

Occidental College

From the Selected Works of Bevin Ashenmiller

May, 2011

The Effect of Income on Recycling Behavior in the Presence of a Bottle Law: New Empirical Results

Bevin Ashenmiller, *Occidental College*



Available at: <https://works.bepress.com/bevin/2/>

The Effect of Income on Recycling Behavior in the Presence of a Bottle Law: New Empirical Results

Bevin Ashenmiller
Occidental College

January, 2006

Draft

Abstract

Eleven U.S. states have enacted “bottle laws” and they are one of the few examples of a policy that takes advantage of the price system to ameliorate environmental damage. A deposit-refund program on beverage containers is a consumption tax combined with a disposal rebate that is the equivalent of a Pigouvian tax. Using individual level data I have collected on observed cash recycling behavior, this paper shows that an unintended consequence of bottle laws is that they have the potential to increase the incomes of very low wage workers. If states set the bottle deposit high enough, harvesting recyclables becomes viable employment. The use of a price system as an environmental remedy is often criticized on the grounds that it leads to lower incomes for the poor. In this case deposit-refund recycling laws may provide a way to improve resource allocation using the appropriate Pigouvian tax, and simultaneously provide a way to increase the income of low wage workers. The first section of this paper I estimate the determinants of recycling behavior in the presence of a bottle law. This provides some insights into the characteristics of those who cash recycle. In particular I find that low income households are much more likely to recycle for cash than are high income households. The second section of this paper uses the dataset of recyclers to examine the importance of recycling income to low income households. The data show the surprising result that recycling income does indeed provide a substantial supplemental income to a certain group of low-income cash recyclers.

I am extremely grateful to Kelly Bedard, Robert Deacon and Jon Sonstelie for their comments and support.

1. Introduction

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 U.S. states 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.¹ A deposit-refund program on beverage containers is a consumption tax combined with a disposal rebate that is the equivalent of a Pigouvian tax. Under a Pigouvian tax a consumer would pay a disposal fee equal to the marginal damage caused by the disposal. A deposit-refund is preferable to a Pigouvian tax because while a Pigouvian tax encourages illegal disposal by individuals trying to avoid paying the fee, a deposit-refund encourages correct disposal, in this case recycling. In the presence of illegal disposal a deposit-refund program is the most efficient way of internalizing the external costs of waste disposal. One of the most general models of a deposit-refund program is described in Fullerton and Wolverton (2000).² Because deposit-refund programs encourage recycling, the deposit-refund literature is a small subset of the literature on recycling.

Within the recycling literature various studies have examined the effect of income level and education level on voluntary and curbside recycling. The general effect of income on recycling is not well understood. There is more agreement on the affect of education level. Callan and Thomas (1997) use community level data that exploit

¹ The eleven states with bottle bills are: Oregon (1972), Vermont (1973), Maine (1978), Michigan (1978), Iowa (1979), Connecticut (1980), Delaware (1983), Massachusetts (1983), New York (1983), California (1987), and Hawaii (2002).

² See also Sigman (1995), Fullerton and Kinnaman (1995), Palmer and Walls (1997).

differences in community characteristics. They find that income and education both increase recycling quantities. Duggal et al. (1991) also find that higher income and education levels increase recycling. Hong et al. (1993) use self-reported survey data to find that income does not affect recycling rates, but that education does increase recycling. Hong et al. (1999) use actual recycling and garbage weights to find that increases in income lead to a higher recycling rate and that education is not significant. Ferrara and Missios (2004) use individual level survey data. The proportions of the materials recycled are self-reported in their survey. They find that income decreases newspaper and plastic recycling and that post-graduate education increases recycling of newspaper, glass, and aluminum. Jenkins et al. (2003) also use individual level survey data in which the proportions of the materials recycled are self-reported. They find that income increases newspaper recycling and education level increases newspaper, glass and aluminum recycling.³

This paper uses a unique dataset I have collected specifically for the purpose of examining the effects of income and education on cash recycling. The important features of this dataset are that the data is defined at the individual level and that the recycling behavior of the individuals is observed, not self-reported. While both Fullerton and Kinnaman (1996) and Hong and Adams (1999) combine a household survey with periodic weighing of garbage and recycling bins, their studies are concerned primarily with curbside and drop-off recycling programs. This study is different because it focuses on people who are recycling specifically for a cash payment, not just leaving their recyclables on the curb. The subjects of this study may also participate in curbside recycling programs at their home and other voluntary drop-off recycling programs. In

³ Reschovsky and Stone (1994) and Judge and Becker (1993) also find that education increases recycling.

fact sixty-nine percent of the study participants reported having curbside recycling at their home, a number that matches curbside recycling availability for the Santa Barbara south coast.⁴

Although most studies show that environmental taxes are mildly regressive, this paper shows that bottle laws have the potential to increase the incomes of very low wage workers.⁵ 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 because environmental taxes are regressive. Deposit-refund recycling laws may provide a way to improve resource allocation using the appropriate Pigouvian tax and simultaneously to increase the income of low wage workers.⁶ This paper provides the first evidence that this happens in practice.

The rest of the paper is laid out as two sections. The first section describes the data on cash recyclers and non-recyclers and the construction of a combined dataset. The dataset of recyclers is from a July, 2002 empirical field study of recyclers and their characteristics in Santa Barbara, California. These data are the first information of their kind ever collected. Using choice-based sampling the recycling survey data are merged with Census 2000 data. The dataset provides the basis for the estimation of a discrete choice model of the decision to recycle for cash. In particular this model permits the

⁴ The California Beverage Container Recycling and Litter Reduction Study reported that in 1999 curbside recycling programs covered 50% of the population of Santa Barbara County. In 2001 curbside programs in California covered 72% of single family dwellings, 58% of multi-family dwellings (2 to 4 households) and 28% of apartment units.

⁵ D.B Suits (1977) finds that sales taxes and motor vehicle taxes. 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 Sipes and Mendelsohn (2001) and West and Williams (2004) for this discussion.

⁶ In this paper the amount of beverage container materials purchased by the each household is ignored. In a second paper I find the value of the collected (not purchased) beverage containers returned by cash recyclers.

estimation of the effects of other demographic variables on the demand for cash recycling while holding income constant. This estimation provides some insights into the characteristics of those who cash recycle. There is a strong the negative relationship between recycling and income. The result that recycling for cash is far greater among low income households than among high income households leads to the second section of the paper.

The second section of the paper seeks to answer the question, how important is recycling income to low income households? The data are used to determine the total amount recyclable materials returned to recycling centers by income level and by income level and English language proficiency and the value of that material. If bottle deposit laws provide a strong incentive for low wage consumers to recycle because they provide a relatively high recycling then what effect does this incentive have on the income distribution? The data show that recycling income provides a substantial supplemental income to a certain group of low-income cash recyclers. The final section of the paper provides a summary and conclusions.

2. The Determinants of Recycling for Cash

2.1. The Model

The question to begin with is what are the attributes of people who are recycling for cash? To begin thinking about a recycling wage let's start with a very simple assumption. Suppose that there is a fixed amount of recycling available, and the wage is simply the value of the recycling divided by the number of people who choose to recycle. 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. The wage then may be high enough to encourage other people to recycle. In this case we might expect to see people recycling whose market wage is higher than their recycling wage, but they have a constraint on the number of hours that they work. Alternatively they may work in a place where they have access to large amounts of recycling, such as a restaurant or hotel.

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 like 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.⁷ In order to examine the decision to recycle for cash I use data on cash recyclers to build a unique dataset. I use this dataset to assess income as a predictor of cash recycling behavior and to examine what other characteristics, besides income, predict cash recycling behavior.

2.2. Data

2.2.1. The Survey of Recyclers

In the economic literature on recycling there is no data currently available that explain recycling behavior in the presence of a bottle law. The unique dataset used for this analysis was created specifically to address empirically the questions surrounding bottle law recycling. In particular I was interested in the characteristics of cash recyclers. How much money do they earn? How much of the total material recycled do they

⁷ Formal models of each of these cases are available upon request.

collect? From where does that material come? The survey instrument grew from these questions. The dataset is the result of one month of face-to-face surveys administered to all people returning bottles and cans for cash at four recycling centers. The survey was administered in Spanish and English.

The recycling centers are located in Santa Barbara and Goleta, California. In July 2002 this area had three main recycling centers and five small buyback centers in supermarket parking lots. The final survey included results from one week spent at each of the high volume recycling centers as well as one week at one of the grocery store buyback centers. All people recycling for cash at each redemption center were approached while they were waiting to check out and asked to participate in the survey. The final question of the survey was a card on which the surveyor recorded the actual cash payment or the weight of each load brought to recycling center by the survey participant. This was reported individually for each material that was recycled: aluminum, glass, and plastic.

There are three main sections in the survey. The first part of the survey asks about the recycled material and recycling activities of the respondent. The survey asks where the recycled materials are from, how much time it takes to recycle, and how far out of their way they had to travel to come to the redemption center. The second part of the survey questions the individual about his age, place of birth, educational attainment, household income, etc. The question about household income was asked using a separate card. This card categorized income levels as A: less than \$10,000, B: \$10,000 to \$25,000, C: \$25,000 to \$50,000, D: \$50,000 to \$75,000 and E: more than \$75,000. The respondent was asked to name the letter which corresponded most closely to her

household income. The third part of the survey was a card filled out by the surveyor recording either the weight by material of the recycling brought into the center, or in some cases the amount paid by the recycling center for each material recycled. Six hundred and sixty participants completed the survey and about one third of them took the survey in Spanish. The refusal rate for the survey was ten percent.

The recycling survey data is a sample of the total population that recycles for cash in the Santa Barbara South Coast. The sample was then weighted to approximate the total number of people who recycle for cash in the course of a year. Because only one month was spent surveying at the recycling centers, a week at each of five centers, I do not have an accurate count of the total number of people who recycle over the course of a year. In order to estimate this number I need to weight each of the cash recyclers in the sample based on the frequency with which they recycle.⁸ To do this I assume that the week I surveyed at each recycling center was a typical week. Each observation is weighted based on the probability that, during the week I was there, I sampled all of the recyclers who visited the recycling center with the same frequency that they did. So, for example, if a person recycled once a week or more then his weight is 1. A person who reported that they recycled once a month has a weight of 52/12. A person who reported that they recycled once a year has a sample weight of 52. Overall, I estimate that about eight percent of the people in the Santa Barbara South Coast recycle at the redemption centers for cash at least once per year.

⁸ Manski and Lerman (1977) explain this technique thoroughly.

2.2.2. Choice Based Sample

If eight percent of the people in the Santa Barbara south coast area recycle for cash, this leaves us with ninety-two percent of the population not recycling for cash. The survey data described above contains detailed information on the people who are recycling for cash. It does not, however, contain any information about people who do not choose to recycle for cash. In order to examine the determinants of this recycling decision it is necessary to have individual level data on both recyclers and non-recyclers. To overcome this problem I use data from the 2000 census 5% sample to gather information on non-recyclers.⁹

Both the recycling data and the census data are weighted samples. In order to merge these datasets the samples need to be re-weighted. The new weights will correct the fact that the cash recyclers in the recycling survey are also accounted for in the census sample. In other words I want to be sure that the survey respondents are not counted twice in the combined dataset. The first step involves matching each observation from the recycling survey sample to an observation from the census. In order to determine which of the observations from the census data most closely match the observations from the recycling survey data, I use propensity score matching.¹⁰ Matching on the propensity score is matching on the probability of recycling conditional on the covariates. This probability is an index of all the covariates and a way of compressing the vector of

⁹ I use the 2000 Census 5% sample of the smallest census area that surrounds the Santa Barbara south coast. This is the Census Public Use Micro Area (PUMA) which includes part of Santa Barbara county including Santa Barbara, Goleta CPD, Isle Vista CPD, Carpinteria, Montecito CDP, Mission Canyon CDP, Summerland CDP and Toro Canyon CDP.

¹⁰ Rosenbaum and Rubin (1983) lays out this approach in detail.

covariates into a simple scalar. The identifying assumption is that the treatment, in this case recycling, is associated only with observable variables.¹¹

I implement the propensity score matching and re-weight the samples in two steps. First the propensity score is obtained by estimating a probit model for recycling using the explanatory variables in the sample. Second, using the nearest-neighbor method, I match census observations to recycling observations. Then I re-weight the census data 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. In other words I never had an observation in the census that was matched to more recycling observations than the value of the observation's original weight.

2.3. A Probit Model

What are the attributes of people recycling for cash? In order to answer this question I use the dataset described above to estimate a probit model of the decision to cash recycle. The probability of recycling is assumed to be given by:

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

where Φ 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.

The variables in the regression include the natural log of income, which should represent the opportunity cost of the time spent collecting and bringing the materials to

¹¹ Heckman and Robb (1985) explains this thoroughly.

the recycling center for payment, as opposed to placing them in curbside garbage or recycling bins. The other variables may reflect the recycler's preference for recycling at the recycling center for payment as opposed to another method. The variables include educational attainment dummy variables: whether the recycler has some high school education or attended college. A high level of educational attainment may lead to a higher preference for recycling. But remember the recycling in this study is specifically recycling for cash, not using a curbside program or drop-off program.

The regression also includes individual characteristics including whether the survey was administered in Spanish, the recycler's gender, age, and marital status. A recycler taking the survey in Spanish may be more likely to live in a multi-unit dwelling. Apartment buildings are less likely to have curbside recycling and this may make it easier to gather additional recycling, increasing the benefit of making the trip to the recycling center. Finally, household characteristics like household size and children under the age of 18 are also included in the regression. Families with children and larger households may have difficulty coordinating a visit to the recycling center with other errands and the use of the family vehicles, since the recycling centers are not easily accessible on foot.

2.4. Results

Table 1 reports the results of a probit model to identify characteristics that determine whether or not a person will choose to recycle for cash. 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 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 that income is negatively correlated to recycling for cash. The higher income you have, the more costly the time spent going to the recycling center, and the more likely you are to recycle in other, less time-consuming ways. The education variables are not significant, which is consistent with the idea that while education might increase your preference for recycling there is no reason to believe that it should increase one's need to get paid for that recycling. The primarily Spanish speakers are more likely to recycle for cash, which may reflect the fact that they may have less disutility from collecting extra recycling, which increases the pay-off of going to the recycling center. Women are less likely to recycle for cash. This may be related to the resource constraints that cause larger households and households with children to be less likely to recycle. Women are generally much more likely to be the care-givers in these situations. Married people and older people are more likely to recycle for cash. This is may be because the costs of recycling also include storage costs. Many families save up their recycling, especially aluminum, for long periods of time because it is compact and the most valuable per pound. More established, married couples are likely to have the space to do this cheaply and this may lead them to recycle for cash.

The most compelling result of the probit model is that income has a strong negative effect on the decision to recycle for cash. This suggests that low income people are much more likely to participate in the cash recycling program than high income people. In fact bottle deposit 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. As this is the case the question, becomes how important is the recycling income for these low income recyclers? Is there a significant effect on the income distribution?

3. The Value of Recycling Income to Households and the Effect on the Income Distribution

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 on the decision to participate in the cash recycling program shows that low-income households are more likely to participate than high-income households. In fact data from the recycling survey shows that low-income households actually recycle more material than they purchase. What additional data are necessary to examine the size of the income redistribution?

3.1. Data on the Total Weight of Recycling for 2002

In order to determine the importance of recycling income I need to find the annual value of the recycling income to people participating in the California Cash Redemption Program. The recycling survey data reports the total amount of materials redeemed for cash at each of four recycling centers for a period of one week each. To find the annual

value of recycling income I combine the data from the survey with the total amount of recycled materials for the Santa Barbara South Coast.¹²

I use the following method to aggregate the numbers from the survey up to the total weight of recycled materials for the year. From the survey data I calculate the proportions of aluminum, glass, and plastic materials brought to the redemption centers by the recyclers of each income level. I do this a second time by income level and language proficiency. I assume that the proportions of materials brought by recyclers to each recycling center throughout the month of July are constant. In addition, while the survey included all three of the high volume redemption centers in the region, it only included one of the supermarket buyback centers.¹³ Therefore I make the assumption that the proportion of recyclables brought by recyclers of each income level is the same at each of the supermarket buyback centers. I then apply these proportions to the total amount of material collected by each recycling center during the 2002 calendar year.¹⁴

Using the proportion of materials recycled by recycling center limits the total amount of recycling to the actual amount of material recycled in 2002. This is important because the next step is to calculate the value of the total amount of materials recycled in 2002. To determine the total amount of cash paid for recycled materials I use the per pound redemption value paid by the State of California in the year 2002. The redemption

¹² The Santa Barbara South Coast is defined as the city of Santa Barbara, Goleta CDP and Isla Vista CDP. A census-designated place (CDP) is an area identified by the United States Census for separate statistical reporting. The household income question is included on the census long form and the distribution is estimated from the sample of households which answers this form. This information is therefore only an estimate and should be treated as such.

¹³ The disaggregated data is proprietary, but to give you an example the average amount of Aluminum for the larger centers was over 9.5 tons and for the supermarket buybacks the average was about 1.5 tons, for glass the averages are approximately 75 tons and 2 tons. For plastic they are about 3.5 tons and 1.5 tons.

¹⁴ The total amount of recycling collected by each recycling center was supplied by the California Department of Conservation, Division of Recycling.

values were \$0.77 for a pound of aluminum, \$0.05 for a pound of glass, and \$0.41 for a pound of plastic.¹⁵

3.2. Results

Table 2 reports the breakdown of participation in the California Cash Redemption Program (CRV recycling) and the weight of the total materials recycled by income level for the year 2002. The participation rate in the program is skewed toward the lower income levels. Twelve percent of the people who earn less than \$10,000 a year and thirteen percent of the people who earn between \$10,000 and \$24,999 recycle, compared to nine percent of people who earn between \$25,000 and \$49,999, five percent of the people who earn between \$50,000 and \$75,000 and four percent of the people who earn over \$75,000. Recyclers with incomes less than \$25,000 are responsible for fifty-six percent of the aluminum recycled, sixty percent of the glass recycled, sixty-six percent of the plastic recycled, and sixty percent of all recycled materials by weight.

Table 3 reports the cash value of the CRV recycling returned by income level. The recyclers with incomes less than \$25,000 received \$608,649 during 2002, which was fifty-eight percent of the value of all of the recycling brought to the redemption centers. The average cash payment per household is the total value of the recyclable materials returned by household in each income bracket divided by the total number of households. The payments to households that earn less than \$25,000 is about \$40, while for the higher income levels the annual payments drop to \$14, \$10, and \$5. 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

¹⁵ This is slightly underestimated 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 of 100 lbs or more.

payment to households that earn less than \$10,000 is about \$340 while for households that earn between \$10,000 and \$24,999 it is about \$315. For the three higher income levels the payments drop to \$144, \$217, and \$124.

Table 4 reports the breakdown of 2002 participation in the California Cash Redemption Program and the weight of the total materials recycled by income level and whether the primary language of the recycler is Spanish. For primarily English speakers four percent of the people who earn less than \$10,000 a year and three percent of the people who earn between \$10,000 and \$24,999, and between \$25,000 and \$49,999, recycle. This is compared to two percent of English speakers who earn between \$50,000 and \$75,000 and one percent of those who earn over \$75,000.

For primarily Spanish speakers the percentage of households that recycle is significantly higher. Twenty-six percent of primarily Spanish speakers earning less than \$10,000 a year and twenty-five percent of Spanish speakers earning between \$10,000 and \$24,999 recycle. The participation rate for Spanish speakers then drastically drops and only six percent of those who earn between \$25,000 and \$49,999, one percent of those who earn between \$50,000 and \$75,000 and less than one percent of those who earn over \$75,000 recycle.

Primarily English speaking recyclers with incomes less than \$25,000 are responsible for eighteen percent of the aluminum recycled, twenty-seven percent of the glass recycled, twenty-seven percent of the plastic recycled, and twenty-six percent of all recycled materials by weight. Primarily Spanish speaking recyclers with incomes less than \$25,000 are responsible for thirty-eight percent of the aluminum recycled, thirty-

three percent of the glass recycled, forty percent of the plastic recycled, and thirty-four percent of all recycled materials by weight.

Table 5 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 twenty-two 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 thirty-seven percent of the value of all of the recycling brought to the redemption centers.

The average cash payment per household is the total value of the recyclable materials returned by households in each income bracket divided by the total number of households in that income bracket, based on the primary language. The payments to primarily English speaking households that earn less than \$10,000 is \$10.51, while the payments to primarily Spanish speaking households that earn less than \$10,000 is \$110.95. The payment to primarily English speaking households that earn between \$10,000 and \$24,999 is \$6.60, while the payment to primarily Spanish speaking households that earn between \$10,000 and \$24,999 is \$107.61. The payments to primarily English speaking households for the higher income levels continue to drop to \$3.73, \$3.68, and \$1.44. Primarily Spanish speaking households face a much larger drop at higher income levels to \$16.50, \$1.64, and \$0.20.

The average cash paid to all recycling households is the total value of the recyclable materials returned by household in each income and language bracket divided by the total number of recycling households in that bracket. At income levels below

\$50,000 the average paid to primarily Spanish speaking recycling households is approximately twice the income paid to primarily English speaking households. The payment to households that earn less than \$10,000 is \$278 for English speaking households and \$428 for Spanish speaking households. For households that earn between \$10,000 and \$24,999, it is \$200 for English speaking households and \$423 for Spanish speaking households. For households that earn between \$25,000 and \$49,999, it is \$115 for English speaking households and \$264 for 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 as compared to \$61.

4. Conclusions

Does income explain recycling behavior in the presence of a deposit-refund program? While it is clear that there is a strongly negative correlation between income and participating in a deposit-refund program, it is not the only significant determinant. Storage costs may play a considerable factor, but other determinants such as gender, age, language, and the presence of children are also significant. This would argue against using the simplest model to describe cash recycling. Even in the case of cash recycling it seems that people may not value their time recycling in the same way as they value time in their labor market job. So while income level has a strong negative influence on the participation in the California Cash Redemption Program, it does not explain everything.

Does the strong negative correlation between income and recycling lead to a significant income redistribution? Lower income households certainly recycle more than

households with higher incomes. Is the recycling income significant? In order to answer this I suggest that we look at the lowest income groups. Twelve percent of households with an income less than \$10,000 participate in the California Cash Redemption Program. These households comprise about one percent of the total households in the Santa Barbara South Coast and yet they receive about twenty percent of the total cash value of recycling in 2002. Suppose that we assume that the average household income for these households is \$5,000. This would mean that the \$340 annual transfer represents 6.8 percent of their 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. Assume that the average household income for these households is \$5,000. This would mean that the \$428 annual transfer represents 8.6 percent of their 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 Santa Barbara area has a very large number of primarily Spanish speaking families. Recyclers are not required to show any form of identification. In other words, your legal working status can not prevent you from recycling. This program indeed seems to provide a significant income transfer to a small number of households that are difficult to support.

The key to the income redistribution is that the low income families are more likely to recycle, and in fact are recycling more materials than they have purchased.¹⁶ This behavior does create a situation in which deposit-refund recycling laws improve

¹⁶ From the survey of recyclers low income households return materials collected from outside of their own household.

resource allocation using the appropriate Pigouvian tax and simultaneously increase the income of very low wage workers.

References

- Coase, R.H., The Problem of Social Cost, *Journal of Law and Economics*, 3 (October, 1960), 1-44.
- Callan, Scott J. and Janet M. Thomas, The Impact of State and Local Policies on the Recycling Effort, *Eastern Economic Journal*, 23 (Fall 1997), 411-423.
- Dehejia, Rajeev H. and Sadek Wahba, Propensity Score Matching Methods for Nonexperimental Causal Studies, *The Review of Economics and Statistics*, 84 (February 2002), 151-161.
- Duggal, Vijaya, Cynthia Saltzman, and Mary L. Williams, Recycling: An Empirical Analysis, *Eastern Economic Journal*, 17 (July-September 1991), 351-358.
- Ferrara, Ida and Paul Missios, Recycling and Waste Diversion Effectiveness: Evidence from Canada, working paper.
- Fullerton, Don and Thomas C. Kinnaman, The Economics of Residential Solid Waste Management, NBER Working Paper 7326, 1999.
- Fullerton, Don and Thomas C. Kinnaman, Garbage, Recycling, and Illicit Burning or Dumping, *Journal of Environmental Economics and Management*, 29 (1995), 78-91.
- Fullerton, Don and Thomas C. Kinnaman, Household Responses to Pricing Garbage by the Bag, *American Economic Review*, 86 (September 1996), 971-984.
- Fullerton, Don and Sarah West, Can Taxes on Cars and on Gasoline Mimic an Unavailable Tax on Emissions? *Journal of Environmental Economics and Management* 43 (January 2002) 135-157.
- Fullerton, Don and Ann Wolverton, Two Generalizations of a Deposit-Refund System, *AEA Papers and Proceedings*, 90 (May 2000), 238-242.
- Heckman, James and R. Robb, Alternative Methods for Evaluating the Impact of Interventions, in J. Heckman and B. Singers (Eds.), *Longitudinal Analysis of Labor Market Data*, Econometric Society Monograph, Vol. 10, Cambridge University Press, Cambridge, U.K., 1985.
- Hong, Seonghoon and Richard M. Adams, An Economic Analysis of Household Recycling of Solid Wastes: The Case of Portland, Oregon, *Journal of Environmental Economics and Management*, 25 (September 1993), 278-282.
- Hong, Seonghoon and Richard M. Adams, Household Responses to Price Incentives for Recycling: Some Further Evidence, *Land Economics*, 75 (November 1999), 505-514.

Jenkins, Robin R., Salvador A. Martinez, Karen Palmer, and Michael J. Podolsky, The determinants of household recycling: a material-specific analysis of recycling program features and unit pricing, *Journal of Environmental Economics and Management*, 45 (2003), 294-318.

Judge, Rebecca and Anthony Becker, Motivating Recycling: A Marginal Cost Analysis, *Contemporary Policy Issues*, 11 (July 1993), 58-68.

Manski, Charles F. and Steven R. Lerman, The Estimation of Choice Probabilities from Choice Based Samples, *Econometrica*, 45 (November 1977), 1977-1988.

Palmer, Karen and Margaret Walls, Optimal Policies for Solid Waste Disposal Taxes, Subsidies, and Standards, *Journal of Public Economics*, 65 (1997), 193-205.

Pigou, A.C., *The Economics of Welfare*, 4th edition, London, 1932.

Reschovsky, James D. and Sarah E. Stone, Market Incentives to Encourage Household Waste Recycling: Pay for What You Throw Away, *Journal of Policy Analysis and Management*, 13, (1994), 120-139.

Rosenbaum, Paul R. and Donald B. Rubin, The Central Role of the Propensity Score in Observational Studies for Causal Effects, *Biometrika*, 70 (1983), 41-55.

Sigman, Hilary, Midnight Dumping, *RAND Journal of Economics*, 29 (Spring 1998), 157-178.

Sipes, Kristin N. and Robert Mendelsohn, The Effectiveness of Gasoline Taxation to Manage Air Pollution, *Ecological Economics*, v36 (February 2001), 299-309.

Suits, Daniel B., Measurement of Tax Progressivity, *American Economics Review*, 67 (1977), 747-752.

West, Sarah E. and Robertson C. Williams, Estimates from a consumer demand system: implications for the incidence of environmental taxes, *Journal of Environmental Economics and Management* 47 (2004) 535-558.

Table 1: The Determinants of Recycling
(Probit Marginal Effects and Standard Errors)

	Census and Sample Weights		Choice Based Sample Weights	
	Recycle	Recycle	Recycle	Recycle
Natural log of Income	-0.443*** (0.045)		-0.447*** (0.045)	
Residuals of Income Equation ¹		-0.443*** (0.045)		-0.447*** (0.045)
Born in US	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)
Spanish language survey	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)
Child under 18 in house	-0.162* (0.088)	-0.216** (0.087)	-0.163* (0.088)	-0.217** (0.088)
Household Size	-0.005 (0.018)	-0.036** (0.018)	-0.006 (0.018)	-0.037** (0.018)
Obs.	9395	9395	9395	9395
Pseudo R ²	0.125	0.125	0.127	0.127

Notes: Robust standard errors are in parentheses. Regression includes a constant term.

***, **, and * are significance at the 1%, 5% and 10% level respectively. ¹These are the residuals from an OLS regression of the natural log of income on the demographic variables.

Table 2: The 2002 Breakdown of CRV1 Recycling Participation and Weight by Income Level

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
Recyclers ²	Obs.	623	1,257	1,523	555	779
	Percent	12%	13%	9%	5%	4%
Non-Recyclers ³	Obs.	4,791	8,445	14,513	10,966	17,392
	Percent	88%	87%	91%	95%	96%
Aluminum Recycled ⁴	Lbs.	184,313	289,934	195,133	78,523	104,336
	Percent	22%	34%	23%	9%	12%
Glass Recycled ⁴	Lbs.	650,840	2,091,391	847,102	904,147	83,834
	Percent	14%	46%	19%	20%	2%
Plastic Recycled ⁴	Lbs.	91,016	168,414	65,777	36,250	28,522
	Percent	23%	43%	17%	9%	7%
Total Recycled Materials	Lbs.	926,170	2,549,739	1,108,012	1,018,920	216,692
	Percent	16%	44%	19%	18%	4%

Notes: ¹CRV are bottles and cans that are included in the California Cash Redemption program. ²These are the corrected sample weights from the recycling survey which estimate the total number of recyclers in a year from each income level. ³This is the total number of households reported for each of these income levels in the 2000 Census for Santa Barbara city, Goleta CDP and Isla Vista CDP (income is estimated from the Census long form which is a sample of 1 out of 6 households), minus the recycling households. ⁴In order to report these estimates I assume that the proportion of the recycling brought by each income level to each of the recycling centers is the same for the month of July as it was for the week the center was surveyed. In addition I assume that all of the grocery store parking lot recycling center have the same proportions as the one that was in the survey. These proportions are then applied to total recycling weights supplied by the Santa Barbara County Department of Public Works, Solid Waste and Utilities Division. The number for glass reported in this chart is the estimated amount of CRV glass captured by the curbside recycling program for all of Santa Barbara County and was supplied by the California Department of Conservation, Division of Recycling. This number is an upper bound because it was not possible to secure the amount of CRV glass in the South Coast recycling region.

Table 3: 2002 Cash Value of CRV¹ Recycling by Income Level

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 ²	\$	\$211,780	\$396,869	\$219,576	\$120,532	\$96,224
	Percent	20%	38%	21%	12%	9%
Average Cash Paid to Household ³	\$	\$39.12	\$40.91	\$13.69	\$10.46	\$5.30
Average Cash Paid to Recycling Households ⁴	\$	\$340.03	\$315.65	\$144.13	\$217.05	\$123.54
Total Households	Obs.	5,414	9,702	16,036	11,521	18,171
Households that CRV Recycle ⁵	Obs.	623	1,257	1,523	555	779
	Percent	12%	13%	9%	5%	4%

Notes: ¹CRV are bottles and cans that are included in the California Cash Redemption program. ²The total cash paid for recycling is the value of the total amount of recycling for the South Coast in Table 1. ³The average cash paid to each household is the total value of all the cash recycling divided by the number of people in each income bracket based on the 2000 Census information for Santa Barbara city, Goleta CDP and Isla Vista CDP. The income question is on the Census long form and therefore is estimated from a sample (1 in 6 households). ⁴The average cash paid to recycling households is the total value of the recycling returned divided by the estimated number of households that participates in the CRV recycling program. ⁵The estimate of the number of households that participate in CRV recycling is based on the frequency that recyclers reported they came to the recycling center.

Table 4: The 2002 Breakdown of CRV¹ Recycling Participation and Weight by Income Level and Language Proficiency

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	
Language ²		English	Spanish	English	Spanish	English	Spanish	English	Spanish	English	Spanish
Recyclers ³	Obs.	364	259	607	650	1,228	295	540	15	770	9
	Percent	4%	26%	3%	25%	3%	6%	2%	1%	1%	0.3%
Non-Recyclers ³	Obs.	9,252	739	17,838	1,907	36,706	4,428	31,167	2,353	65,816	2,672
	Percent	96%	74%	97%	75%	97%	94%	98%	99%	99%	99.7%
Aluminum Recycled ⁴	Lbs.	81,414	102,899	71,760	218,174	131,920	63,213	74,437	4,085	103,646	690
	Percent	9.6%	12.1%	8.4%	25.6%	15.5%	7.4%	8.7%	0.5%	12.2%	0.1%
Glass Recycled ⁴	Lbs.	414,903	235,937	829,021	1,262,370	424,799	422,302	890,372	13,775	83,834	0
	Percent	9.1%	5.2%	18.1%	27.6%	9.3%	9.2%	19.5%	0.3%	1.8%	0%
Plastic Recycled ⁴	Lbs.	43,048	47,969	60,899	107,515	45,924	19,853	36,108	142	28,522	0
	Percent	11.0%	12.3%	15.6%	27.6%	11.8%	5.1%	9.3%	0.04%	7.3%	0%
Total Recycled Materials	Lbs.	539,365	386,805	961,681	1,588,058	602,644	505,369	1,000,918	18,002	216,002	690
	Percent	9%	7%	17%	27%	10%	9%	17%	0.3%	4%	0.01%

Notes: ¹CRV are bottles and cans that are included in the California Cash Redemption program. ²The language assigned to each household is based on the whether they reported that their first or most spoken language was Spanish and they spoke English "not well" or "not at all". These are people who took the recycling survey in Spanish. ³These numbers are based on the corrected sample weights from the US Census and the recycling survey. ⁴To find these values I assume that the proportion of the recycling brought by each income level to each of the recycling centers is the same for the month of July as it was for the week the center was surveyed. In addition I assume that all of the grocery store parking lot recycling center have the same proportions as the one that was in the survey. These proportions are then applied to total recycling weights supplied by the Santa Barbara County Department of Public Works, Solid Waste and Utilities Division. The number for glass reported in this chart is the estimated amount of CRV glass captured by the curbside recycling program for all of Santa Barbara County and was supplied by the California Department of Conservation, Division of Recycling. This number is an upper bound because it was not possible to secure the amount of CRV glass in the South Coast recycling region.

Table 5: 2002 Cash Value of CRV¹ Recycling by Income Level and Language

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	
Language ²		English	Spanish	English	Spanish	English	Spanish	English	Spanish	English	Spanish
Total Cash Paid for	\$	\$101,084	\$110,696	\$121,675	\$275,193	\$141,647	\$77,929	\$116,640	\$3,892	\$95,693	\$531
Recycling ³	Percent	10%	11%	12%	26%	14%	7%	11%	0.37%	9%	0.05%
Average Cash Paid to											
Household ⁵	\$	\$10.51	\$110.95	\$6.60	\$107.61	\$3.73	\$16.50	\$3.68	\$1.64	\$1.44	\$0.20
Average Cash Paid to											
Recycling Households ⁶	\$	\$278	\$428	\$200	\$423	\$115	\$264	\$216	\$257	\$124	\$61
Total Households	Obs.	9,616	998	18,445	2,557	37,934	4,723	31,707	2,368	66,586	2,681
Households that CRV	Obs.	364	259	607	650	1,228	295	540	15	770	9
Recycle ⁴	Percent	4%	26%	3%	25%	3%	6%	2%	1%	1%	0.3%

Notes: ¹CRV are bottles and cans that are included in the California Cash Redemption program. ²The language assigned to each household is based on the whether they reported that their first or most spoken language was Spanish and they spoke English "not well" or "not at all". These are people who took the recycling survey in Spanish. ³The total cash paid for recycling is the value of the total amount of recycling for the South Coast in Table 3. ⁴The estimate of the number of households that participate in CRV recycling is based on the frequency that recyclers reported they came to the recycling center. ⁵The average cash paid to each household is the total value of all the cash recycling divided by the number of people in each income bracket based on the corrected sample weights from the 2000 US Census and the recycling survey. ⁶The average cash paid to recycling households is the total value of the recycling returned divided by the estimated number of households that participates in the CRV recycling program. ⁷The average cash amount paid to recycling households in the survey is the average of their project annual recycling income based on the total payment they received the day of the survey and the frequency that they report recycling.

