The Reduction of Litter Through Self-funded "Bottle Bill" Incentives

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ABSTRACT

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Among the more problematic environmental issues is the degradation of the visible environment. Container litter, like plastic and glass bottles, aluminum and metal cans, that have been improperly discarded is an important cause. Environmental programs designed to reduce container litter generally fall into four groups: financial programs featuring refundable bottle deposits, known as "bottle-bills", manufacturing programs that incorporate discarded container materials into new containers through recycling and repurposing, adjustments to product design, and programs that incentivize reusable containers. In this paper, the economics of bottle-bills throughout the United States are studied. Litter programs using bottle-bills are state-level programs where they exist. There is no federal bottle-bill program. Our statistical results show that bottle-bills significantly (0.001% level) increase recycling rates. Further, bottle-bill states have significantly lower (at the 5% level) soda and beer container litter than non-bottle-bill states. An additional result is that overall littering (all types of litter) rates in bottle-bill states are significantly lower (5% level) than in non-bottle-bill states.

KEYWORDS: Bottle-bills, Litter, Plastics, ESG, Sustainability, Recycling

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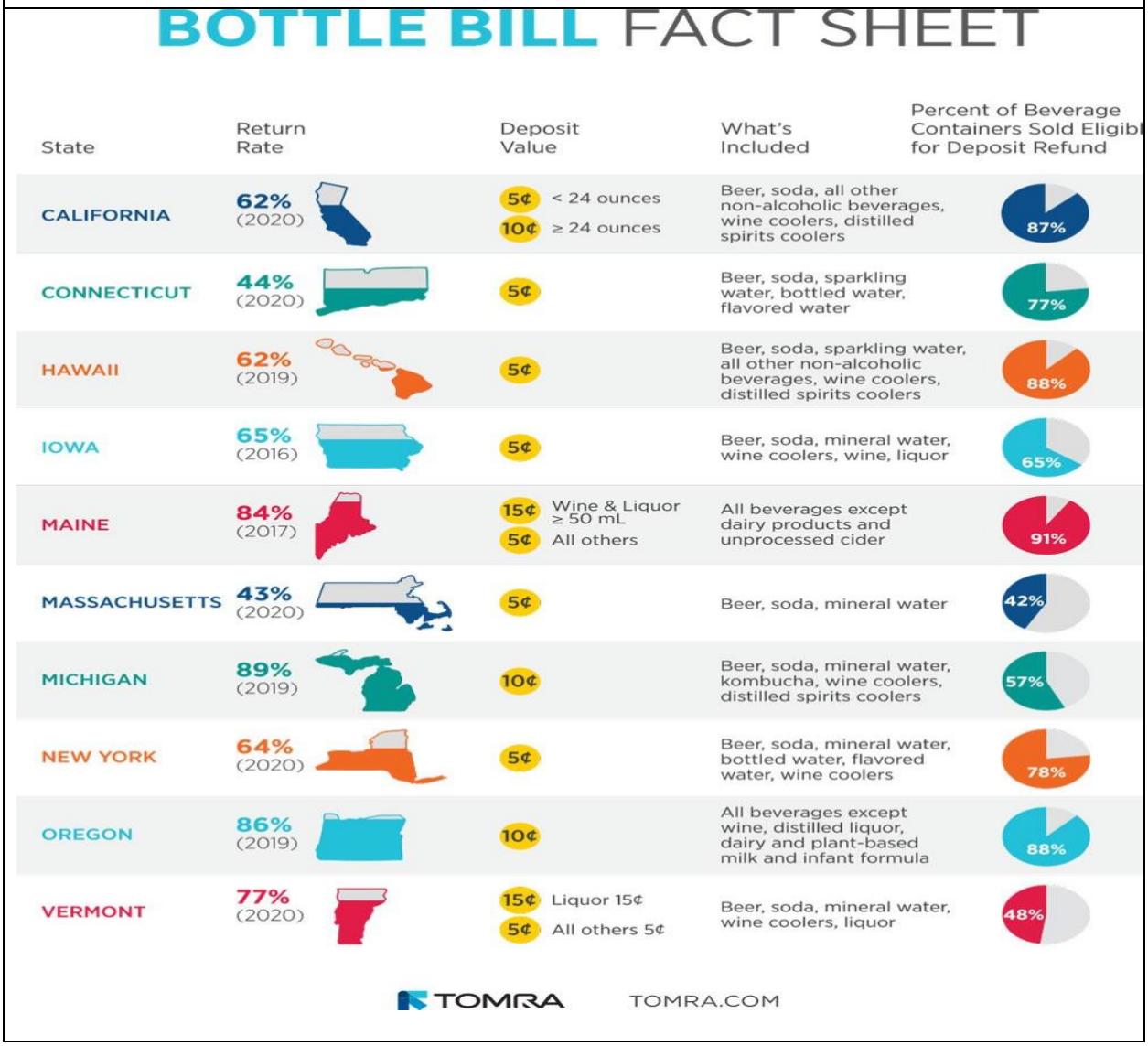
Introduction

This study is an analysis of the impact of "bottle-bill" incentives on reducing litter in the United States. The litter addressed here is improperly discarded plastic and glass bottles and aluminum and metal cans. Bottle-bills are deposit systems which incentivize the recovery (and potential reuse) of these plastic, glass, aluminum and metal containers. They should help reduce litter. "Bottle-bills are the best recycling programs for beverage containers" (Fernandez, 2022, pg. 1). In fact, Figure 1 below shows that return rates range from 44% (Massachusetts) to 89% (Michigan) in these bottle-bill states. An analysis of state-by-state data (Eunomia (2021)) shows that the Common Container Packaging Materials (CCPM) overall recycling rates for bottle-bill states are 52% versus an average of 22% for non-bottle bill states.

Currently, ten states, namely, California, Connecticut, Hawaii, Iowa, Maine, Massachusetts, Michigan, New York, Oregon and Vermont, have bottle deposit systems (Tomra (2023)). The bottle deposit systems typically require the consumer to pay a deposit upon purchase of the beverage, and then, the buyer (or whoever returns the bottle) receives a refund when the bottle is redeemed. These states typically require a 5¢ USD deposit (10¢ USD in Michigan), although a higher deposit for larger containers is required in California, Maine, and Vermont. The material types of containers the bills address across the ten states are aluminum, glass, metal, and plastic. As for the type of containers themselves, all bottle-bills cover beer and soda containers, but the

extent of coverage varies by state and may or may not include water, sports drinks, and juice bottles. Details on the states' bottle-bills are provided in Figure 1 and are from TOMRA (2021).[1]

Figure 1



[1] It is worth noting that eight of these states are historically 'Blue' and exhibit strong connections with progressive environmental behavior - https://us-states.sdgindex.org/rankings. This is a potential influence on littering rates.

Three of these states, California, Vermont, and Connecticut, have expanded the scope of the items covered by the original legislation. Washington D.C. has introduced a bottle bill in January 2025 which would implement a 10-cent deposit on most beverage containers (Quinn, 2025a).

Three other states, Washington, Texas, and Tennessee, have proposed bottle-bill legislation that has been defeated. One state, Delaware, has repealed its 27-year-old bottle-bill act. The legislature actually repealed the act twice. It was repealed June 2009, but this action was vetoed by the governor. The legislature repealed it again in December 2010. Instead of the 5-cent redeemable deposit, the state then instituted a non-refundable 4-cent tax per bottle. This tax expired in 2014. As of this date (March 2026) five states, Maryland, Texas, Rhode Island, New York, and Oregon, plus Washington, D.C. are considering or pursuing either a deposit program or other recycling legislation (Quinn, 2025a, 2025b). Massachusetts expanded its bottle bill to cover bottled water and sports drinks. Their most recent bill's (3-15-26) passage has increased the deposit value to 10 cents (MA H3464, 2026).

National bottle-bills have been introduced/proposed at the U.S. Congressional level four times since 1973. House Resolution 9782 (93rd): the "Nonreturnable Beverage Container Prohibition Act" was introduced on August 1, 1973, but it was not subject to a vote (Govtrack.us, (2024)). S.1867: the "National Beverage Producer Responsibility Act of 2003" was introduced on Nov. 14, 2003 but it was not voted on (www.congress.gov, (2003)). H.R. 1512:The "Climate Leadership and Environmental Action for our Nations" (CLEAN) act was introduced on March 2, 2021. however, no action was ultimately taken (CRI 1994 - 2025)). A similar bill was introduced in 2021. Ultimately, this legislation did not get past the Subcommittee on Water Resources and Environment (www.congress.gov – H.R. 1512 (2022)). S.984 the "Break Free from Plastic Pollution Act" (BFfPPA) was introduced on March 25, 2021 (www.congress.gov – S. 3127

(2023)). It was read twice and referred to the Senate Committee on Finance (Ibid, pp. 1-2) with no further action taken. S.3127 was entitled the "BFfPPA of 2023" and was re-introduced on Oct. 27, 2023. Its current status is "introduced" to the Senate Committee on Environment and Public Works (Ibid, pp. 1-2)). Thus, all national attempts so far have been unsuccessful, and no federal bottle bill has been enacted.

The objectives of this study are to develop evidence that bottle-bills promote recycling and decrease redeemable littering. Second, to explore if state-wide bottle-bills lead to decreases not only in redeemable litter but also litter in general. Third, to examine the efficacy and benefits of curbside recycling in comparison to redemption centers that redeem deposit-returnable bottles and cans. Fourth, we examine if bottle-bill states have less non-redeemable litter than non-bottle-bill states. Finally, we present the reader with Keep America Beautiful's suggestions for how litter can be more effectively combatted and how our research provides evidence on their suggestions.

I. Why are Bottle-Bills Important?

A. Litter is Pervasive by any Measure.

The Keep America Beautiful (KAB, 2021) 2020 National Litter Study (the Study, henceforth) is the most recent national litter survey. It reveals that after accounting for the U.S. population, 50 billion pieces of litter along roadways and waterways equated to 152 pieces per U.S. resident. The Study noted that 90% of U.S. residents reported litter as a problem in their state, while an average of 75- 90% recognize that litter negatively impacts waterways, the environment, property taxes, home values, business and tourism. The Study notes this is an improvement, representing a 54% drop from the 2009 KAB Study. This decrease "builds on the 2009 National Litter Survey that estimated that visible litter had been reduced 61% between 1969 and 2009" (KAB, 2021, pg. 2).

There is still plenty of room for progress, as litter reduction must still be assessed in comparison to current significant litter problems. The Study (pg. 2) states that litter problems are bad both along waterways (25.9 billion pieces of litter) and roadways (23.7 billion pieces). A major reduction in roadway litter since 2009 is due to changes in construction debris and soft-drink and fast-food packaging. Cigarette butts, the most predominant type of litter, have shown a notable decrease from 18.6 billion in 2009, to 5.7 billion as of 2020. However, increased amounts of beer containers, food packaging film, sports drink and water containers since 2009 were found.

B. Litter in Bottle-Bill versus Non-Bottle Bill States

The Study is the first to compare litter rates between states with and without bottle-bills. They found that container litter made of redeemable materials "redeemable containers" (as they are described in the bills) was significantly lower in bottle-bill states with a two-to-one difference (KAB, pg. 3). An item from the Study addresses bottle-bill versus non-bottle-bill states directly.

> "There is twice as much litter from alcoholic beverage containers as from non-alcoholic containers. Beer container litter is up 27 percent from 2009. In terms of the most frequently littered items, beer containers and single-serve wine and liquor containers are both ranked ahead of any non-alcoholic beverage products (e.g., soda, water, juice, tea & coffee)" (Ibid, pg. 4).

An issue that our study addresses is whether there is a "spill-over" effect in bottle-bill states - that a reduction in litter of redeemable containers can also lead to a reduction in litter of non-redeemable containers. Under this possibility of a spill-over, it is hypothesized that there will be significantly less nonredeemable litter in bottle-bill states than in non-bottle bill states. The Study states:

> "There was also more non-deposit litter per capita in non-bottle states, though the difference in litter per capita for these non-deposit items in non-bottle bill versus bottle bill states was significantly less than for deposit materials. The difference in non-deposit litter raises the question of the extent to which deposit legislation itself or other factors that may be associated

with deposit legislation (such as enhanced infrastructure, more frequent and accessible services, and attitudes) are contributing to the difference in litter between states" (Ibid., pg. 3).

The data presented in the Study allow this question to be directly addressed. The focus of our study is the recycling and reuse of redeemable containers that are made of aluminum, plastic, metal, and glass. The next section addresses how redemption fees have increased the reclamation and recycling of recyclable bottles and containers. Redemption fees are the same thing as a bottle/can deposit fee. If the redeemable item is returned to the appropriate redemption center, the consumer receives a refund of the fee/deposit.

II. Do Deposit Return Systems Reduce Litter?

A. Recycling and Litter Rates for Bottle-Bill versus non-Bottle-bill States

The KAB study addresses several aspects of the litter issues facing the U.S. The authors state the following:

"The Study was not designed to examine the causal relationship between bottle deposit legislation and litter but does provide data from a national perspective to enable a more informed conversation about how policy, infrastructure, community services, and individual behavior change contribute to reduced litter and littering. In terms of public opinion, the Public Attitudes Survey component of the Study finds that large majorities of U.S. residents support refundable deposits or rebate incentives to increase recycling," (KAB pg. 5).

As the KAB authors state, their objective was not designed to statistically test the link between bottle- deposit legislation and litter. This paper closes the loop between the data in the Study with a statistical analysis that provides results of testable hypotheses. To this end, t-tests for a significant difference in recycling and littering rates for bottle-bill versus non-bottle-bill states are utilized.[2]

[2] The Excel t-test (Add-in) used is adjusted for sample size. This compensates for the sample size difference in bottle-bill states (10) versus the other non-bottle-bill states (40). P-values of 0.05 or less are considered significant.

Eunomia's "The 50 States of Recycling" (2021) provides state-by-state data on the recycling rates of all Common Container Packaging Materials (CCPM), including aluminum, glass, metals, and plastic (Table 1). The table is sorted so that the ten states with bottle-bills are at the top. The third column shows each state's ranking based on the overall CCPM recycling percentage rank

TABLE 1 (Source: Eunomia (2021))

STATE-BY-STATE OVERVIEW OF COMMON CONTAINER & PACKAGING MATERIALS (CCPM) RECYCLING RATES LISTED ACCORDING TO CCPM RECYCLING RANK (Excluding cardboard/boxboard)

		CCPM Recycling Rate	Rigid Plastics Total	PET Bottles	Aluminum Cans	Steel Cans	Glass Bottles and Jars Inclusive	Glass Bottles and Jars Exclusive	Bottle Bill	CCPM Supportive Legislation
1	MAINE	72%	57%	78%	85%	29%	83%	73%	Yes	No
2	VERMONT	62%	37%	51%	67%	48%	76%	55%	Yes	Yes
3	MASSACHUSETTS	55%	28%	38%	70%	39%	71%	50%	Yes	Yes
4	OREGON	55%	26%	69%	85%	35%	72%	53%	Yes	No
5	CONNECTICUT	52%	33%	47%	61%	24%	66%	46%	Yes	No
6	NEW YORK	51%	32%	54%	64%	43%	66%	52%	Yes	No
8	MICHIGAN	48%	39%	57%	86%	35%	56%	42%	Yes	No
10	IOWA	44%	18%	30%	76%	19%	66%	61%	Yes	No
11	CALIFORNIA	44%	30%	57%	78%	29%	54%	44%	Yes	Yes
17	HAWAII	37%	26%	44%	61%	4%	44%	40%	Yes	No
7	MINNESOTA	49%	14%	25%	43%	48%	68%	35%	No	No
9	NEW JERSEY	46%	27%	22%	60%	60%	56%	30%	No	No
12	WISCONSIN	44%	21%	24%	27%	61%	65%	34%	No	Yes
13	MARYLAND	44%	31%	30%	54%	57%	52%	27%	No	No
14	DELAWARE	43%	12%	9%	36%	35%	61%	32%	No	Yes
15	WASHINGTON	41%	21%	28%	46%	46%	53%	28%	No	No
16	RHODE ISLAND	39%	28%	36%	39%	61%	47%	25%	No	No
18	PENNSYLVANIA	36%	21%	14%	48%	69%	44%	23%	No	No
19	NEW HAMPSHIRE	32%	25%	29%	32%	32%	38%	20%	No	No
20	SOUTH DAKOTA	32%	13%	16%	25%	25%	47%	25%	No	No
21	KANSAS	32%	14%	16%	25%	26%	47%	25%	No	No
22	MISSOURI	30%	13%	9%	18%	26%	45%	24%	No	No
23	NORTH DAKOTA	29%	12%	15%	23%	23%	43%	23%	No	No
24	INDIANA	27%	17%	16%	17%	37%	35%	19%	No	No
25	VIRGINIA	23%	9%	10%	23%	40%	45%	25%	No	No
26	NORTH CAROLINA	23%	8%	8%	16%	27%	39%	22%	No	Yes
27	FLORIDA	21%	8%	7%	25%	24%	33%	18%	No	No
28	ILLINOIS	20%	11%	12%	24%	25%	26%	14%	No	No
29	OHIO	19%	9%	11%	16%	24%	32%	17%	No	No
30	NEVADA	18%	11%	16%	15%	18%	25%	13%	No	No
31	UTAH	17%	12%	14%	17%	17%	24%	13%	No	No
32	GEORGIA	17%	9%	9%	20%	24%	24%	13%	No	No
33	ARIZONA	17%	14%	15%	16%	15%	23%	12%	No	No
34	IDAHO	17%	11%	13%	17%	17%	23%	12%	No	No
35	COLORADO	16%	9%	8%	14%	18%	23%	12%	No	No
36	MONTANA	15%	10%	12%	15%	15%	21%	11%	No	No
37	WYOMING	15%	10%	12%	15%	15%	21%	11%	No	No
38	ARKANSAS	14%	7%	5%	12%	13%	22%	12%	No	No
39	KENTUCKY	14%	7%	8%	16%	11%	22%	12%	No	No
40	NEBRASKA	14%	13%	14%	19%	21%	13%	7%	No	No
41	NEW MEXICO	13%	8%	10%	13%	13%	18%	9%	No	No
42	TEXAS	13%	10%	11%	16%	23%	13%	7%	No	No
43	ALABAMA	11%	5%	6%	16%	11%	14%	8%	No	No
44	OKLAHOMA	10%	7%	7%	13%	14%	13%	7%	No	No

45	MISSISSIPPI	8%	4%	4%	12%	8%	11%	6%	No	No
46	SOUTH CAROLINA	8%	4%	2%	10%	17%	10%	5%	No	No
47	TENNESSEE	7%	4%	3%	17%	11%	7%	4%	No	No
48	ALASKA	6%	1%	1%	3%	8%	11%	6%	No	No
49	LOUISIANA	4%	5%	4%	11%	5%	3%	2%	No	No
50	WEST VIRGINIA	2%	2%	3%	7%	7%	1%	1%	No	No

A two-sample t-test analysis (adjusted for sample size) for a significant difference in means is utilized to compare recycling rates for bottle-bill states versus non-bottle-bill states. Seven comparisons are possible given the available data. The results are provided in Table 2. For the seven comparisons, the calculated t-test statistic exceeds the critical t value in six cases. Except for steel cans, the mean recycling rate for bottle-bill states is higher than that for non-bottle-bill states at extremely high levels of significance. These results collectively support the hypothesis that bottle-bills increase recycling rates.

Table 2

Statistical Analysis of Recycling Rates for Bottle-Bill versus Non-Bottle Bill States

	Recycling Rate Means				
Comparison	Bottle Bill	Non-Bottle Bill	t-Stat	Critical t	p-Value
CCPM Recycling	52.00%	22.15%	7.9721	2.1098	0.000
Rigid Plastics	32.60%	11.93%	5.9177	2.2010	0.000
PET Bottles	52.50%	12.85%	8.5408	2.0796	0.000
Aluminum Cans	73.30%	22.28%	13.5135	2.1098	0.000
Steel Cans	1.62%	26.18%	0.8956	2.1009	0.382
Glass Bottles (incl.)	65.40%	30.45%	7.6489	2.0796	0.000
Glass Bottles (excl.)	51.60%	16.23%	10.2501	2.1604	0.000

The results in Table 2 also suggest that since more recycling reduces the amount of potential litter, the "spill over" effect of bottle-bills can reduce litter. Indeed, the Study revealed that plastic (38.6%), metal (7.9%) and glass (7.2%) constitute the largest, third largest, and fourth largest groups of roadway and waterway litter, respectively (KAB 2021, pp. 17-18).

The Study examines litter rates based on soda and beer for bottle-bill versus non-bottle-bill states. Table 3 (Table 2-5, the Study, pg. 24) provides an aggregate count comparison of soda and beer litter in bottle-bill versus non-bottle-bill states.

Table 3
(Source: The Study (2021), pg. 24)

Aggregate Count of Soda and Beer Litter, Bottle-Bill and Non-Bottle Bill

	Bottle Bill		Per Capita	**Non-Bottle Bill**		**Total Containers**	Per Capita
Soda	37,753,100	11%	3,775,310	305,063,200	89%	342,816,300	7,626,580
Beer	181,741,500	16%	18,174,150	945,871,400	84%	1,127,612,900	23,646,785
Total	219,494,600		21,949,460	1,250,934,600		1,470,429,200	31,273,365

Table 3 shows that the ten bottle-bill states account for 11% of soda bottle litter and 16% of beer bottle litter. The difference in comparison to the other forty non-bottle bill states appears to be notable, but of course this comparison is ten versus forty states. A paired t-test for a significant difference in means is the appropriate statistical test in this comparison. This test is appropriate since it corrects for a difference in sample size, and it can be used to test directly whether average littering and recycling rates differ in deposit versus non-deposit states. In Table 3 the t-test is based on **per capita** data averages for the deposit vs. non-deposit states. It shows that bottle-bill states have significantly less soda and beer container litter than non-bottle bill states at a 3% significance level ($p = 0.031$)[3].

B. Bottle-Bills Decrease not only Redeemable Bottle Litter but also Litter in General

An analysis of the Study's aggregate count of deposit material litter (Table 2-7, pg. 25) is used to directly examine the difference between bottle-bill and non-bottle-bill litter. These data are shown in Table 4.

[3] The null hypothesis of the t-Test is that the mean recycling rates being compared are equal. The p-value may be interpreted as the probability of rejecting the null hypothesis when it is in fact true. Thus, low p-values provide evidence that the null hypothesis should be rejected.

Table 4 (Source: The Study (2021) pg. 25)			
Aggregate Count of Deposit Material Litter by Product Type, Bottle Bill and Non-Bottle Bill			
Product Type	**Bottle Bill**	**Non-Bottle Bill**	**Total Containers**
Soda	37,753,100	305,063,200	342,816,300
Beer	181,741,500	945,871,400	1,127,612,900
Single-serve Wine & Liquor	67,205,900	296,055,200	363,261,100
Other Wine & Liquor	3,069,800	33,223,200	36,293,000
Sports & Energy Drinks	16,034,000	130,832,900	146,866,900
Still Water	42,070,100	233,667,700	275,737,800
Other Water	5,359,200	19,244,500	24,603,700
Other Plastic Beverage Bottles	12,472,200	37,525,300	49,997,500
Total	365,705,800	2,001,483,400	2,367,189,200

The eight product types shown are those to which bottle-bills typically apply. Again, a paired t-test statistic for a difference in means is appropriate for this comparison. The calculated t-test statistic equals 2.0582, which exceeds the critical value of 1.8595 (p-value = 0.0369). This comparison indicates that the amount of deposit material litter is significantly lower in bottle-bill states than in non-bottle bill states. Taken together, the statistical analysis in this section shows three aspects. First, bottle-bills significantly increase recycling, second, they reduce litter and third, they lead to decreased litter.

The Study also provides data for bottle-bill versus non-bottle-bill states, which separates deposit material litter from non-deposit litter items. Table 2-8 from the Study are reproduced in Table 5. A paired t test for a significant difference in means is utilized to compare the two samples. The calculated t-test statistic equals -1.6159, and the corresponding p-value is 0.0786. This evidence is consistent with the observation that non-redeemable litter is also significantly lower in bottle-bill states than in non-bottle bill states. As noted in the Study, if the number of litter items that are not redeemable decreases in bottle-bill states, then a monetary incentive is not the only factor behind lower litter rates (pg. 25).

Table 5 (Source: The Study (2021) pg. 25)			
Aggregate Count of Litter per Capita, Bottle Bill and Non-Bottle Bill			
Product Type	**Bottle Bill**	**Non-Bottle Bill**	**Total**

Deposit Material Litter Items	365,705,800	2,001,483,400	2,367,189,200
Non deposit Material Litter Items	9,867,790,500	37,338,065,700	47,205,856,200
Total Litter Items	10,233,496,300	39,339,549,100	49,573,045,400
Population*	88,751,439	236,634,918	325,386,357
Deposit Material Litter Items Per Capita	4.12	8.46	7.28
Non deposit Material Litter Items Per Capita	111.18	157.79	145.08
Litter Items Per Capita	115.31	166.25	152.35

*Source: U.S. Census 2020

III. Benefits of Redemption versus Curbside Recycling

A. Single-Stream Recycling vs. Dual-Stream/Source Separated Recycling

Single-stream recycling occurs when all of the recyclable materials are emptied into the same refuse container at the recycling center. Dual-stream/source separated recycling typically divides paper from other recyclables. This separation creates cleaner and higher-quality materials.

Contamination of recyclable materials is characteristic of single-stream recycling programs. A report by the Environmental and Energy Study Institute (2018) noted the following:

> "By requiring consumers to sort and rinse containers, contamination is greatly reduced, and recycling facilities can more cheaply recycle a larger percentage of materials. As a result, the CRI (Container Recycling Institute, 2006) found that while only 60 percent of single-stream curbside glass is recycled into new bottles, 98 percent of glass returned in states with bottle-bills is successfully recycled. Taking into account rates of recycling at the consumer level, the disparity is even larger; in 2010, 75 percent of glass bottles in non-bottle bill states were never recycled, compared to 35 percent in states with bottle-bills" (pg. 2).

Bottles and cans that are redeemed alleviate a common problem endemic to curbside recycling. Wagner and Broaddus (2016) examined how effective curbside recycling is at containing litter. They specifically considered how uncovered and overflowing recycling containers (15.2% overflow, with a mean overflow rate of 66.9%) contribute to litter. They concluded that it would be more cost-effective to prevent the litter from being removed in the first place instead of having to be continually cleaned. This finding is important for those advocating curbside recycling as a better alternative to bottle-bills.

B. Curbside Recycling Availability versus Usage

The argument often made by the beverage industry and retailers, in opposition to bottle-bill advocates, is that redemption of redeemable containers is less convenient than curbside recycling.[4] The Container Recycling Institute (Gitlitz and Franklin, 2006) addresses this question directly.

> "If the goal is to maximize recovery of recyclables, reduce reliance on raw materials for manufacturing new containers, and maximize waste diversion, then a combination of recovery options should be employed to ensure the highest diversion and recovery rates possible. Not only are combined and deposit systems more effective than curbside programs alone, the materials collected through deposit programs are of a much higher quality than materials collected through curbside recycling programs," (Ibid, pg. 9)…."Many people prefer both deposit systems and curbside programs, but approximately half the American population does not have access to curbside recycling," (Ibid, pg. 17).

Direct access to curbside recycling does not necessarily lead to increases in recycling. The CRI (2006) report shows that there was an enormous increase in curbside program access from 1990 to 2000, but this did not lead to recycling increases.

> "Despite a tripling in curbside program access from 1990 to 2000, recycling rates for cans, glass, and plastic dropped during that period. …Residential curbside programs do not target and cannot capture containers away from home" (Ibid, pg. 18).

Although access to curbside recycling may be increasing in some localities, other municipalities have found that the costs of these systems are too expensive to pass along to residents. A recent report from The Times-Picayune (Paterson & Calder, February 8, 2023) describes how Jefferson Parish (New Orleans, LA) has chosen to discontinue the service considering rising costs and a lack of public participation.

> "Following months of limbo, recycling will end in Jefferson Parish after council members failed to approve a five-year contract with Ramelli Waste LLC, joining a growing number of municipalities across the country choosing to do away with the service. …Jefferson Parish residents already faced higher water and utility costs this year, partially due to already-approved rate increases to support major infrastructure improvement projects over the next two

4 "Bottle Bill Myths and Facts" (6 May 2021), published by the Container Recycling Institute (pg. 2)

decades," (Paterson & Calder, pg. 1A). 'Parish officials have said recycling is used by around 30% of residents, and an estimated 1% of waste materials are diverted from landfills….I'm not against recycling, but this program has proven not to be effective,' Bonano said. 'For $6 million a year we're going to (be) recycling 1% of our waste stream or less. I just can't in good conscience impose this fee on our citizens" (Paterson & Calder, pg. 4A).

C. The Curbside Recycling Fee versus the Redemption Fee: Forcing the Producers to Bear the Cost of Their Actions

The Container Recycling Institute (Gitlitz & Franklin, 2006) discussed how bottle-bills do a much better job of removing bulky plastic bottles and glass from trash than single-stream curbside recycling does. Furthermore, the redeemed materials are of higher quality and more easily made into new containers. Several states have either updated their original bottle-bills to include plastic water and juice bottles or are considering doing so. CRI (2006) states:

"Updated bottle-bills will affect glass and plastic containers more than aluminum cans, since very few non-carbonated beverages sold in the U.S. are packaged in aluminum cans. The cost of curbside collection and processing far outweighs the revenue generated by the sale of commingled glass and plastic bottles. Plastic bottles have a high volume-to-weight ratio, taking up excessive space in curbside recycling collection trucks. Glass breaks and contaminates materials, especially paper, in the curbside stream, reducing the value of all the materials collected. Updated deposit laws remove most glass and plastic containers from the waste stream, increasing the efficiency of curbside and commercial recycling programs, and reducing collection and processing costs. In addition, the value of glass and plastic bottles collected through deposits systems is higher than those collected at curbside, because deposit systems produce cleaner, color-sorted materials" (pg. 14).

Bottle-bills do not represent a new tax, as retailers and others opposed to bottle-bills have claimed. Importantly, these redemption schemes will transfer the costs of curbside recycling from the taxpayers back to the manufacturers of these one-time use bottles. CRI (2006) states:

"Under deposit systems, the cost of recycling is borne by producers and consumers, not by governments and taxpayers. It is unfair to expect curbside recycling to generate revenue when this expectation has never been made of landfilling or incineration In fact, deposits actually help curbside programs by removing cumbersome, low-value glass and plastic bottles from the waste stream" (pg. 16).

Just-zero.org (Fernandez, 2022) states the same conclusion:

> "Bottle-Bills don't cost taxpayers money. How then, do they operate? With funding from beverage giants. These companies, or their distributors, pay fees to retailers and redemption centers for collecting, sorting, and packaging bottles and cans for recycling. This way, the financial responsibility of recycling gets put on the companies profiting off all these bottles and cans in the first place" (pg. 3).

According to the CRI (2006), currently, there is more interest in expanding bottle-bills. Both activists and legislators note that mounting container waste and funding issues from state and local governments, and that a general increase in interest in this (redemption) issue has resulted in attention to extended producer responsibility.

The EU Polluter Pays Principle and the Extended Producer Responsibility (EPR) are alternate frameworks that U.S. municipalities, states or the federal government could implement to force producers to pay for the costs of their pollution or that related to their products. Under EPR, for example, "The EPR policy approach is a group of economic instruments that raise revenues and set incentives for the collection and recovery of material at the post-consumer stage of the product lifecycle, including by improving design and waste management" (OECD Environment Policy Paper No. 41, pg. 5).

Bottle-bill states require that cans/bottles be charged a redemption fee when they are sold. When consumers return the redeemable item, they get back their deposit. The proposal for a nationwide bottle bill was introduced/proposed in the U.S. Congress on Nov. 14, 2003; March 2, 2021; March 25, 2021; and Oct. 27, 2023. Nationwide bottling-bills seldom get to the floor for a full vote. CRI (2006) states:

> "They are generally defeated in small committees, often by narrow margins. These defeats are due to the tremendous influence the well-funded, politically powerful beverage industry wields over our elected officials (pg. 11). …

> "A 1996 report by the U.S. Public Interest Research Group revealed that between 1989 and 1994, when a national bottle bill proposal was under consideration by the Senate Environment and Public Works Committee, 34 political action committees (PACs) in the beverage, grocery, retail, and container manufacturing industries spent over $14 million in campaign contributions aimed at defeating national bottle bill proposals. Anti-deposit PACs gave an average of $16,999 each to EPW committee members who voted against the national bottle bill; more than 40 times the average contribution they made to senators who voted for the bill ($416). The bill failed 10-6" (pg. 11).
>
> "From 1982 to 1979, industry lobbies spent almost $9 million to defeat new or updated deposit initiatives in Colorado, Ohio, Oregon, Washington State and Washington D.C." (pg. 11).

Most recently, CRI (1994-2026) notes:

> "The most outspoken opponents to bottle-bills are almost exclusively the big-name beverage producers. Retail grocers and liquor storeowners also oppose deposit laws.…They know there is a cost to the disposal, recycling and cleanup of littered beverage bottles and cans, and they don't want to be saddled with it" (pg. 1).

These citations clearly show that the bottling/beverage industry has been the major opponent to Federal bottle bill legislation. The retailers who would be redeeming these containers have also been significant opponents.

Another beverage industry claim is that bottle-bills reduce beverage sales. The logic is that higher costs will ultimately be passed on to consumers. In contrast, the CRI has issued a report based on case studies showing that bottle-bills and increases in deposit fees have not caused sales to decline (CRI (2023)).

While bottle-bills remove valuable aluminum cans and bottles from the curbside recycling system, bottle-bills actually make curbside recycling more efficient. Single-use bulky plastic bottles are gaining market share in relation to aluminum cans and bottles and thus are becoming a larger proportion of curbside recycled materials (CRI (2006), pg.16). Furthermore, the redemption of glass bottles through deposit fees increases the value of recycled materials. Glass bottles are prone to breakage, and these shards have a nasty tendency to contaminate paper that is recycled in

the same single-stream container. CRI (2006, pg. 16) noted that the value of deposit systems clearly helps curbside programs since problematic glass and bulky plastic bottles are removed from the system.

D. Keep America Beautiful's Recommendation for Combating Litter

The Study has proposed the following five elements for a national litter-combating strategy (pg. 10). We have summarized them here to indicate where our research provides important evidence to support these elements.

1) "The solution to litter starts with a better understanding about the nature of the problem and the data to support continuous improvement.

2) "Based on environmental and behavioral science, research into litter provides the framework for combating litter effectively at scale across the United States.

3) "In policy conversations around the country, the front end of our waste system, including preventing litter, needs to be an important part of the dialog.

4) "Partnerships and scaling are necessary to solve the problem of litter.

5) "The decreases that we have seen in litter represent systemic change" (KAB, 2021, pg. 10).

Our research addresses both points 2) and 3) above by showing first, that deposit systems in bottle-bill states significantly increase the recycling rates as compared to non-bottle bill states. Second, since a much larger proportion of potentially littered items are removed through redemption fewer of them should end up as litter. Significantly lower littering rates in bottle-bill states are demonstrated in this paper. Finally, in respect to point 5) we have provided evidence that citizens of bottle-bill states actually do a better job of dealing with *non-redeemable* litter. Perhaps,

these citizens have become more litter conscious. In any event, the environment is less littered for their efforts.[5]

IV. Summary and Conclusions

Single-use plastic bottle and aluminum can litter are significant problems in the U.S. by any measure. To increase recycling and reduce litter, ten U.S. states have enacted bottle-bills, sometimes termed deposit redemption systems (DRS). Bottle-bill proponents such as Keep America Beautiful have conducted data collection on littering rates and types in bottle-bill and non-bottle-bill states. Additionally, they and Eunomia collected data on state-by-state recycling on the basis of material type. Finally, they have also collected data on redeemable compared with nonredeemable litter in bottle-bill versus non-bottle bill states.

This research uses the KAB and Eunomia data to conduct statistical analyses. Our analysis provides evidence for three important issues.

1) Recycling rates for aluminum, glass and plastic containers are significantly higher in bottle-bill states than in non-bottle-bill states (at minimally a 5% level).
2) The analysis shows that redeemable container litter is significantly lower (again at least at the 5% level) in the ten bottle-bill states than in the other 40 states where deposits are not required.
3) The analysis revealed that *nonredeemable* litter is (similarly) significantly lower in bottle-bill states than in states without redeemable deposits. This last result suggests that financial

[5] Analysis by Schultz, Bator, Large, Bruni and Tabanico (2013) documents statistically that 65% of smokers litter their butts. Again, this supports the KAB findings cited above that 17% of general littering is due to disposal behaviors. Schultz, et al find proper disposal of littered items are directly related to the proximity of trash receptacles. Whereas littering is more likely to take place in already littered areas.

motivation may not be the only reason bottle-bill residents choose not to litter. The overarching conclusion is that bottle-bill redemption schemes result in less litter.

While any recycling is better than everything being trashed, not all recycling is the same. This research examines the extent to which single-stream curbside recycling is inferior to bottle-bill redemption systems. Bottle-redemption systems that redeem one-use plastic and glass bottles are shown to generate higher-quality recyclable materials. Furthermore, they reduce the bulky plastic bottles in curbside recycling buckets. Meanwhile, they remove problematic glass from the waste stream. The statistical analysis in this paper, which uses state-wide data, revealed that litter rates are significantly lower for redeemable items in bottle-bill states. Additionally, an important (and unexpected) result is that in these bottle-bill states, nonredeemable items are less littered than they are in non-bottle-bill states. This suggests that while monetary motives are important for redemption in bottle-bill states, residents in these states may have developed an anti-litter attitude and just do not litter.

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