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## ECONOMIC UNDERPINNINGS OF RECYCLING AND WASTE DISPOSAL POLICIES<sup>†</sup>

### The Effect of Bottle Laws on Income: New Empirical Results

By BEVIN ASHENMILLER\*

This paper reports the results of an empirical study of an unintended consequence, the transfer of income to low income households, of the use of bottle deposit laws to promote consumer recycling. Eleven states (Oregon, Delaware, Vermont, Massachusetts, Maine, New York, Michigan, California, Iowa, Hawaii, and Connecticut) have enacted “bottle laws” which apply a deposit-refund system to the purchase of beverage containers. A bottle law is one of the few examples of an environmental protection policy that takes advantage of the price system. A classic Pigouvian tax requires a consumer to pay a fee at the time of disposal that is equal to the marginal damage caused by the disposal. A deposit-refund program on beverage containers combines a consumption tax with a rebate for recycling. While a Pigouvian tax creates an incentive for consumers to dispose illegally, a deposit-refund creates an incentive for proper disposal. Putting a bounty on trash is the most efficient way of internalizing the external costs of waste disposal. For a formal model of deposit-refund programs see Fullerton and Wolverton (2000).

This paper is unique because it examines the effect of recycling for cash on income rather than the effect of income on recycling. The important features of this dataset are that the data are defined at the individual level and that the recycling behavior of the individuals is observed, not self-reported. This study focuses on people who are recycling specifically for a cash payment, although they may also participate in other recycling programs. While most environmental taxes are mildly regressive, this paper shows

that bottle laws have the potential to increase the incomes of very low wage workers.<sup>1</sup> If states set their bottle deposit high enough, harvesting recyclables becomes viable employment for low income households. The use of the price system as an environmental remedy is often criticized on the grounds that it leads to lower incomes for the poor in this case, however, cash recyclers augment their incomes by redeeming more containers than just the ones they purchased. Deposit-refund recycling laws provide a way to reduce post-consumer waste and simultaneously increase the income of low wage workers.<sup>2</sup> This paper provides the first evidence that this happens in practice.

To model a recycling wage assume that the amount of recycling available per day is fixed. Then the daily recycling wage is simply the value of the recycling divided by the number of people who choose to recycle on that day. Because the wage is very low, only the lowest wage people will recycle, perhaps only the homeless. In this case the only people recycling for cash would be those whose recycling wage is higher than their labor market wage. In practice, however, we observe other people recycling. This suggests the wage may be high enough to encourage non-destitute people to recycle. In this case we might expect to see people recycling even though their market wage is higher than their recycling wage. Perhaps they have a constraint on the number of hours that they work, or they may work in a place where they have access to large amounts of discarded containers, such as a restaurant or hotel.

<sup>1</sup> D. B. Suits (1977) finds that sales taxes and motor vehicle taxes are regressive. There is also current literature examining the distributional effects of a tax on gasoline, which has also been found to be a regressive tax. See West and Williams (2004) for more discussion of this.

<sup>2</sup> In this paper the amount of beverage container materials purchased by the each household is ignored. Ashenmiller (2009) calculates the value of the collected (not purchased) beverage containers returned by cash recyclers.

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In the first two cases the decision to recycle for cash is based entirely on a person's market and recycling wages. A third case would be that perhaps people do not value their time recycling in the same way that they value their time spent in the labor market. People may actually enjoy recycling for cash. People who receive some utility from their recycling—say a nice walk on the beach—might choose to recycle even if their recycling wage was less than their market wage.<sup>3</sup> This paper uses data on cash recyclers to build a unique dataset to examine the decision to recycle for cash. This dataset is then used to assess what characteristics predict cash recycling behavior.

The dataset used for this analysis was created specifically to address empirically the questions surrounding bottle law recycling. The dataset is the result of one month of face-to-face surveys administered to all people returning bottles and cans for cash in and around Santa Barbara, California. The data collected included information about the material being recycled, sociodemographic characteristics of the person recycling, and the actual breakdown of material cashed out. The survey was administered in Spanish and English. Six hundred and sixty participants completed the survey, and about one third of them took the survey in Spanish. The refusal rate was 10 percent.

The sample of recyclers was then weighted to approximate the total number of people who recycle for cash over the course of a year. Because the recycling centers were surveyed for one month, a week at each of five centers, the data represent only a sample of the total number of people who recycle over the course of a year. In order to estimate this number each of the cash recyclers in the sample is weighted based on the frequency with which he recycles. The one assumption made, to do this, is that each recycling center was surveyed on a representative week. Each observation is then weighted based on the probability that it was surveyed. About 8 percent of population of the Santa Barbara South Coast brings materials to a redemption center for cash at least once a year. It is important to note that this is not an assumption that the recycling supply is constant, only an assumption

that the proportions of people recycling at the center, the types of recyclers, remain constant in frequency throughout the year. Data on nonrecyclers is from the 2000 census 5 percent sample.

Propensity score matching was used to reweight and merge the recycling data with the census data. The propensity score matching and reweighting of the samples was implemented in two steps. First the propensity score was obtained by estimating a probit model for recycling using the explanatory variables in the sample. Second, using the nearest-neighbor method census observations were matched to recycling observations. The census data were then reweighted by subtracting from the original census weight the frequency that each census observation was matched to a recycling survey observation. In every case the resulting weight remained positive.<sup>4</sup> The resulting dataset was used to estimate a probit model of the decision to cash recycle.

The probability of recycling is assumed to be given by:

(1)

$$\begin{aligned} \Pr(\text{Recycling}) &= \Pr(R_i = 1) \\ &= \Pr(\alpha \ln y_i + \beta X_i + v_i > 0) \\ &= \Phi(\alpha \ln y_i + \beta X_i) \end{aligned}$$

where  $\Phi$  is the standard normal cumulative density function. The model includes household income ( $y_i$ ) and a vector ( $X_i$ ) of demographic, household and other characteristics that may reflect the individuals' preferences and costs associated with recycling at the recycling center and may therefore explain their recycling behavior.

Table 1 reports the results of the probit model to identify characteristics that determine cash recycling. The first two columns report the results from the combined census and recycling survey dataset. The second two columns report the results from the dataset using the corrected choice-based sampling weights. In the first and third columns the income variable used is the natural log of income. In the second and fourth columns the income variable is the error term

<sup>3</sup> Formal models of each of these cases are available upon request.

<sup>4</sup> Dehejia and Wahba (2002) explains this thoroughly.

TABLE 1—REGRESSIONS PREDICTING THE DETERMINANTS OF RECYCLING

	Census and sample weights		Choice based sample weights	
Natural log of income	-0.443*** (0.045)		-0.447*** (0.045)	
Residuals of income equation <sup>a</sup>		-0.443*** (0.045)		-0.447*** (0.045)
Born in the United States	0.208** (0.086)	0.123 (0.086)	0.213** (0.087)	0.127 (0.086)
No high school	-0.025 (0.112)	-0.007 (0.112)	-0.025 (0.112)	-0.007 (0.112)
Some college or more	-0.028 (0.091)	-0.092 (0.113)	-0.054 (0.113)	-0.093 (0.113)
Survey given in Spanish	0.753*** (0.127)	0.892*** (0.127)	0.769*** (0.127)	0.907*** (0.128)
Female	-0.481*** (0.070)	-0.463*** (0.070)	-0.486*** (0.070)	-0.467*** (0.070)
Married	0.355*** (0.075)	0.239*** (0.074)	0.360*** (0.075)	0.242*** (0.074)
Age	0.005*** (0.002)	0.004*** (0.002)	0.005*** (0.002)	0.004*** (0.002)
Children under 18 in the house	-0.162* (0.088)	-0.216** (0.087)	-0.163* (0.088)	-0.217** (0.088)
Household size	-0.005 (0.018)	-0.039** (0.018)	-0.006 (0.018)	-0.037** (0.018)
Pseudo R <sup>2</sup>	0.125	0.125	0.127	0.127

Notes: Robust standard errors in parentheses. There are 9,396 observations.

<sup>a</sup>These are the residuals from an OLS regression of the natural log of income on the demographic variables.

\*\*\*Significant at the 1 percent level.

\*\*Significant at the 5 percent level.

\*Significant at the 10 percent level.

from an ordinary least squares regression of income on the demographic characteristics. The residual here represents the portion of income not explained by the demographic characteristics in the dataset. This allows us to interpret the significance of the impact of the demographic variables on the recycling choice, separate from their impact on the recycling choice through income.

Table 1 shows a strongly negative correlation between income and participating in a deposit-refund program. This is in contrast to the inconclusive findings in the literature review concerning the relationship between income and recycling. This suggests that low income people are much more likely to participate in the cash recycling program than are high income people. In fact bottle laws provide a very strong incentive for low wage consumers to recycle because they provide a relatively high wage to

low income workers who recycle. Other determinants such as gender, age, language, and the presence of children are also significant.

Under a bottle law consumers pay a deposit when they purchase a beverage container and receive a refund when they return the container to a recycling center. When a consumer chooses not to participate in the cash recycling program, the effective result is that the deposit becomes a tax. The probit model of the decision to participate in the cash recycling program shows that low-income households are more likely to participate than are high-income households. In fact data from the recycling survey show very clearly that low-income households actually recycle more material than they purchase. In fact less than 50 percent of the recyclable material returned for the refund is returned by the household that purchased the material and paid the deposit.

TABLE 2—THE CASH VALUE OF RECYCLING BY INCOME LEVEL IN 2002

Household income level	Less than \$10,000	\$10,000 to \$24,999	\$25,000 to \$49,999	\$50,000 to \$75,000	Over \$75,000
Total cash paid for recycling	\$211,780	\$396,869	\$219,576	\$120,532	\$96,224
Average cash paid to recycling household	\$340	\$316	\$144	\$217	\$124
Households that cash recycle	623	1,257	1,523	555	779

In order to determine the size of the recycling income to people participating in the California Cash Redemption Program the survey data were used to calculate the proportions of aluminum, glass, and plastic materials brought to the redemption centers by the recyclers of each income level and language proficiency. The proportion of the materials redeemed by each recycler type are assumed to be representative. These proportions are then applied to the actual total amount of material collected by each recycling center during the 2002 calendar year.<sup>5</sup> To determine the total amount of cash paid for recycled materials the per pound redemption value paid by the State of California in the year 2002 was used. The redemption values were \$0.77 for a pound of aluminum, \$0.05 for a pound of glass, and \$0.41 for a pound of plastic.<sup>6</sup>

Table 2 reports the cash value of the redeemed CRV materials by income level. The recyclers with incomes less than \$25,000 received \$608,649 during 2002, which was 58 percent of the value of all of the recycling brought to the redemption centers. The average cash paid to all recycling households is the total value of the recyclable materials returned by household in each income bracket divided by the total number of recycling households. The payment to households earning less than \$10,000 is about \$340 while households earning between \$10,000 and \$24,999 receive about \$315. For the three higher

income levels the payments drop to \$144, \$217, and \$124.

Table 3 reports the cash value for the year 2002 of the CRV recycling returned by income level and whether the primary language of the recycler is Spanish. The primarily English speaking recyclers with incomes less than \$25,000 received \$222,759 during 2002, which was 22 percent of the value of all of the recycling brought to the redemption centers. The primarily Spanish speaking recyclers with incomes less than \$25,000 received \$385,889 during 2002, which was 37 percent of the value of all of the recycling brought to the redemption centers. At income levels below \$50,000 the average cash payment to primarily Spanish speaking recycling households is approximately twice the cash payment to primarily English speaking households. The payment to households earning less than \$10,000 is \$278 for English speaking households and \$428 for Spanish speaking households. For households earning between \$10,000 and \$24,999, \$200 goes to English speaking households and \$423 goes to Spanish speaking households. For households earning between \$25,000 and \$49,999, \$115 goes to English speaking households and \$264 goes to Spanish speaking households. For households with income between \$50,000 and \$74,999 the payments are about equal at \$216 for English speaking households and \$257 for Spanish speaking households. For households with incomes over \$75,000, the payment to English speaking households is twice the payment to Spanish speaking households, \$124 compared to \$61.

Lower income households recycle for cash more than households with higher incomes. While the cash transfers are small numbers and do not represent a large change in the income distribution, the more important question

<sup>5</sup> The total amount of recycling collected by each recycling center was supplied by the California Department of Conservation, Division of Recycling.

<sup>6</sup> These values are lower than the true values since the redemption centers pay a slightly elevated price for larger loads of aluminum. For example, all the redemption centers pay \$1.00 a pound for a load of aluminum larger than a 100 pounds.

TABLE 3—THE CASH VALUE OF RECYCLING BY INCOME LEVEL AND LANGUAGE IN 2002

Household income level	Less than \$10,000	\$10,000 to \$24,999	\$25,000 to \$49,999	\$50,000 to \$75,000	Over \$75,000
Total cash paid for recycling					
English	\$101,084	\$121,675	\$141,647	\$116,640	\$95,693
Spanish	\$110,696	\$275,193	\$77,929	\$3,892	\$531
Average cash paid to recycling household					
English	\$278	\$200	\$115	\$216	\$124
Spanish	\$428	\$423	\$264	\$257	\$61
Number of households that cash recycle					
English	364	607	1,228	540	770
Spanish	259	650	295	15	9

from a policy perspective is whether the recycling income is significant. Twelve percent of households with an income less than \$10,000 participate in the California Cash Redemption Program. These households constitute about 1 percent of the total households in the Santa Barbara South Coast, and yet they receive about 20 percent of the total cash value of recycling in 2002. Assuming the average household income for these households is \$5,000, then a \$340 annual transfer represents 6.8 percent of annual income. When we narrow our focus to primarily Spanish speaking the transfer is even greater. Twenty-six percent of primarily Spanish speaking households earning less than \$10,000 receive about \$428 a year from cash recycling. Assuming the average household income for these households is \$5,000, then a \$428 annual transfer represents 8.6 percent of annual income. So while the overall effect of the deposit refund for many income levels may be very small, for the people falling into the lowest income bracket it is quite meaningful. The bottle law provides a significant income transfer to a small number of households that are difficult to support. This paper is the first empirical estimation of the value of this income redistribution. The scavenging of bottles and cans to return for the deposit creates a situation in which deposit-refund recycling laws improve resource allocation using the appropriate Pigouvian tax and simultaneously increase the income of very low wage workers.

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