BOTRECP = 3]
BOTDEPP.
How much money (in cents) per plastic bottle do you get for returning them for deposit?
_____ cents

[ASK IF BOTRECG = 3]
BOTDEPG.
How much money (in cents) per glass bottle do you get for returning them for deposit?
_____ cents

[ASK IF BOTRECJ = 3]
BOTDEPJ.
How much money (in cents) per plastic gallon jugs do you get for returning them for deposit?
_____ cents

[ASK IF BOTRECW = 3]
BOTDEPW.
How much money (in cents) per water cooler container do you get for returning them for deposit?
_____ cents

[ASK IF BOTBUY = 1]
BOT10P.
Out of every 10 plastic bottles, how many would you say that you recycled or returned for reuse?
☐

[ASK IF BOTBUY = 2]
BOT10G.
Out of every 10 glass bottles, how many would you say that you recycled or returned for reuse?
☐

[ASK IF BOTBUY = 3]
BOT10J.
Out of every 10 plastic gallon jugs, how many would you say that you recycled or returned for reuse?
☐

[ASK IF BOTBUY = 4]
BOT10W.
Out of every 10 water cooler containers, how many would you say that you recycled or returned for reuse?
☐

[ASK IF BOTBUY = 1]
BOTREUSE.
How often do you re-fill your plastic water bottles using tap water or filtered water?
Never 1
Rarely (1-2 out of every 10 bottles) 2
Sometimes (3-4 out of every 10 bottles) 3
Often (refill half or more of your bottles) 4

RECYCLE.
Consider all of the recyclable materials that you use. Relative to your neighbors, would you say you recycle....

Much Less Of my Recyclables	Less Of my Recyclables	About the Same as my Neighbors	More Of my Recyclables	Much More Of my Recyclables

[ASK IF STATE = CT]

(*Continued*)

Table A2. Continued

AWARE.
Were you aware that Connecticut recently changed its bottle deposit law to include a 5-cent deposit on plastic water bottles?

Yes 1
No 2

GREEN1.
Would you describe yourself as an environmentalist?

Yes 1
No 2

ENVORG.
Are you a member of any of the following organizations?

Environmental Defense Fund 1
Greenpeace 2
National Audubon Society 3
National Wildlife Federation 4
Nature Conservancy 5
Natural Resources Defense Council 6
Sierra Club 7
None of these 8

Appendix B: Bottle Deposit Laws and State Recycling Laws

Concerns about diminishing landfill space have prompted many states to pass legislation encouraging recycling.[43] States with the highest disposal fees and limited amounts of disposal capacity remaining were the first to pass waste reduction legislation. 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.

B.1. Bottle Deposit Laws

A bottle deposit bill, or container deposit law, requires a refundable deposit on beverage containers, usually ∼5–10 cents, and encourages consumers to return these containers for recycling to receive their deposit back.[44] As of 2009, eleven states—California, Connecticut, Delaware,

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

44. 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.

Hawaii, Iowa, Maine, Massachusetts, Michigan, New York, Oregon, and Vermont—have bottle deposit laws. These states represent 29% of the U.S. population and 28% of our sample. In our survey, five of these states—California, Connecticut, Hawaii, Maine, and Oregon—included deposits on bottled water in their regulatory scheme.[45] Most states have a modest 5-cent deposit on beverages; only Michigan has a 10-cent deposit on all covered beverages. Six states retain the unredeemed deposits, which provide state revenue in the millions.[46] 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.[47] Connecticut and New York both passed updated bills allowing the state to retain unredeemed deposits.[48] While Connecticut's update has already been implemented, New York's update has been delayed by a court ruling.[49] 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 20–30-cent deposits.[50] Florida's bill is the only bill to propose that bottlers retain unclaimed deposits; the rest proposed that the state retains unredeemed deposits.[51] All proposed laws, except New Hampshire's, would cover water bottles.

45. Connecticut's addition of bottled water to its bottle deposit scheme was implemented on October 1, 2009. New York had already passed a bill that would add bottled water, but a court order delayed implementation of this bill until October 30, 2009, which was after the final round of the survey used for this paper.

46. 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 was delayed to past the scope of this paper.

47. Maryland only considered setting up a task force to study the possibility of a bottle deposit, so it was not included in this statistic.

48. New York's bill would also add water bottles to its list of bottles covered by the deposit.

49. Confessore, Nicholas. Bottle Bill, Bottled Up, City Room, *New York 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.

50. Only Tennessee and one West Virginia bill proposed 5-cent deposits.

51. New Jersey's bill proposed a mixed retention plan, where the state retains 75% of the unredeemed deposits.

B.2. 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.[52] These kinds of programs are usually implemented at the municipality or county level,[53] 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% of the population.[54] 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, New Jersey, New York, West Virginia, and Wisconsin have passed similar "mandatory" recycling laws. Table B1 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% of the

52. Kinnaman (2005, 2006) finds that about eighteen to twenty-two states mandate curbside recycling. Because we did not have this information for 2008, we group states with comprehensive statewide recycling provisions with those with mandatory curbside recycling programs.

53. In 2007, more than 8,600 curbside recyclables collection programs were reported in the United States (EPA, 2007). The EPA (2007) found that 84, 76, 61, and 30% 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.

54. 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.

Table B1. States that either require recycling or an opportunity to recycle

State	Mandatory recycling or opportunity to recycle?	Source	Notes	State recycling or waste reduction goal?
Arizona	Opportunity to recycle	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	Opportunity to recycle	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	Mandatory recycling	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	Mandatory recycling	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	Opportunity to recycle	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	Opportunity to recycle	Minn. Stat. § 115A.552.	"Counties shall ensure that residents, including residents of single and multifamily dwellings, have an opportunity to recycle."	Yes (35%)
Nevada	Opportunity to recycle	Nev. Rev. Stat. Ann. § 444A.040.	"The board of county commissioners in a county whose population is 100,000 or more, or its designee, shall make available for use in that county a program for . . . [t]he separation at the source of recyclable material from other solid waste . . . [and] [t]he establishment of recycling centers for the collection and disposal of recyclable material . . ."	Yes (25%)
New Jersey	Mandatory recycling	N.J.S.A. 13:1E-99.16	"The governing body of each municipality shall adopt an ordinance which requires persons . . . to source separate from the municipal solid waste stream. . . the specified recyclable materials for which markets have been secured."	Yes (60%)
New York	Mandatory recycling	McKinney's General Municipal Law § 120-aa	"[A] municipality shall adopt such a local law or ordinance to require that solid waste. . . shall be separated into recyclable, reuseable or other components for which economic markets for alternate uses exist."	Yes (40%)

(*Continued*)

Table B1. Continued.

State	Mandatory recycling or opportunity to recycle?	Source	Notes	State recycling or waste reduction goal?
Oregon	Opportunity to recycle	Or. Rev. Stat. §§ 459A.005 to .010.	"The 'opportunity to recycle' means at least that the city, county or metropolitan service district . . . [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%)
Pennsylvania	Mandatory recycling	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
South Carolina	Opportunity to recycle	S.C. Code Ann. § 44-96-80.	"Each county or region submitting a solid waste management plan . . . shall provide its residents with the opportunity to recycle the categories of solid waste materials designated in the county or regional solid waste management plan."	Yes (35%)

Washington	Opportunity to recycle	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	Mandatory recycling	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	Mandatory recycling	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, except Nevada, have a planning requirement.

Table B2. 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 Mexico	N. M. S. A. 1978, § § 74-9-4-7.	Yes (50%)
North Carolina	N.C. Gen. Stat. Ann. § 130A-309.03.	Yes (40%)
Ohio	Ohio Rev. Code Ann. § 3734.53.	No
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%)

population. [55] Arizona, Arkansas, Florida, Nevada,[56] Oregon, South Carolina, and Washington have passed similar laws ensuring adequate recycling opportunities for their populations. These laws are grouped with mandatory recycling laws in Table B1.

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, except Nevada, have planning requirements and most have a statewide recycling goal. The remaining states

55. 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.

56. Although only two counties meet Nevada's high county population cut-off of 100,000 or more for the requirements (Clark County and Washoe County), this cut-off still covers ~88% of Nevada's population.

Table B3. States that only have a recycling or waste reduction goal

State	Source	Goal amount
Louisiana	La. Rev. Stat. Ann. § 30:2413.	25%
Mississippi	Miss. Code Ann. § 17-17-221	25% (waste reduction)
Montana	Mont. Code Ann. § 75-10-803.	17%
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)
South Dakota	SDCL § 34A-6-60	50% (waste reduction)

that have a planning requirement are summarized in Table B2, which provides documentation of the applicable laws. Finally, the states that have only a statewide recycling goal are summarized in Table B3, 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.

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