

AAEA Invited Paper

Recycling Policies, Behavior and Convenience: Survey Evidence from the CalRecycle Program

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Abstract *AB2020 established a deposit-refund system in California, where consumers are reimbursed the California Redemption Value (CRV) upon recycling eligible containers at a recycling center. We study recycling under this policy, focusing on consumer convenience, reported recycling and diversion behavior, and responses to changes in the CRV amount. We find that consumers prefer nearby centers with flexible operating hours and short waiting times. While the CRV induces recycling, an increase in CRV would not lead to major recycling increases, given the limited number of containers entering trash streams. Finally, most diverted containers are taken from trash streams, not curbside recycling bins.*

Key words: AB2020 California Bottle Bill, convenience, recycling, survey.

JEL codes: Q53, Q58.

To encourage recycling and reduce littering, California implemented AB2020 (the Act), popularly known as the “Bottle Bill,” in 1987. The Act is a deposit-refund recycling program with the goal of increasing the recycling rate for recyclable beverage containers to 80%, by providing consumers with a monetary incentive to recycle their containers. Much like in other deposit-refund programs in other US states and countries, California’s program requires consumers to pay a small tax upon purchase for each eligible beverage container at the time of purchase, and when the container is empty, they may return the container to have this tax refunded. This refund is called the California Redemption Value (CRV). At present, the CRV is five cents for a container less than 24 oz and 10 cents for larger containers (Berck et al. 2018).

In most deposit-refund programs, supermarkets and other beverage retailers serve as collection points for the empty cans, for consumer convenience purposes. (The idea is that if it is convenient to purchase a container at a retailer, it is also then convenient to return it to that location.) Yet in California, due to strong lobbying from the beverage and supermarket industries, supermarkets were not chosen as the location for consumers to return containers. Instead, consumers may take containers to a state-certified recycling center to receive their CRV. However, in order to not strip away the convenience of access provided by supermarket return sites (nor to harm lower-income consumers who may be especially prone to collect CRV), the Act required major supermarkets (with over \$2 million in annual sales) to ensure that there is at least one recycling center located within a half-mile radius of the store. The policy termed these half-mile radius areas “convenience zones.” These convenience zone centers were also mandated to receive additional funds to help them stay open in unprofitable areas under the Act, and tend to pay consumers their CRV refund in terms of vouchers that can be redeemed at the associated supermarket. The fundamental tenet of the Act was that retailers traded the obligation to take back containers against an obligation to provide for convenient recycling by another entity.

Given this anomalous policy, this paper provides an analysis of whether the goals of the Act are being met, namely, by empirically investigating who recycles, how the policy affects recycling behavior, and whether consumers find recycling under the policy convenient. Specifically, we conduct two surveys of California consumers regarding their recycling behavior and preferences. The first survey consists of a sample of 1,000 individuals and is representative of all Californians. The second survey was an intercept survey of 628 recyclers conducted at 88 randomly selected recycling centers and is representative of trips made by users of those centers. Notably, the latter user survey can help us learn about people who visit recycling centers frequently, such as people who divert containers from the others’ trash or curbside collection bins to receive CRV payments. Sampling people who come to centers gives many more observations on these “diverters” than does a general survey of the California population.

In analyzing the data from these two surveys, we find that 69% of the respondents who recycle at centers in order to receive the CRV come from the bottom half of the income distribution. Although 30% of the Californian population has a family income over \$100,000, only 11% of recyclers who redeem containers for the CRV are in the same income bracket. Additionally, recyclers who use curbside pick-up services (where no CRV payment is awarded to the consumer) are more likely to live in urban areas and not identify as Hispanic or Black.

In terms of recycling behavior, we find that only 8% of surveyed Californians report that they throw eligible beverage containers in the trash. The remainder use either curbside recycling or return containers at a recycling center for the CRV. We also present survey respondents with hypothetical scenarios to estimate how recycling behavior would differ if the CRV payment was to increase. From survey responses, if the CRV were increased to seven cents, 34% of those who use curbside recycling and 11% of those who put their containers in the trash say they would recycle for the CRV. Since only 8% place containers in the trash, the increase in the recycling rate would be less than 1%. We also consider diversion as a subclass of recycling behavior. Diverters, defined as people who remove containers from trash or recycling bins to redeem at recycling centers, have low incomes (generally less than \$10,000 annually) and concentrate in the 35–54-year-old age range. 26% of all returns to recycling centers comes from diversion (trash or recycling bins). Our best estimate is that about 4% of diversion specifically comes from recycling bins. Nondiverting recyclers make about one trip per month to a recycling center. Those returning material that was 75% or more diverted make three or more trips per week to a center.

In terms of convenience, we find that nearly all Californians are aware of the deposit-refund program and where they can return containers. Consumers define the primary elements of convenience as: time spent traveling to recycling centers, centers' hours of operation, and time spent in line at recycling centers. There is evidence from our survey that consumers generally find recycling convenient. Ninety-two percent of recycling center users arrive at centers by car, meaning they likely are unconstrained by having to access centers through public transit. Users report that the travel and wait times are acceptable and that they would be willing to invest about five additional minutes traveling to centers. However, we find evidence that recycling centers in "convenience zones" may not be as convenient as supermarkets as a return site, because their operating hours often do not match peak shopping hours. Users do not report that convenient recycling opportunities have either improved or deteriorated over time. The average distance from the center of each zip code in the state to the nearest recycling center was 2.76 miles in 2006 and is 2.73 miles in 2017. While California had almost 200 more recycling centers in 2006 than 2017, the composition of centers has shifted from 48% of centers in convenience zones in 2004 to 39% of centers in convenience zones in 2012. This also suggests that convenience zone centers are not instrumental in consumer definitions of recycling convenience.

Related Literature

This paper contributes to the literature on policies to increase recycling rates. Various papers, such as Fullerton and Fullerton and Wolverton (2000) and Ashenmiller (2009), also study deposit-refund systems. The merits of these deposit-refund systems have been debated in the literature. Porter (1978), for instance, shows that the desirability of mandatory deposit systems on efficiency alone is not indisputable. Moreover, it depends critically on the average value of the time it takes consumers to return empty containers and the average value of the benefits associated with decreased beverage container litter.

We also contribute to the literature on how consumers view and value the attributes of various recycling options. A related piece, Berck et al. (2020), focuses on the consumer survey evidence to estimate California residents'

preferences and willingness to pay (WTP) for current beverage container recycling methods. This and related studies focus on assessing preferences for curbside pickup services and alternatives (e.g. Beatty et al. (2007) in California, Abbott et al. (2017) in the UK, Best & Kneip (2018) for Germany), drop-off at government-subsidized recycling centers, and drop-off at nonsubsidized centers. In a similar vein, Jakus, Tiller, and Park (1996) surveys consumers at a disposal center to estimate average WTP for drop-off, while Tiller, Jakus, and Park (1997) uses a contingent valuation (CVM) method, which asks consumers their hypothetical willingness to pay for more drop-off centers. Studies find that the results obtained from these valuation methods can vary significantly, and none of them focuses specifically on defining convenience.

Additionally, this paper provides three unique contributions to the literature worth highlighting. First, we are able to empirically assess how the public defines convenience in recycling opportunities, as well as understand who recycles, using both a representative survey of Californians and a survey of recycling center users conducted at recycling centers across the state. Second, and separately, we investigate diverting behavior of recyclers, combining evidence from the consumer and recycling center surveys. To our knowledge, this is one of very few studies (including Ashenmiller (2009)) that is able to reach this population, and in an economically significant context, of California (the world's 5th largest economy by GDP). Third, and finally, we obtain the zip codes of our respondents, and can thus match respondents to their nearest recycling center. This allows us to create individual-specific measures of recycling center convenience.

The Survey Data

We conducted two surveys of Californians about beverage container recycling.¹ The first survey is representative of all Californians, while the second survey was an intercept survey conducted at recycling centers and is representative of trips made by users of those centers. Given this, frequent recycling center users (i.e., people who visit every three days or fewer) have a higher chance of participating in the intercept survey than the average Californian.

Survey of California Households

We engaged the Nonpartisan and Objective Research organization at the University of Chicago (NORC) to implement a survey for 1,000 households in California, chosen to be a representative sample of the state. The sample was collected from AmeriSpeak, which is a representative panel with over 2,800 participants from California. These panel members receive rewards for answering surveys such as ours. The key issues in administering surveys are representativeness of the panel itself and obtaining a representative set of responses from that panel.

NORC describes its coverage this way: “The fundamental advantage of the AmeriSpeak Panel is that it is probability based, producing response rates for clients that are significantly higher than any we have seen from publicly available household panels. The foundation of our panel is the NORC National

¹We thank Nicholas Atchison, Saranbyamba Batdorj, Archer Kiang, Wenjun Shi, Poojan Thakrar, Yan Xu, and Yichi Zhang for excellent research assistance with helping to gather and organize the data collection.

Frame, an area probability sample frame that provides sample coverage of 97% of U.S. households for the AmeriSpeak Panel, the General Social Survey, the FTC Survey of Consumer Finances, and other studies. The National Frame contains almost 3 million households, including over 80,000 rural households added through the in-person listing of households that were not recorded on the United States Postal Service (USPS) Delivery Sequence File. This ensures comprehensive coverage and representation of the U.S. population, as well as minimal design effect.”

NORC obtains representative responses by taking two major steps. First, the panel is free to respond by either telephone or Internet. This is important because low-income groups and the elderly, among others, do not have access to the Internet or are not comfortable using the Internet. Second, the survey was available in both English and Spanish because an appreciable portion of Californians are primary Spanish speakers. NORC also has protocols for encouraging responses, if needed, and weighting the responses to make the answer representative.

Intercept Survey in Recycling Centers

Our team conducted an intercept survey at randomly selected recycling centers throughout California. Surveyors asked recyclers 25 questions regarding their recycling habits and requested a copy of their recycling receipt. The purpose of this survey was to learn about people who recycle frequently, such as people who divert containers from the trash or from curbside collection bins. The survey included 88 recycling centers and 628 participants. The survey was designed to have an error rate of 10% with 90% confidence under an assumption that the people surveyed in each recycling center would not be completely independent draws. If people are independent draws, the error rate would be closer to 4%.

Results

Here we present our results of various investigations utilizing our two sets of survey data. This section is organized as follows. First, we use this survey evidence to assess recycling opportunities, and characterize the recycling behavior on average, and by socioeconomic characteristics. Second, we empirically investigate how Californians define convenience in recycling. Third, we estimate how recycling behavior would differ if the CRV payment was to differ in hypothetical scenarios posed to respondents. Finally, we provide empirical analysis of diverter behavior.

Recycling Opportunities and Behavior

Recycling centers are most heavily used by people who make less than \$50,000 per year (table 1). The higher-income groups are more likely to use curbside recycling as their preferred disposal method. The median household income in California is \$63,783. Sixty-nine percent of those who recycle for CRV (noncurbside) come from the lower half of the income distribution, while the 30% of the households that have an income over \$100,000 account for only 11% of the CRV redemption. Education is also a major determinant of recycling method choice, where people without a high school diploma are the most likely to redeem beverage containers at a recycling center, and those with a bachelor’s degree or higher are most likely to use curbside services.

Table 1 Recycling Center Usage by Income

Income	Recyclers at nonconvenience zone centers	Recyclers at convenience zone centers	Total
Under \$10,000	92 25%	47 22%	139 24%
\$10,000–\$25,000	70 19%	41 19%	111 19%
\$25,000–\$50,000	88 24%	46 21%	134 23%
\$50,000–\$100,000	57 15%	33 15%	90 15%
More than \$100,000	29 8%	34 16%	63 11%
Prefer not to say	32 9%	15 7%	47 8%
Total	368 100%	216 100%	584 100%

Note: Source is the Intercept Survey conducted by the University of California, Berkeley research team.

Black and Hispanic respondents are less likely to use curbside programs than others, and more likely to return material through recycling centers. This is at least partially due to the income effect described above, as Black median income and Hispanic median income are only 72% and 77% of the general California median income, respectively. Although disposal of beverage containers in the trash was not commonly reported by respondents, this largely did not vary across income groups. Rural residents were less likely to use curbside services (they are available less frequently in rural areas), and more likely to visit recycling centers infrequently, compared to respondents in urban areas.

Knowledge About and Barriers to Recycling

Among the respondents from the AmeriSpeak survey (of general Californians), information about recycling and its benefits is largely known, and likely not a major barrier to recycling opportunities. Out of the 78 individuals who put their containers in the trash, only 12 of them did not know about CRV redemption or where to take recyclable materials. The AmeriSpeak survey had 1,000 respondents with only 8% saying that they threw CRV containers into the trash in the past week rather than recycle them. In terms of containers, there were 35,120 total containers of which 3,523 (10%) were put in the trash. Notably, it is possible that social desirability concerns caused respondents to underreport their true disposal of recyclable containers in the trash, hence biasing these figures downwards. Yet we do not feel this bias is likely greatly affecting our figures and conclusions, given that CalRecycle reported an aggregate beverage container recycling rate in California of 76% in 2018, which is fairly consistent with these findings (Klug 2019)².

²Klug, Lance, “Still a Recycling Leader, California Recycles the Second-Highest Number of Bottles and Cans Ever,” In the Loop (blog), CalRecycle, December 10, 2019, <https://www.calrecycle.ca.gov/blogs/in-the-loop/in-the-loop/2019/12/10/california-recycled-18.5-billion-beverage-containers-2018>.

Defining Convenience

Data from both surveys were used to determine an appropriate definition of convenience. Respondents from the AmeriSpeak survey listed “nearby” (73%) and “extended hours of operation” (48%) as the top two reasons for choosing recycling centers. In addition, although 41% of AmeriSpeak respondents who visit recycling centers use centers in convenience zones, only 17% of respondents state that having a recycling center in their store parking lot was important to them, suggesting that official convenience zone centers may not be essential for households.

As seen in figure 1, using intercept survey data, 70% of respondents listed “close to home or work” as their top reason for selecting a recycling center, and “open at good times” (21%) as well as “short lines” (18%) were also key factors. Seventy-five percent of recyclers are aware of other centers available to them and selected a recycling center with an average wait time of 10 minutes. Based on these observations, we define convenient recycling opportunities as recycling centers that are close to home or work, open at good times, and have short wait lines. Now that we have a sense of consumers’ definition of convenience, we can explore whether centers appear to be convenient to consumers under the current policy and conditions.

Convenience Zone Center Hours

Do consumers find the hours that recycling centers are open to be convenient? One way we can assess the answer to this question is to look at whether

Figure 1 Top reasons for choosing a recycling center.

Note: Figure depicts the percentage of responses stating a certain reason for choosing a recycling center. The source is the Intercept Survey conducted by the University of California, Berkeley research team [Color figure can be viewed at wileyonlinelibrary.com]

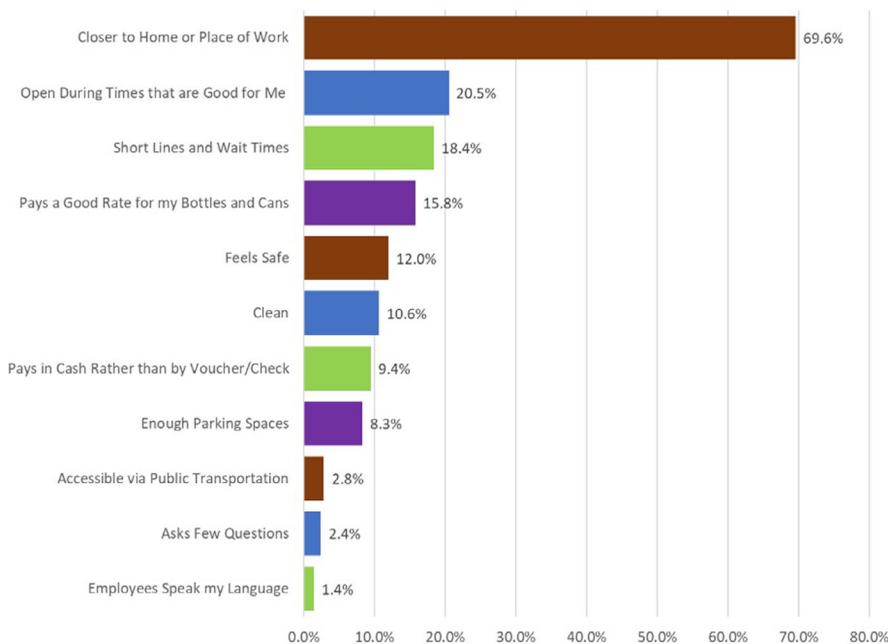
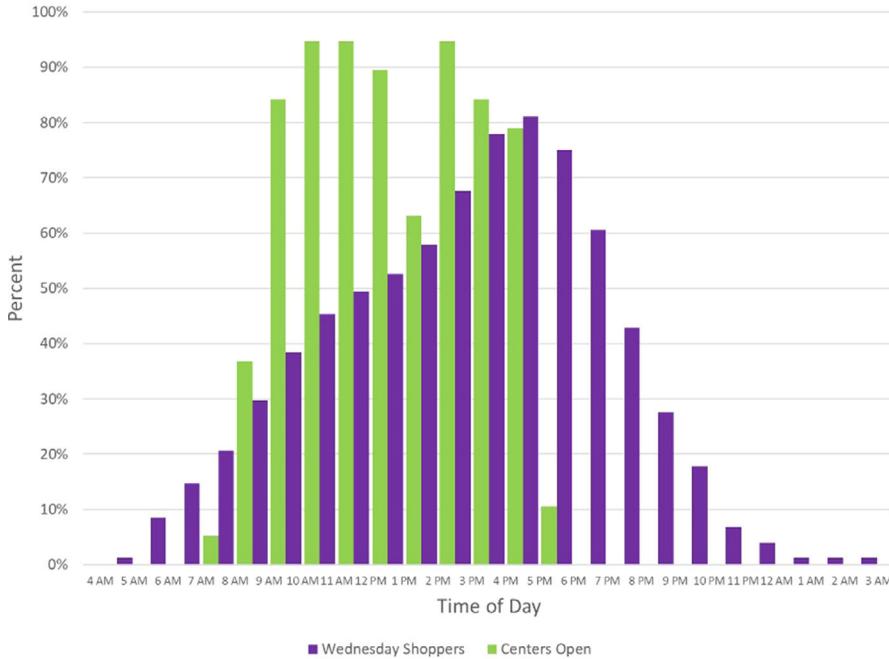


Figure 2 Wednesday average percent of total daily shoppers and centers open.

Note: Figure depicts Wednesday’s percentage of daily shoppers by hour of the day in purple, and in green the percentage of centers that are open by hour of the day on Wednesday. The source is the Intercept Survey conducted by the University of California, Berkeley research team for the green bars and google analytics for the purple bars [Color figure can be viewed at wileyonlinelibrary.com]



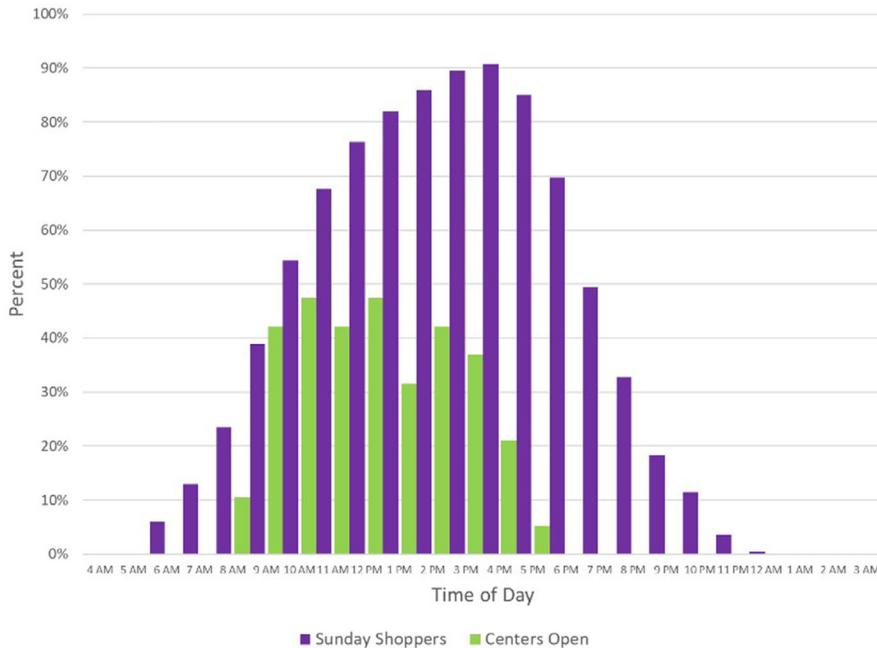
recycling centers in convenience zones have similar hours to their corresponding supermarket (as this would allow consumers to go shopping and recycle their containers during a single trip). Recycling centers in convenience zones are required to be open for at least 30 hours per week as designated by CalRecycle. To show the typical hours of operation, we sampled 19 recycling centers and their nearby supermarkets on a weekday and a weekend day. We recorded their open hours from CalRecycle records and their relative traffic frequencies from Google Analytics.³

In general, we found that the average recycling center is open in the early mornings when traffic at the supermarkets is slower and is closed or has limited hours on the weekend. Figures 2 and 3 show the average percentage of total daily shoppers and centers open for Wednesdays and Sundays. The green bars show centers open during each hour and the purple shows the relative frequency of shoppers. On Wednesdays, the average supermarket-sited recycling center is open earlier in the day while most of the supermarket traffic comes in the afternoon and evening. As seen in figure 2, typical hours for a recycling center to operate on a Wednesday is from 8 a.m. until 5 p.m. while the busiest time for supermarkets is from 1 pm until 8 pm; thus, not capturing the majority of shoppers’ recycling.

³Note that in our data of recycling centers, if a center changed ownership or relocated within less than 120 yards, we treated that center as a single recycling center. We found that centers located within the same area generally maintained the same center type as either an official convenience zone center or not, so our specification is reliable.

Figure 3 Sunday average percent of a total daily shoppers and centers open.

Note: Figure depicts Sunday’s percentage of daily shoppers by hour of the day in purple, and in green the percentage of centers that are open by hour of the day. The source is the Intercept Survey conducted by the University of California, Berkeley research team for the green bars and google analytics for the purple bars [Color figure can be viewed at wileyonlinelibrary.com]



On the weekend, more shoppers will visit supermarkets on Sundays, yet fewer than half of recycling centers are open on Sundays. Figure 3 shows fewer than 50% of recycling centers we sampled were open on Sundays with limited hours from 9 a.m. until 4 p.m. Supermarkets have the highest traffic from 9 a.m. until 7 p.m. on Sundays. As previously mentioned, hours of operation for centers is a major dimension of convenience for consumers. Hence because of their limited hours, convenience zone centers are not actually convenient for many consumers. Additionally, as was noted in figure 1, about 9% of consumers disprefer receiving vouchers instead of cash. Given convenience zone centers tend to pay in vouchers rather than cash, this may be another reason these centers are less convenient in practice.

Transportation and Willingness to Wait at and Travel to Recycling Centers

Given that consumers also define convenience as being related to a center’s proximity to home, and wait times, we consider whether users currently find recycling convenient on these dimensions. The AmeriSpeak survey found that driving to a center is the most common mode of transport, with 93% of AmeriSpeak respondents who recycled at centers stating they drive to recycling centers to redeem containers. In the intercept survey 85% of respondents drove to the recycling center. As seen in figure 4, the next most popular mode of transportation was walking, with 9% of respondents. This total is out of 625 people who responded to this question. Each person took one trip. Hence, we focus less on availability of centers through public transportation, and more on travel times via car.

In figures 5 and 6 we look at respondents’ reported acceptable travel and wait times *versus* their current travel and wait times. Figure 5 plots acceptable travel time against typical travel time with a 45-degree line showing people who are traveling their maximum acceptable distance. Figure 6 plots acceptable wait time against typical wait time with a 45-degree line showing people are waiting their maximum acceptable length of time. Plot points that fall above the 45-degree line correspond to people who find their current travel or wait times to be acceptable, while points that fall below the 45-degree line correspond to people who are currently traveling or waiting longer than what they believe is acceptable.

In figure 5, frequent recyclers typically travel what they view as an acceptable amount of time and indicate that they would be willing to travel further. The average time people typically travel is 10 minutes while the median time people travel is five minutes. This is compared to a mean willingness to travel of 15 minutes and median of 10 minutes to travel to a recycling center. People’s response to waiting times at recycling centers follows a similar pattern. As seen in figure 6, people are willing to wait longer at recycling centers than their current typical wait times. On average, people wait 10 minutes, with a median of five minutes at a recycling center. This is compared to their willingness to wait an average of 16 minutes and a median of 10 minutes to recycle. We can conclude that, on these dimensions, there are currently convenient recycling opportunities, as actual travel and wait times tend to be less than the times that respondents are willing to travel and wait.

Figure 4 Transportation to recycling center of frequent recyclers.

Note: Figure depicts survey response data where a bar in each row corresponds to the percentage of responses for each of the labeled transportation methods to recycling centers. The source is the Intercept Survey conducted by the University of California, Berkeley research team [Color figure can be viewed at wileyonlinelibrary.com]

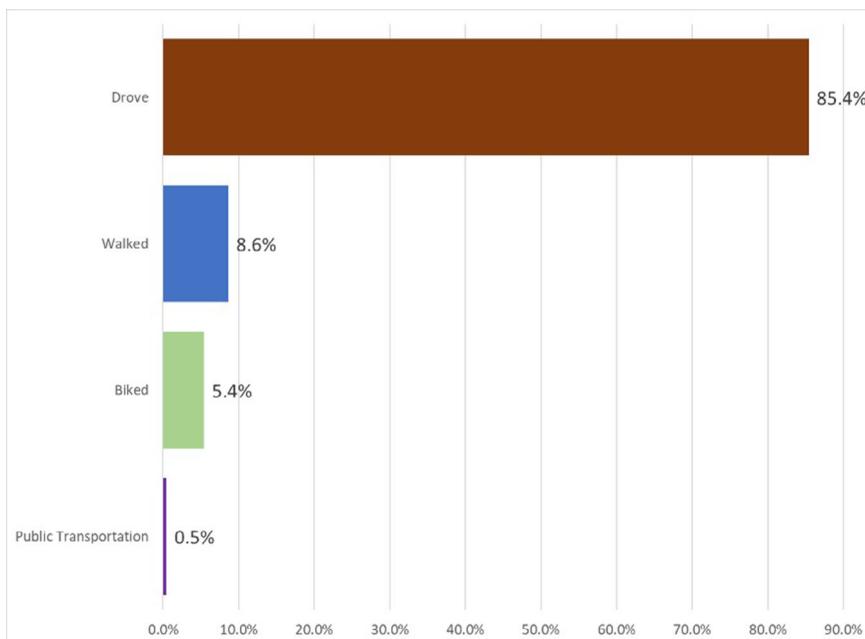
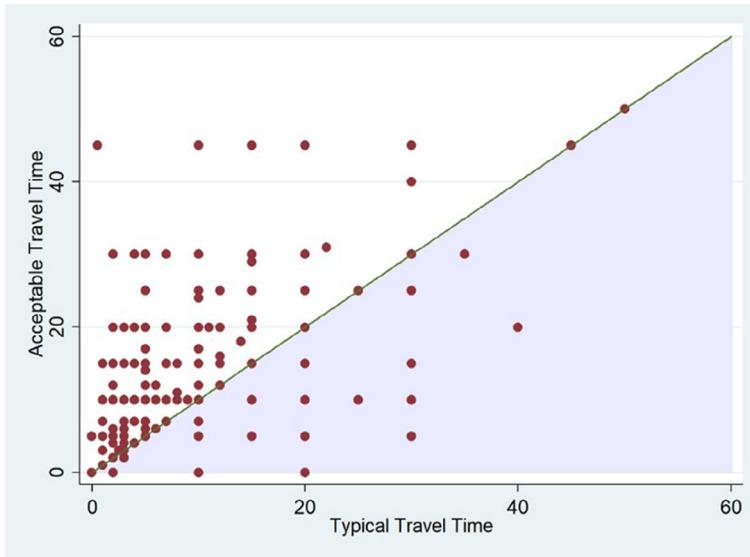


Figure 5 Travel time plotted against acceptable travel time.

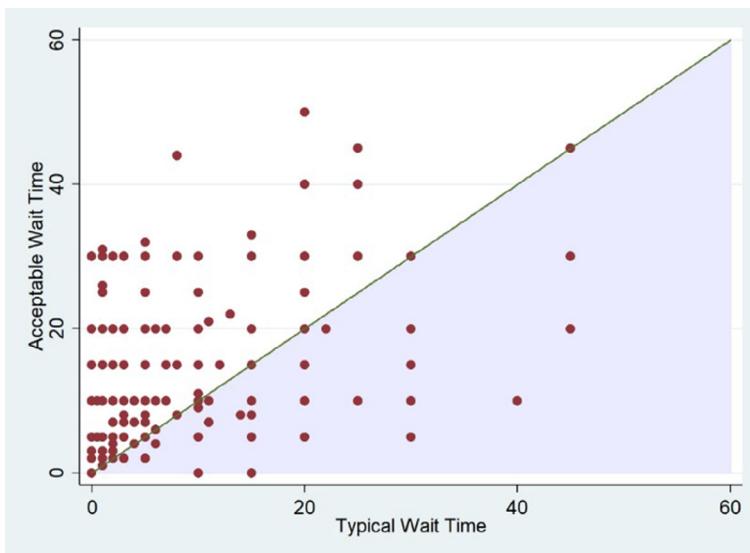
Note: Figure depicts survey response data where a point corresponds to a pair of stated responses, and on the horizontal axis we illustrate typical travel time and on the vertical axis the reported acceptable travel time. The source is the Intercept Survey conducted by the University of California, Berkeley research team [Color figure can be viewed at [wileyonlinelibrary.com](#)]



Yet it should be noted that not all consumers find recycling at a drop-off center convenient. On average, people live 2.73 miles away from their closest recycling center. The respondents that did not take their recyclable materials to a recycling center commonly reported they felt it was not worth the money,

Figure 6 Wait time plotted against acceptable wait time.

Note: Figure depicts survey response data where a point corresponds to a pair of stated responses, and on the horizontal axis we illustrate typical waiting time and on the vertical axis the reported acceptable waiting time. The source is the Intercept Survey conducted by the University of California, Berkeley research team [Color figure can be viewed at [wileyonlinelibrary.com](#)]



although the time and effort required to sort the material and take it to the center were regularly cited choices as well. For people who responded that they lived too far away from their nearest center to recycle there, the average distance to the nearest center was 3.39 miles, which is above the average distance.

Change in Convenience over Time

AmeriSpeak survey respondents were asked if they found recycling to be harder or easier than in the previous year. This has mixed results—about 12% said it was easier (with increased access to curbside services), 9% said it was harder (with the closure of recycling centers), 66% said they had experienced no change, and the rest were not sure.

Additionally, the distance people have had to travel on average has not drastically changed over the years. As seen in figure 7 showing the number of recycling centers in California for 2006 and 2017 respectively, the number of recycling centers has remained relatively constant and no visual difference can be seen without a deeper numerical analysis.

Hypothetical CRV Scenarios and Stated Recycling Options

To learn more about consumer recycling preferences, survey respondents were asked if a change in CRV (currently five cents for most containers) would induce them to bring containers back to recycling centers. The number of people who said they would redeem their containers at a recycling center increased with the CRV amount. For those currently using trash for disposal, an increase to 7 cents lead to 11% saying they would redeem and an increase to 10 cents lead to 35% saying they would redeem. Moreover, it took an increase in the CRV to 15 cents before more than half said they would start taking containers to a recycling center. Of people who said that they were currently using curbside bins to recycle their beverage containers, an increase in the CRV to 15 cents was also necessary before more than half would start taking containers to a recycling center. At a CRV of 7 cents, only 34% said they would redeem. Hence, we can see that it would take a large increase in CRV for most respondents to change their behavior, especially since these are hypothetical choices, and respondents may overestimate their response to a change in CRV. For instance, the 2016 PET recycled share was 76%. According to our estimation, with an increase in CRV to 7 cents, the recycled share would go at most from 76% to 78%.

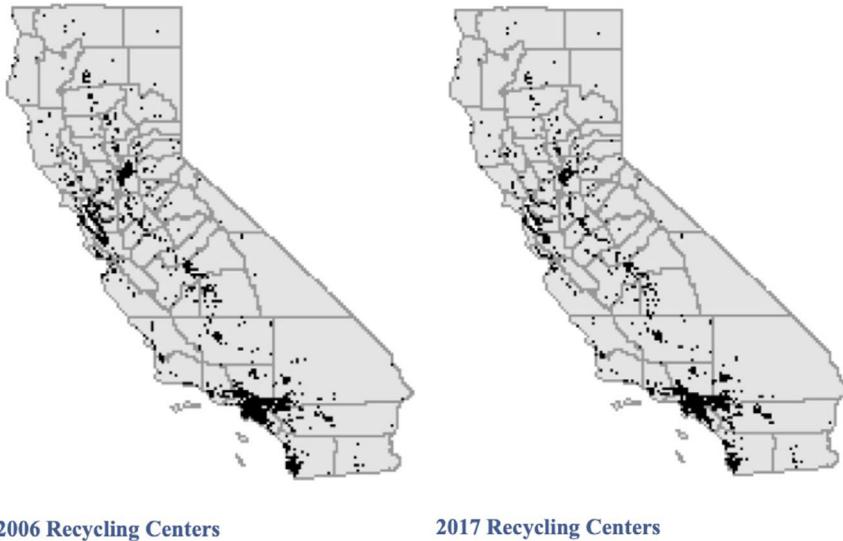
Empirical Analysis of Diversion

There are three options for disposing of a beverage container: recycling center, curbside recycling program, or trash. The consumers who recycle at a recycling center will receive CRV for their beverage containers, while the consumers who recycle through curbside or put the containers in the trash will not receive the CRV payment. The curbside providers will receive the CRV payment for the containers collected via curbside. Any CRV eligible containers in the trash will be unredeemed containers. Figure 8 outlines these different pathways for a container to be disposed of.

Diverting material occurs when the person or household that consumed the beverage is not the person who redeems the container for the CRV refund. Instead, a diverter takes the material out of another household's recycling or trash bin at the curb and brings the material to a recycling center. Any containers that were diverted from their original disposal method fall into two categories: good and bad diverting. "Good" diverting is when containers

Figure 7 Recycling centers in 2006 and 2017.

Note: Figure plots in the left panel the location of recycling centers in 2006 and in the right panel the location of recycling centers in 2017 [Color figure can be viewed at wileyonlinelibrary.com]



are moved from trash bins or the ground to be recycled. “Bad” diverting is when containers are moved from curbside bins.

One purpose of the Act was to increase recycling rates. Hence, we may want to encourage “good” diverting because it decreases the number of containers going to the landfill and helps the state of California achieve its AB32 goal to decrease greenhouse gases. However, “bad” diverting is in a sense inefficient; it does not increase the total recycling rate, but rather the method in which containers are recycled. Diverting from curbside is a burden to the curbside provider, as taking material from curbside decreases the amount CRV these providers collect but does not decrease the costs of collection very much. Moreover, curbside providers cannot fully adjust their services much in response to diversion, given the various California laws that mandate their service.

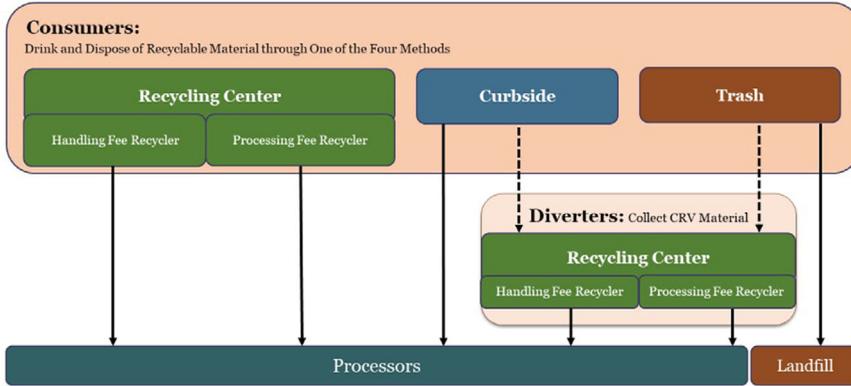
On the other hand, the diverters tend to be impecunious people that can earn a significant amount of money from diversion. Diverters tend to make less than \$10,000 annually, and to be between 35–54 years old. The more diverted material people bring to the recycling centers, the less income their household typically declares. As the percentage of diverted material per trip to the recycling center decreases, the household income declared increases while the age remains relatively constant. This data suggests that people are recycling at centers to supplement their household income. Hence while diversion decreases payments for curbside providers and does not affect the overall recycling rate, it can also be an important source of income supplementation to low-income households.

Movement of Material and Diverting

Approximately 40% of containers will be recycled at a center that is not located within the same zip code as the recycler; however, we must state caution when interpreting this data, because zip code sizes vary depending on the area of California.

Figure 8 Recycling pathways.

Note: Figure illustrates the several pathways consumers dispose of recyclable materials [Color figure can be viewed at wileyonlinelibrary.com]



Respondents from the intercept survey receive an average of \$28.33 per visit to a recycling center, with people collecting containers to recycle during that trip over an average of 44 days. Respondents who collected material over a longer period before visiting a center receive a higher redemption payment per visit. We used the data from the frequency of center visits to construct the average redemption payment people receive per year. Combining the amount the individual received at the visit we observed with the frequency of visits, we estimate the average yearly amount of redemption received by individuals is \$1,244.41.

To understand diverting, we first looked at the percentage of material to be recycled claimed as not one’s own. In table 2 we can see the percentage of all containers recycled at recycling centers by the percent of material diverted. When we look at the people who divert, we see that 11% of diverters had 100% diverted materials, but these individuals return less material per visit than other recyclers. As the percent of diverted containers per trip increases, the frequency a person visits a recycling center also increases (table 3). People who divert less than 50% of their collected material tend to visit recycling centers monthly while people who divert over 50% of their material visit recycling centers multiple times a week.

We also found that people who return containers for their workplace claimed 100% of their material to not be their own. This shows up as “diversion” under the above classification, but may not truly be, as these individuals may not have a recycling option at their place of work. Since those who return containers for their workplace are not frequent visitors to centers, looking at those who visit centers multiple times per week gives a better picture of true diversion behavior. As seen in table 4, people with high visit frequency make up 16% of the total people visiting recycling centers and bring a median of 187.34 containers per visit. These frequent recyclers bring about half of the containers that a less frequent recycler brings per visit. As seen in table 5, people who frequent recycling centers every three days or fewer receive a median redemption payment of \$10.89 per visit while people who are less frequent recyclers receive a redemption payment of \$19.40 per visit.

Table 2 Percent of Diverted Material

	Percent of all recycling containers
100% Material diverting	9%
75% Material diverting	8%
50% Material diverting	10%
25% Material diverting	16%
0% Material diverting	56%
Total	100%

Note: Source is the Intercept Survey conducted by the University of California, Berkeley research team.

Table 3 Days Collected by Diverter

	N	Percent	Days collected		
			Mean	St. dev	Median
100% Material diverting	65	11%	8.2	15.5	1.0
75% Material diverting	46	7%	28.1	60.8	3.0
50% Material diverting	49	8%	30.9	33.0	30.0
25% Material diverting	96	16%	58.3	88.5	30.0
0% Material diverting	360	58%	58.9	69.2	30.0
Total	616	100%	48.9	68.5	30.0

Note: Source is the Intercept Survey conducted by the University of California, Berkeley research team.

Table 4 Total Containers Collected by Frequency to Center

Frequency	N	Percent	Total containers		
			Mean	St. dev	Median
3 Day or fewer	98	16%	370.66	531.08	187.34
More than 3 days	530	84%	493.51	506.16	346.74
Total	628	100%	474.34	511.64	308.32

Note: Source is the Intercept Survey conducted by the University of California, Berkeley research team.

With a total of 298,000 containers in the sample returned to recycling centers, we find the percentage of material that is returned *via* different diversion pathways. We see in table 6 that 26% of all recycled material comes from containers collected from recycling and trash bins. The majority of containers that were diverted come from trash bins (73% of diverted containers, or 19% of all recycled material). Additionally, in table 7, we see that 12% of all containers brought to recycling centers are brought by frequent recyclers (who we characterize as likely diverters).

Intercept survey participants stated that the material they returned to the center contained 1% of material that they had diverted from curbside. Curbside, however, is only about 9% of total collections (we have averaged curbside’s percentage across all materials collected for June 2015). Thus 1% of center returns is 12% of what would originally have been placed in curbside bins; therefore our lowest estimate of the diversion from curbside is 12%, as shown in table 8. When asked in the intercept survey if people diverted material from trash and/or recycling bins, 71% of people only diverted from trash

Table 5 Total Redemption Payment Collected

Frequency	N	Percent	Total redemption		
			Mean	St. dev	Median
3 Day or fewer	98	16%	19.79	25.18	10.89
More than 3 days	530	84%	28.28	30.03	19.40
Total	628	100%	26.95	29.47	17.22

Note: Source is the Intercept Survey conducted by the University of California, Berkeley research team.

Table 6 Percent of Diverted Recycling

Diverting	Percent of All Recycling Containers
From Both	6%
From Recycling Bins	1%
From Trash Bins	19%
Total	26%

Note: Source is the Intercept Survey conducted by the University of California, Berkeley research team.

Table 7 Recycling by Frequency to Center

Frequency	Percent of All Recycling Containers
3 Day or Fewer	12%
More than 3 Days	88%
Total	100%

Note: Source is the Intercept Survey conducted by the University of California, Berkeley research team.

bins, 9% of people diverted only from recycling bins, and 20% of people diverted from both trash and recycling bins. If half of the material categorized by respondents as “mixed between trash and curbside” was fully from curbside, then the percent of diversion is 31%.

In table 9 we see that people who divert material only from trash bins bring in a median of 313.19 containers per visit and receive a redemption payment of \$16.85 per visit. The median number of days to collect containers from trash bins before a center visit is 14, while the medians for recycling bins and “either trash or recycling” are three and one, respectively. This is logical because recycling bins in many areas of California are sorted, therefore, making it easier for a person to collect containers from the curbside bin, while trash bins require a more thorough search for containers.

Conclusion

We empirically investigate recycling and diversion behavior in California under AB2020, as well as the convenience of recycling. Using two complementary surveys of California residents and of recycling center users, we find that recycling centers located within convenience zones are not considered to be especially convenient by recyclers, often due to limited operating hours and use of cash vouchers. Our findings imply that the definition of convenient

Table 8 Diverted Curbside Containers

Diverting	Total Containers	% of Total Curbside
Recycling Bins Only	3,873	12%
Recycling Bins and 50% of Both	12,362	31%

Note: Source is the Intercept Survey conducted by the University of California, Berkeley research team.

Table 9 Total Redemption Payment by Source of Diverting

Diverting	N	Percent	Total Redemption Payment		
			Mean	St. Dev	Median
From Both	41	20%	22.61	21.04	12.10
From Recycling Bins	19	9%	11.99	9.34	10.93
From Trash Bins	144	71%	27.99	26.44	16.85
Total	204	100%	24.98	24.37	15.41

Note: Source is the Intercept Survey conducted by the University of California, Berkeley research team.

recycling should be recycling at centers that are nearby, open during convenient hours, and have short lines. Moreover, if increased convenience is required, the requirement of open hours for convenience zone centers could be changed to better match shopping hours. This change would likely increase convenience zone centers’ collection of recyclable material and increase consumer convenience. However, one must recognize that convenience zone centers could have already extended their hours. The fact that they have not means that they or their host supermarkets do not consider extended hours to be desirable.

While the CRV induces people to recycle, we find that an increase in the CRV would not lead to major increases in recycling, due to the small number of containers that enter trash streams. We also find that diverting activity is a significant income source for diverters, who have low overall incomes (median < \$10,000) and tend to be between 35 and 54 years old. Any policy changes aimed at reducing diversion would impact those residents and would need to take into account the evidence that most diversion comes from trash streams, rather than from recycling bins, suggesting that diverters may be operating in line with the overall goals of the recycling program.

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