Evaluating the Relationship Between Refund Values and Beverage Container Recovery

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Beverage Container Management Board

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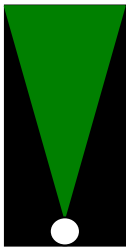

About the authors:

This report was prepared by Melissa Felder and Clarissa Morawski, CM Consulting. Melissa Felder was the principal author of this report, supported by Clarissa Morawski, who provided both quantitative and qualitative data and contributed to overall report preparation.

Melissa Felder is an independent environmental consultant working in collaboration with CM Consulting. Ms. Felder's work focuses on linking optimization and environmental benefits. Specific areas of research and interest include; municipal solid waste management, renewable energy, emissions reduction, and water quality.

Melissa has a Master of Science degree in Biological and Chemical Engineering from the University of British Columbia.

Projects in waste management include: a review of Extended Producer Responsibility in Canada and various research reports relating to municipal solid waste and reduction strategies for urban areas.

Ms. Felder has published works in the *International Journal of Solid Waste Management*, the Globe and Mail's business journal *Corporate Knights*, and has been featured in *New Scientist*.

Clarissa Morawski is principal of CM Consulting. Working with industry, federal, provincial and municipal governments, and the not-for-profit sector, Clarissa brings over ten years of technical, analytical and communications experience in waste minimization policy and operations.

Ms. Morawski focuses her work on product and packaging stewardship programs in Canada, with a specific interest in beverage container management. Clarissa has also written over twenty articles and cover stories on this area of public policy for several Canadian and US trade publications, including *Solid Waste and Recycling Magazine, Resource Recycling*, and *Municipal World*.

Contact information:

CM Consulting
51 Wolseley St., 2nd Floor
Toronto, Ontario
M5T 1A4
Tel: 416.682.8984
morawski@interlog.com
melissafelder@shaw.ca

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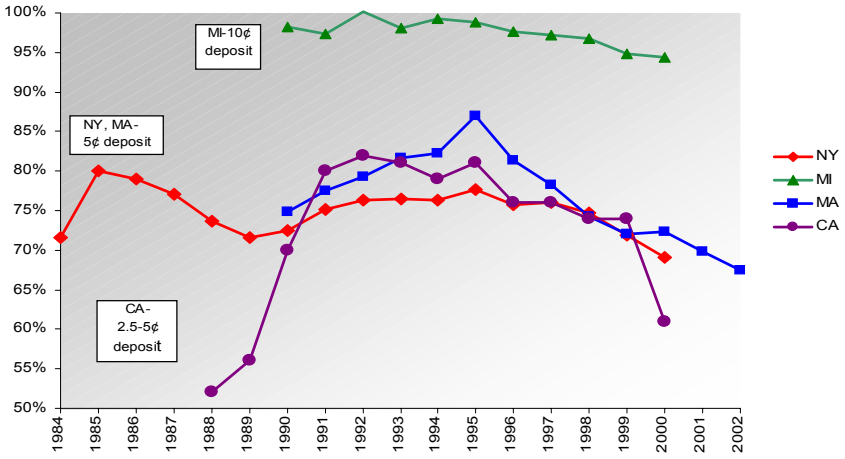
1.0 Background and Overview

A deposit-refund system, or 'bottle bill', is a mandatory or voluntary program that requires a minimum refundable deposit on beer, soft drinks, alcohol and other beverage containers in order to ensure a high rate of recovery of containers for recycling or reuse. A deposit-refund system combines a chargeable deposit (fee) on a commodity with a refundable credit (return) upon the execution of a desired action. Program costs for deposit-refund are borne by those who benefit from the sale of the product: the producer, the seller and/or the consumer.

Deposit-refund systems result in high recovery rates because of the influence of the economic instrument on consumer behavior. In essence, these systems motivate the consumer to act responsibly in the management of the used container. Today, ten U.S. states, eight Canadian provinces, and several European countries have legislation requiring refundable deposits on select beverage containers.

Unfortunately, the level of recovery/capture for some container types is on the decline (Figure 1.1). Various system design components like convenience and education are thought to affect performance directly. In addition, and the primary focus of this study, is the hypothesis that the level of the economic incentive to return containers (the refund) is a key driver of recovery rates and hence the primary driver of environmental performance of the system.

Figure 1.1: U.S. Recovery Rates, Four Bottle Bill States (1984- 2002)



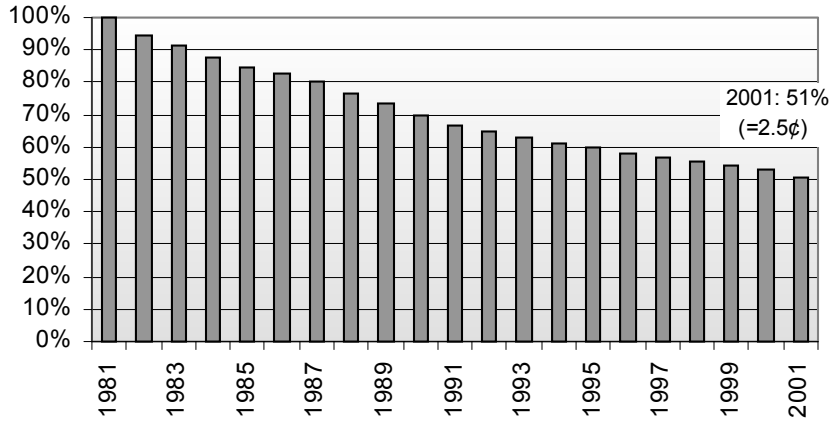
Source: MI Dept. Env.Quality, NY Dept. Env.Conservation, MA DEP, and CA Dept. Conservation

Container Recycling Institute, Dec. 2002

Note: In 2000, CA added non-alcoholic, non-carbonated containers to its law , contributing to the sharp decline in % redeemed.

Perhaps the first indication of the relationship between the level of the return incentive and return rates is provided by considering Figure 1.1 (declining return rates in several US jurisdictions over time) in context with Figure 1.2 (the decreasing real value of a nickel refund over time). Most deposit-refund systems were established in the late 1970s and early 1980s and were instituted with a 5-cent refund on containers– this latter refund level has not changed significantly over the last few decades. As the relative value of the refund has declined over time it would seem that its effectiveness as an economic instrument has been proportionally reduced.

Figure 1.2: Declining Value of a 1981 Nickel ($USD)



Source: The Consumer Price Index *Container Recycling Institute, Dec. 2002*

As mentioned, this study examines the relationship between refund levels and recovery rates, particularly for Canada. Data on refund levels and recovery rates was collected and compiled for various regions in the U.S., Europe and Canada. The data was analyzed to determine the degree of relationship between refund levels and recovery rates. Recovery rates were also examined in light of several more qualitative characteristics, including characteristics of the collection system in place and the container being recovered, as well as the duration of the program.

This report is organized into five sections:

1) A brief discussion of "deposit refund" as a market-based instrument;
2) A brief overview and analysis of recovery rates in the U.S. and Europe relative to refund levels;
3) A compilation and analysis of recovery rates and refund levels in Canada;
4) A discussion of other factors affecting recovery rates and implications for the data collected; and,
5) A summary of findings.

2.0 Economic instruments for environmental protection

Market-based instruments have been described as "regulations that encourage behavior through market signals rather than through explicit directives regarding pollution control levels or methods". The use of financial incentives to encourage desirable behavior can provide cost-effective and ultimately efficient mechanisms to address pollution control burdens[1]. In addition, the inherent flexibility of such mechanisms encourages pollution control efforts that are in the interests of both industry and policy-makers[2].

Succinctly, benefits of market-based instruments include:

- Incentives for 'environmentally friendly' behaviour;
- Incentives for research and development of more efficient processes and technologies;
- Flexibility for public authorities through reduced administrative burden, overhead, and regulatory enforcement;
- Flexibility for private entities in terms of compliance options; and,
- Potential to generate revenue that can be earmarked for environmental protection.

Examples of market-based instruments include taxes, charges, tradable permit schemes, pollution charges, tax credits, or deposit-refund schemes.

Deposit Refund as an Economic Instrument

Deposit-refund systems are a combination of a product charge (the deposit) and a credit for return or proper disposal (the refund). Deposit refund systems impose a cost (or financial penalty) on the consumer only when the product is discarded, whereby the consumer voluntarily forfeits their refund. Deposit-refund systems are considered to be the least costly of other waste management policies in addition to being very effective, as they give consumers the necessary incentive to find appropriate recycling avenues.[3]

Deposit-refund systems have been used for a variety of products including pesticide containers, lead-acid batteries, tires, shopping carts, and secondary packaging like pallets. Some of these systems have been voluntarily implemented by industry as a means of recovering product, or initiated by provincial or local authorities as waste management strategies[4]. One of the major applications of such an approach in North America has been for beverage containers, in the form of state-level 'bottle bills' in the United States and 'deposit-refund' systems in Canadian provinces. In such programs, consumers pay a deposit at the time of purchase, which can be recovered by returning the empty container to a redemption center (either a depot or a retail outlet).

Analysis of the intrinsic factors affecting performance of container deposit-refund systems has been limited. The few rigorous studies carried out have traditionally focused on comparing the effectiveness of deposit-refund systems to traditional curbside recovery programs. The following analysis will concentrate on factors affecting recovery rates for jurisdictions with deposit-refund systems, focusing on the influence of refund level.

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[1] As an example, tradable permits, which set an overall limit on the total emission of a pollutant (a unit), essentially allows 'owners' (industry) to treat permits as property rights. This means that permits, like other assets, can be freely sold or traded. This system provides incentives for the greatest reductions in pollution by those firms that can achieve these reductions most cheaply, allowing pollution mitigation to be realized at the lowest overall cost to society.

[2] As in allowing industry flexibility in meeting targets and in lowering the administrative burden to government (as opposed to a traditional 'command-and-control' regulation).

[3] Palmer *et al*, 1997; Stavins, 2001

[4] In Canada for example, grocery store shopping carts often carry a 25-cent deposit, airport baggage carts a $1 deposit, car batteries a $5 deposit, and secondary packaging like pallets and plastic carrying cases can also carry a deposit.

3.0 An overview of the recovery rates of various jurisdictions in the U.S. and Europe relative to their refund levels

In the United States, 10 states have container deposit programs. These include: California, Connecticut, Delaware, Iowa, Maine, Massachusetts, Michigan, New York, Oregon, and Vermont[5]. Container deposits, or 'bottle bills' have had a large impact on recycling rates - the 10 states with bottle bills recycle more tons of beverage containers than the other 40 states combined (Legislative Research Commission, 1999). Container deposit-refund systems are widely used in other OECD countries, including Australia, Austria, Belgium, Canada, Denmark, Finland, Iceland, the Netherlands, Norway, Portugal, Sweden, Germany, Sri Lanka, and Switzerland (Stavins, 2001).

Data was collected on several **refund** levels and recovery rates in Europe and the United States, where available (Table 3.1). U.S. States that did not have values on recovery rates were not included in this analysis (Connecticut, Delaware, and Maine[6]). Similarly, data available on European countries was limited, as recovery values were rarely distinguished according to refund level. Most jurisdictions cited a range of refund levels – i.e. 3 to 15 cents – but provided only one overall recovery rate. This offers no indication of the corresponding range of recovery rates.

Table 3.1: Refund and Recovery Values, U.S. States and Europe

Jurisdiction	Year of Inception	Refund Value	Recovery Rate	Source
California	1986	2.5 5	69.7 57.2[7]	Californians Against Waste
Iowa	1979	5	93	Bottle Bill Resource Guide[8]
Massachusetts	1982	5[9]	67.4	Bottle Bill Resource Guide
Michigan	1976	10[10]	96	Updated from Guide, Pers. Comm: K. Paulson
New York	1982	5	69.8	New York State. Beverage Container Deposit and Redemption Statistics
Oregon	1971	2-5[11]	84	Bottle Bill Resource Guide
Vermont	1972	5-15[12]	92.5	Bottle Bill Resource Guide
Finland	--	15[13]	95	TOMRA Systems ASA
Norway	--	13[14]	93	TOMRA Systems ASA
Sweden	--	5.4[15]	86	TOMRA Systems ASA
Switzerland	--	4	68	TOMRA Systems ASA

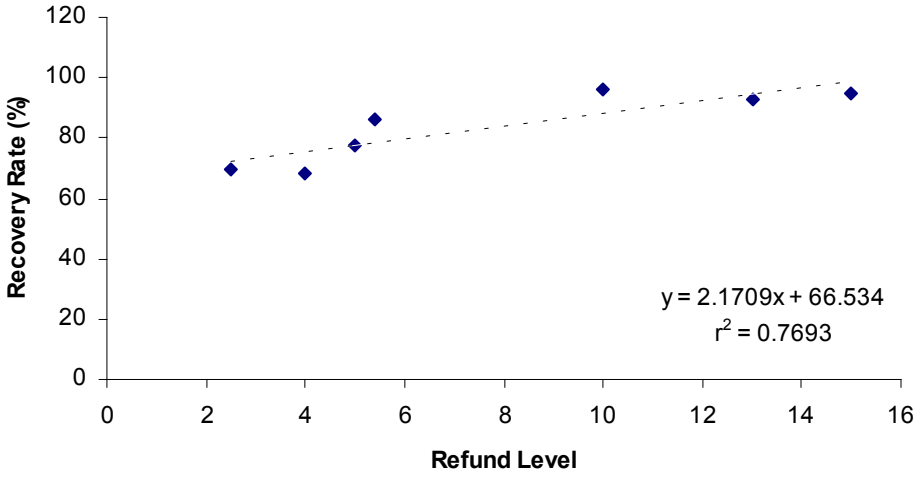
Data provided in Table 3.1 was graphed according to average refund level (Figure 3.1). The relationship between the refund level and return rate provides an r^2 value[16] of 0.76. This means

[5] Hawaii is currently developing a new bottle bill.
[6] Personal Communication: K. Paulson (Container Recycling Institute)
[7] California has a 5-cent refund on containers larger than 24 oz. This recovery rate is lower than that for 5-cent refund levels. It is thought that 'non-traditional' containers can have an added (negative) effect on recovery rates. This is further discussed in Section 5.0.
[8] Container Recycling Institute Website, at: www.bottlebill.org/USA/states-all_deposit-systems.htm
[9] The Massachusetts Beverage Container Recovery Law places a 10 cent deposit on soft drinks and beer 32 ounces or greater, and a five cent deposit on these same products less than 32 ounces
[10] The Michigan law has a 10-cent deposit on beer, soft drinks, carbonated water, and mineral water.
[11] Standard refill (2-cent); Non-standard refill and non-refill (5-cent).
[12] Liquor (15-cent); Other (5-cent).
[13] Cans only.
[14] Cans only.
[15] Cans only.
[16] When r^2 equals 0.0, the 'line-of-best-fit' fits the data no better than a horizontal line going through the mean of all Y values. In this case, knowing X does not help predict Y. When r^2=1.0, all points lie exactly on

that 76% of the variance in recovery rates can be explained by its relationship to refund levels[17]. **According to this linear regression, recovery rates have a positive relationship to increasing refund levels.** Non-refund level factors are thought responsible for 24% of the remaining variability.

This supports preliminary analysis by Californians Against Waste (CAW), which revealed that increasing the refund value to 5 cents could boost overall recycling rates to at least 80%. CAW indicates this strategy would result in the diversion of nearly 400,000 tons of material annually; an avoided disposal cost savings of nearly $40 million.

Figure 3.1: Plot of Average Recovery Values by Refund Level, U.S. and Europe



These findings must be tempered by the following considerations:

1. The ranges in refund values used in some jurisdictions. Three states (Massachusetts, Oregon, Vermont) report one overall recovery value but have two refund levels. This makes it difficult to relate a specific recovery value to either refund level, although the refund level selected for these states was determined to represent the majority of containers collected[18].
2. All recovery values other than that for 5-cent refund levels had only one example. This confounds determining with any confidence whether such a refund level would result in similar recovery rates in other jurisdictions.

These shortcomings were noted and addressed for data from Canadian jurisdictions, in that:

1. Data was collected on specific refund levels and counterpart recovery rates; and,
2. There was a minimum of ten samples for each refund level examined.

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the line, therefore if X is known, Y can be calculated. Succinctly, as r^2 approaches 1.0, the better the regression.

[17] Approximately 76% of the total variance in Y is "explained" by the linear regression model.

[18] Pers. Comm: K. Paulson, Container Recycling Institute/C. Morawski, CM Consulting.

4.0 Relationship between refund levels and recovery rates for Canada

Every province in Canada has some form of policy or regulation with regard to beverage container waste management. In eight provinces, laws require a deposit-return system for most or all beverage containers except those used for milk. Refillable beer containers are collected through a voluntary deposit return system operated countrywide.

In Canada, there are two 'unique' situations in terms of deposit-refund systems – the refillable beer bottle and half-back refund systems. Refillable beer bottles represent approximately 75% of all beer containers sold in Canada. In every province, refillable beer containers are returned through a 10-cent deposit-return system that, in most cases, is operated voluntarily by the beer industry. This system has resulted in average return rates of over 97% across the country. One key factor influencing these high recovery rates is thought to be the *minimum perceived refund*. Beer bottles are typically refunded in their original 'multi-pack' carrying case; a 6-pack, a case of 12 or a case of 24 bottles, thus making the minimum perceived refund 10-cent *multiples* of 6, 12 and 24, or, $0.60, $1.20 and $2.40[19].

Half-back deposit return systems are operated mainly in the maritime provinces – New Brunswick, Nova Scotia, and Newfoundland for non-refillable containers - and Prince Edward Island for alcohol containers. Half-back systems are unique in that the customer receives a refund half that of the original deposit amount paid (i.e. a 5-cent refund on a 10-cent deposit). Being a tiered economic instrument, half-back programs influence consumers to return containers, but also encourage them to choose to make purchases in refillable containers. This system is in essence a public policy to support and encourage the use of refillable containers.

Methodology

Data from fiscal 2001 on refund level, type of container, units recovered, and recovery rate was collected from various provinces and grouped by refund level (i.e. 5-cent, 10-cent, and 20-cent). Data from fiscal 2002 was used for Alberta and Newfoundland. In some cases, refund levels were further broken down if samples fell within the half-back or refillable beer deposit-refund systems. Averages (means) and confidence intervals for each refund level were calculated based on samples collected (confidence intervals describe the likely range of the mean).

Presenting a simple average or mean doesn't always tell the whole story, especially when some data values have a greater overall impact on the average (i.e. for example indicating an overall average recovery rate of 80% when (a) 100 containers are returned at a 70% recovery rate and (b) 1 container is returned at a 90% recovery rate). Consequently, 2001 recovery rates for each refund level were calculated by adjusting for the number of units recovered (weighted average).

The overall analysis provided the following values (Table 4.1). Data tables compiled by refund level are provided in Appendix A.

[19] Personal communication with Usman Valiante, Vice-President, Strategic Policy & Issues Management, Brewers of Canada.

Table 4.1: Summary of Data Analysis, Canada

Refund Level	2001 Recovery Rate[1] (weighted average)	Mean +/- Confidence Interval[2]	Sub-categories	2001 Recovery Rate (weighted average)	Mean +/- Confidence Interval
5 cent	75.1	68.7 +/- 6.1	5 cent	74.7	60.7 +/- 8.1
			5 cent half[3]	76.6	77.8 +/- 6.7
10 cent	94.3	90.4 +/- 3.3	Non-beer[4]	86.4	85.6 +/- 4.2
			Beer	97.2	96.7 +/- 1.1
20 cent	83.4	68.2 +/- 9.5			

1 Based on weighted averages, derived from total units recovered.
2 Indicates the range of values where the population mean likely falls (i.e. 95% confidence the average for 5-cent refund falls between 68.7%+/- 6.1%)
3 Indicates 5-cent refunds in half-back provinces (i.e. original deposit was 10 cents)
4 10-cent refund level data was sub-divided to distinguish refillable beer containers

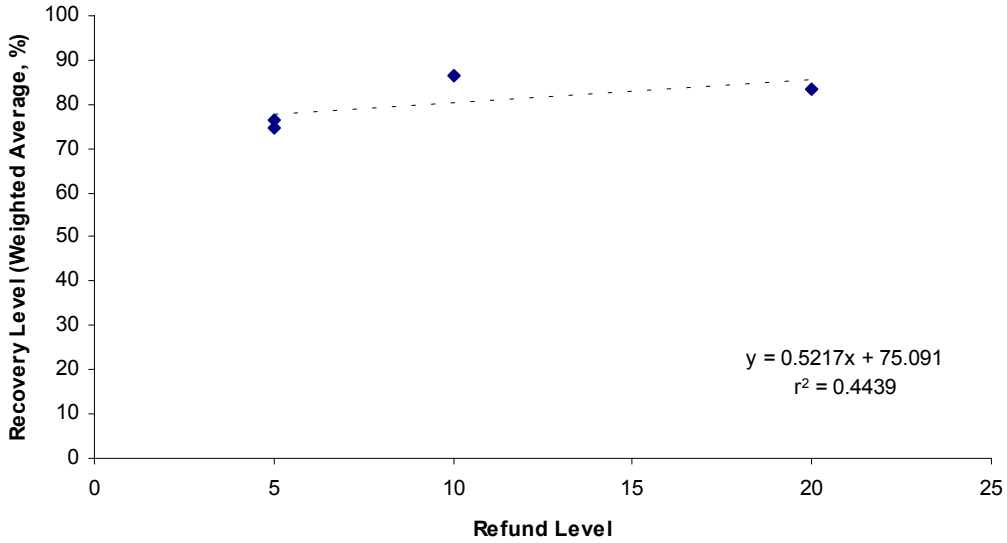
This data indicates that in Canada, recovery levels in 2001 were:

a) 75.1% for 5-cent refund levels. These refund levels resulted in recovery rates of 76.6% in half-back provinces and 74.7% in non-half-back provinces;
b) 94.3% for 10-cent refund levels; of which refillable beer had a recovery rate of 97.2 % and non-beer 86.4%; and,
c) 83.4% for containers with 20-cent refund levels.

The data also indicates the ranges within which average recovery values are likely to fall (mean +/- confidence interval). Generally, the less variability in recovery values within a refund category the more precise the estimate (narrower confidence interval). This is illustrated by contrasting the range for refillable beer *vs.* that for 20-cent refund containers (i.e. 96.7% +/- 1.1% *vs.* 68.2% +/- 9.5%).

The weighted average recovery rates for four refund levels/systems: 5 cent, 5-cent in half-back provinces, 10-cent, and 20-cent were plotted (Figure 4.1). A line of best fit indicates an r^2 value of 0.44 for this data.

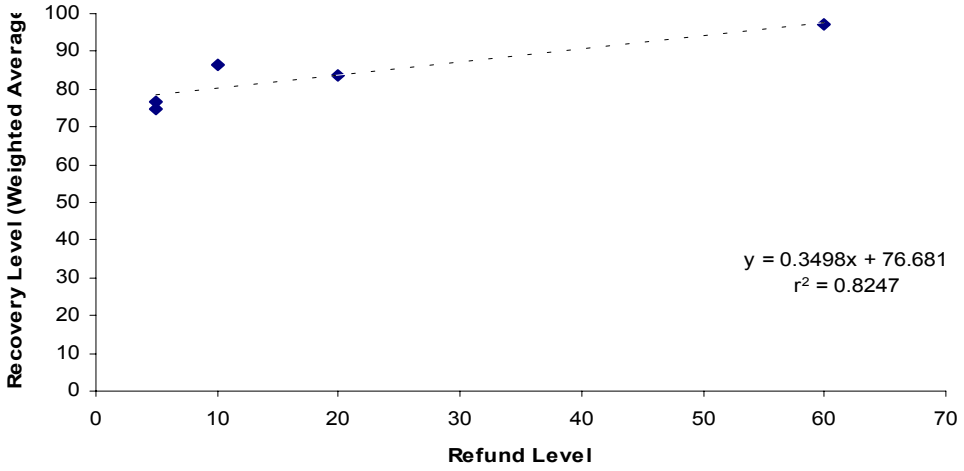
Figure 4.1: 2001 Recovery Values Based on Refund Levels, Canada[20]



[20] This figure includes separate values for 5 cent refunds in half-back provinces.

Additional analysis on the effect of 'multi-pack' systems – and therefore the effect of minimum perceived value – was achieved through incorporating the recovery values for refillable beer into Figure 4.1. As previously discussed, beer bottles are typically refunded in 6s, 12s, or 24s, which makes the minimum perceived refund a 10-cent multiple of 6, 12, and/or 24. Consequently, the average recovery value for refillable beer was plotted as having a minimum refund level of 60-cents (Figure 4.2). A line of best fit indicates an r^2 value of 0.82 for this data.

Figure 4.2: 2001 Recovery Values Based on Refund Levels and Including "Multi-pack" Materials, Canada



According to this linear regression, recovery rates show a strong relationship to higher refund levels in Canada.

In applying this finding to the data, the average derived for 10-cent refund levels (mean and range for containers excluding refillable beer) is 6.7 to 15.1% higher than the **weighted average** derived for the 5-cent refund levels (in non-half back provinces). Theoretically this means that increasing the refund level from 5- to 10-cents for these materials would have recovered from 141- to 319 million more containers in 2001.

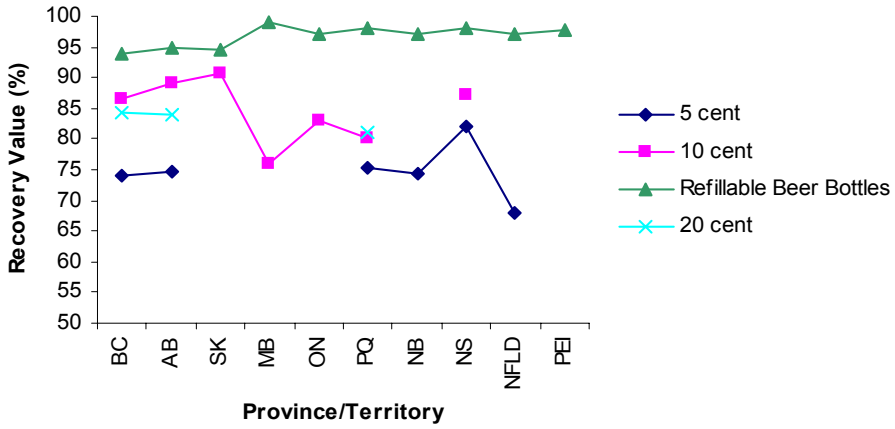
A second component to the analysis examined recovery values by jurisdiction. For this portion, recovery values for different refund levels were computed for each province, using the weighted average method (Table 4.2).

Table 4.2: Recovery Values by Province and Refund Level (Weighted Average)

Province	Refund Level/System			
	5-cent	***10-cent***	***10-cent (Refillable Beer)***	***20-cent***
BC	73.9	86.4	93.8	84.3
AB	74.7	89.0	95	84.1
SK	--	90.6	94.6	--
MB	--	76	99	--
ON	--	83	97	--
PQ	75.4	80.0	98	80.9
NB	74.5	--	97	--
NS	81.9	87.2	98	--
NFLD	67.9	--	97	--
PEI	--	--	97.9	--

Plotting these values provides a visual illustration of recovery rates by province and by refund level (Figure 4.3). This data indicates that for provinces where data exists, 10-cent refund levels result in higher recovery rates than 5-cent levels, and the system for refillable beer engenders still higher recovery values (likely attributable to the minimum perceived refund characteristic discussed earlier). Data on 20-cent refund levels remains sparse.

Figure 4.3: 2001 Recovery Values by Province and Refund Level/System (Weighted Average)

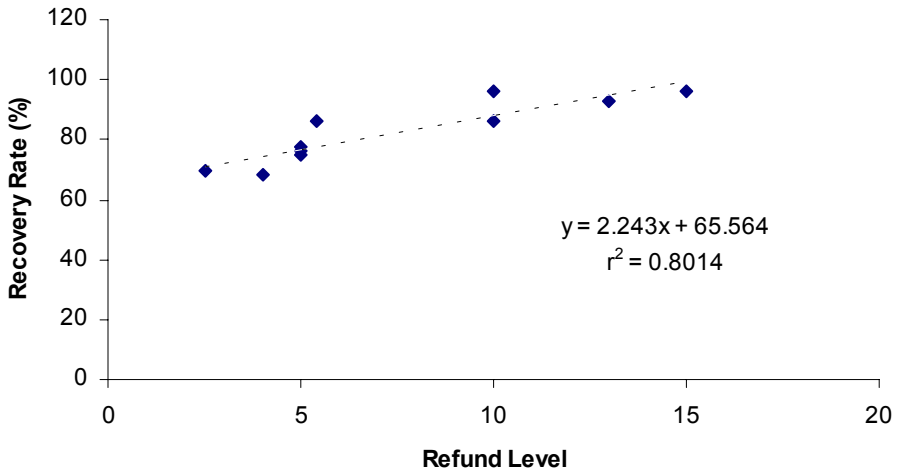


Lastly, the recovery values for 5-cent and 10-cent levels in Canada were plotted with the recovery values exhibited for these and alternate refund levels in the U.S. and Europe (Figure 4.4). Recovery values for 20-cent and 60-cent (refillable beer) refund levels in Canada were not included, as:

a) The 20-cent recovery rate had a low value compared to lesser refund levels. As this refund level is relatively novel and many of the containers falling within this sector are non-traditional in material type - i.e. 'bag-in-box' *vs.* aluminum can - it is thought that lack of consumer familiarity with the recyclability and refund of the material may result in lower returns. This is further investigated in Section 5.0; and,
b) The 60-cent refund level exemplifies a multi-pack recovery type. Most values examined for Canadian and other jurisdictions were for single units.

This line of best-fit indicates an r^2 of 0.80: also supporting the hypothesis that the level of the economic incentive to return containers ('the refund') is a key driver of recovery rate.

Figure 4.4: Average 2001 Recovery Values Based on Refund Levels (Canadian Provinces, U.S. States, and European Countries)



5.0 Other factors affecting recovery rates

While it has been determined that there is a strong and positive relationship between the level of the refund and the recovery rate, there are other factors which may influence recovery rates - such as the interplay between the scrap value of container materials and regional socio-economic characteristics. In economically depressed regions for example, the high scrap value of aluminum has resulted in "cottage industries" whereby aluminum cans are scavenged from roadsides and thereby drive up recovery rates.

In some sense, socio-economic factors can be closely tied to the effectiveness of deposit-refund systems in that they affect the perceived value of the refund (i.e. a 10-cent refund level is of more value to an unemployed individual living in an economically depressed area to an individual in a converse situation), however an analysis of these interactions was beyond the scope of this study.

It has been proposed that the ratio between the price of the product and refund level may also influence recovery rates. However, a consumer faced with discarding a spent container does not necessarily factor the original purchase price into the decision on whether to return or discard the container, as it is, rather, the 'money in hand' that influences behaviour[21].

Considered in concert with high refund levels, other non-economic factors also play a role in affecting recovery rates. These include:

1. Method of return (i.e. return to retail and/or return to depot);[22]
2. Whether or not the material is a 'traditional beverage material" (i.e. glass, aluminum, PET);
3. Duration of program (i.e. program in place for more than a decade) and the attendant level of education/public awareness; and,
4. Where beverages are consumed (i.e. liquor, wine, and spirits which are consumed either at home or in a licensed establishment *versus* soft-drinks, water and juice which may be consumed anywhere).

These factors can be qualitatively correlated to return rate, as illustrated in the matrix provided in Table 5.1 (overleaf).

[21] As an example consider that the $0.05 deposit on a $1.00 can of pop (aluminum can) and the $2.40 deposit on a $28.25 case of 24 beer bottles falls between 5-8%. Whereas the pop container is redeemed at a rate of about 80% (in BC and AB) beer bottles are recovered at a rate exceeding 95% in these areas. Where the product is consumed is certainly one factor but most importantly it is the fact that the case represents $2.40 "in hand" – a significant amount of money for anyone to simply discard the case.

[22] **Return to retail:** When the customer returns containers to the point of purchase (retailer) and receives a refund in the amount of the deposit paid upon purchase of the beverage.
Return to depot: Similar to the return-to-retail except that depots (also called universal depots in Canada and redemption centers in the U.S.) are where customers return their containers for refund. Depot operators are most often independent small business people who may have their depot attached to another business (gas station, scrap yard, etc.). The greater the population density of an area, the more likely the depot is to be a stand-alone business.

Table 5.1: Matrix Illustrating Qualitative Factors Affecting Recovery Rates

Province	Material	Return-to-Retail	Return-to-Depot	Traditional Beverage Material (Glass, Al, PET, HDPE)	Program in place for more than a Decade	Consumed in home or licensed establishment	High Refund 10 cents +	Recovery (%)
AB	Beer, nonrefillable							100.0
MB	Beer, refillables							99.0
PQ	Beer, refillables							98.0
NS	Beer, refillables							98.0
PEI	Beer, refillables							97.9
ON	Beer, refillables							97.0
NB	Beer, refillables							97.0
NFLD	Beer, refillables							97.0
AB	Beer, refillables							95.0
SK	Beer, refillables							94.6
BC	Beer, cans							93.9
BC	Beer, refillables							93.8
SK	Aluminum cans							90.6
AB	Glass (wine+spirits), > 1 litre							89.0
BC	Plastic, > 1 litre							88.4
BC	Beer, nonrefillable							88.2
AB	Beer, cans							88.0
BC	Glass (wine+spirits), > 1 litre							87.4
AB	PET, > 1 litre							87.0
PQ	Glass over 450 ml							86.0
BC	Beer, nonrefillable							85.5
BC	Plastic, > 1 litre (LBD)							84.9
BC	Glass (wine+spirits), <1 litre							84.8
NFLD	Plastic, other							83.1
BC	Aluminum cans							83.1
ON	Beer, cans							83.0
BC	Beer, nonrefillable							81.2
AB	Aluminum cans							81.0
PQ	Beer, nonrefillable							80.0
PQ	Aluminum, big size							80.0
NS	Aluminum cans							79.6
PQ	Aluminum cans							76.0
NB	Aluminum cans							76.0
MB	Beer, cans							76.0
AB	Glass, <= 1 litre							75.8
PQ	PET							74.0
NB	PET							74.0
NS	Glass							73.3
AB	Plastic bottles, > 1 l							73.0
NB	Beer, cans							72.0
PQ	Glass, < 450 ml							71.0
BC	Plastic, < 1 litre							71.0
NB	Glass							70.0
AB	PET							66.0
NFLD	Aluminum cans							65.9
BC	Plastic bottles, < 1 litre							64.8
NFLD	PET							64.1
AB	Other							59.0
NS	Other plastic							58.5
BC	Glass (all, non-alcohol)							58.0
AB	Pure pak/Gable top, > 1 l							55.8
BC	Bag in box							55.3
AB	Metal, <1l							55.0
AB	Gable top/Tetra pak							54.1
BC	Metal cans, > 1 litre							49.2
AB	Metal, >1l							47.0
BC	Aseptic, gable top, polycoat							47.0
BC	Gable top, polycoat 1 l>							44.5
AB	Drink boxes							43.0
AB	Bag-in-box							42.0
BC	Metal (<1 litre)							41.1
BC	Bag in box (LBD)							40.7
AB	Pure pak/Gable top, < 1 l							22.7

A number of key observations can be made from this qualitative application:

1) Notably, materials that fulfilled most of the outlined requirements were in the upper echelon of recovery rates (>85%);
2) High refund levels (>10 cents) result in high recovery levels (>85%);
3) Although they may have higher refund levels, non-traditional beverage containers suffer lower recovery levels (<59%). This is compounded by the relative novelty of these programs;
4) Substances consumed in homes or licensed locations *versus* 'on-the-go' dominate high recovery rates (>~80%); and,
5) Return to retail and return to depot appear to be interchangeable as to effect, however this analysis would be better served by examining the total number of return locations available to consumers as convenience likely plays a major role in influencing recovery rates.

6.0 Summary of Findings

A deposit-refund system combines a deposit (or fee) on a commodity with a refund for implementation of a specific action. This study examined the relationship between refund levels and recovery rates, focusing on Canada. Data on refund levels and recovery rates was collected and analyzed to determine if a relationship existed between refund levels and recovery rates. Other qualitative factors that could influence recovery rates were also considered.

The analysis indicated that:

1. A strong, positive relationship exists between higher refund levels and corresponding recovery rates in Canada (r^2 = .82) and internationally (r^2=0.80), supporting the hypothesis that the level of the economic incentive to return containers ('the refund') is a key driver of recovery rates;

2. Data indicates 10-cent refund levels (~86.2%) result in higher recovery rates than 5-cent levels (~75.1%), and the system for refillable beer (~97.2%) engenders still higher recovery values in Canada due to the high perceived refund associated with the returns of multi-container packs. These findings also support the premise that higher refund levels (perceived or real) result in higher recovery rates;

3. Hypothetically applying a 10-cent refund level (the mean and range derived for non refillable beer containers) to the containers recovered under a 5-cent refund level (weighted average for non-half back provinces), would have recovered from 141 to 319 million more containers for the dataset observed (a 6.7 to 15.1% increase). This must be tempered by other considerations that can affect recovery rates (see Findings 4, 5, and 6).

4. High recovery rates can also be associated with the following factors:

    (a) Traditional material type (i.e. PET, glass, aluminum),
    (b) A long-running program (i.e. longer than 10 years),
    (c) Location of consumption in homes or licensed locations *versus* 'on-the-go'; and,
    (d) Refund level of 10-cents or more.

5. Non-traditional (i.e. non-glass, non-aluminum, non-PET) material had lower recovery rates in spite of higher refund values (20-cents) - this is likely compounded by the relative novelty of these programs;

6. Although the impact of method of return was unclear in this analysis, further study would benefit from examining the total number of return locations available to consumers (convenience), regardless of whether they are depot or retail outlets.

In terms of system implications, the analysis indicates that higher refund levels have a positive impact on recovery rates, however, when new, or non-traditional materials are included, program expansion should be accompanied by targeted marketing strategies to ensure consumers are aware of both the new refund values and the type of container included.

Lastly, although the data indicates a strong, positive relationship between increasing refund levels and corresponding recovery rates, this finding would be strengthened by obtaining more data values on refund levels lesser than 5-cents and greater than 10-cents.

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8.0 Personal Communication

Elizabeth Basta, Research Intern. Container Recycling Institute

Malcolm Harvey, Encorp Pacific

Pat Franklin, Container Recycling Institute

Kyle Paulson, Research Associate. Container Recycling Institute

Usman A. Valiante, Brewers Association of Canada

APPENDIX A: Data values by Refund Value, Canadian Jurisdictions

5-cent Refund Level

Jurisdiction	Description	Units Recovered	Recovery Rate (%)
BC	Glass (all, non-alcohol)	36146711	58
BC	Metal, < 1 l	1875011	41.1
BC	Aluminum cans	344192051	83.1
BC	Aseptic, gable top, polycoat	58233374	47
BC	Plastic bottles, < 1 l	106632915	64.8
AB	Glass <= 1 l	89586638	75.8
AB	PET	118555314	66
AB	Aluminum cans	379899124	81
AB	Gable top, tetrapack	65722603	54.1
AB	Pure pack, gable top, < 1l	706986	22.7
AB	HDPE/PVC <= 1 l	2257015	59
AB	Drink Pouches	2219322	43
AB	Metal, < 1l	2149893	55
PQ	Glass, <450 ml	18925957	71
PQ	PET	211093232	74
PQ	Aluminum cans	677488743	76
Total samples		16	
Average		60.7	
Weighted Average		74.7	
Standard Deviation		16.6	
Confidence Intervals		8.1	

5-cent Refund Level, Half-Back Systems

Jurisdiction	Description	Units Recovered	Recovery Rate (%)
NB	Glass	6612072	70
NB	PET	48439978	74
NB	Aluminum cans	64811738	76
NB	Beer, cans	17641654	72
NS	Glass	16311734	73.29
NS	Metal cans, bimetal*	3044930	100
NS	Aluminum cans	113323527	79.55
NS	Gable top, tetrapak*	10368760	100
NS	HDPE	4689048	87.69
NS	Other plastic	3358588	58.54
NS	PET	75599415	84.93
NFLD	PET	31489470	64.1
NFLD	Aluminum cans	60598087	65.93
NFLD	Plastic other	15319361	83.14
Total samples		13	
Average		77.8	
Weighted Average		76.6	
Standard Deviation		12.4	
Confidence Intervals		6.7	

* Individual rates are deceiving as one of the major distributors in Nova Scotia does not provide a break-down by container. Consequently, recovery rates for certain general container categories (i.e. metal cans/bimetal, gable top/tetrapack) are recorded as being a 100% or more, as containers from other classifications have been allocated to these categories.

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10-cent refund, Excluding Refillable Beer

Jurisdiction	Description	Units Recovered	Recovery Rate (%)
BC	Glass (wine & spirits), <1 l	37860338	84.8
BC	Plastic, <1 l	3649027	71
BC	Beer, non-refillable	57542962	88.2
BC	Beer aluminum cans	331792692	93.9
BC	Beer. non-standard refillable	33955752	85.5
AB	Beer, cans	270689559	88
AB	Beer, non-refillable	25360174	100**
SK	Aluminum cans	115022185	90.62
MB	Beer, cans	283218862	76
ON	Beer, cans	141096148	83
PQ	Beer, non-refillable	43860489	80
NS	Other	367070	79.88
NS	PET, > 1l	617091	91.61
Total samples		13	
Average		85.6	
Weighted Average		86.4	
Standard Deviation		7.8	
Confidence Intervals		4.2	

** A 100% recovery is probably attributable to time lags between purchase and return.

10-cent refund, Refillable Beer

Jurisdiction	Description	Units Recovered	Recovery Rate (%)
BC	Beer, refillables	162274320	93.8
AB	Beer, refillables	168659484	95
SK	Beer, refillables	129548770	94.6
MB	Beer, refillables	145134126	99
ON	Beer, refillables	1529724944	97
PQ	Beer, refillables	1327627908	98
NB	Beer, refillables	111918579	97
NS	Beer, refillables	108161003	98
NFLD	Beer, refillables	101746128	97
PEI	Beer, refillables	24158676	97.9
Total samples		10	
Average		96.7	
Weighted Average		97.2	
Standard Deviation		1.7	
Confidence Intervals		1.1	

20-cent refund

Jurisdiction	Description	Units Recovered	Recovery Rate (%)
BC	Metal cans, > 1 l	960336	49.2
BC	Gable top, polycoat >1 l	5131075	44.5
BC	Plastic, > 1l	58338863	88.4
BC	Bag-in-box	281700	55.3
BC	Glass (wine & spirits), > 1 l	9657644	87.4
BC	Bag-in-box (LBD)	2400017	84.9
BC	Plastic, > 1 l (LBD)	564385	40.7
BC	Beer, non-refillable	645851	81.2
AB	Glass (wine & spirits), > 1 l	8197319	89
AB	PET, > 1 l	57660194	87
AB	Purepack, gabletop, > 1 l	5706447	55.8
AB	HDPE/PVC > 1 l	3080355	73
AB	Bag-in-box	287699	42
AB	Metal cans, > 1 l	947570	47
PQ	Glass, > 450 ml	4518869	86
PQ	Aluminum, big size	23640157	80
Total samples		16	
Average		68.2	
Weighted Average		83.4	
Standard Deviation		19.4	
Confidence Intervals		9.5	

APPENDIX B: Recovery Rate Data Sources

British Columbia	Recovery Data non-alcohol	Beverage Container Stewardship Program Regulation - Annual Report the Director - 2001 reporting period
	Recovery Data - alcohol	Beverage Container Stewardship Program Regulation - Annual Report the Director - 2001 reporting period
Alberta	Recovery Data domestic beer	BCMB Annual Report - 2001
	Recovery Data - non-alcohol, wine & sprits and imported beer	Alberta Beverage Container Recycling Corp - 2002 Annual Report
	Recovery Data - refillable beer	BCMB Annual Report - 2001
Saskatchewan	Recovery Data -non-refillables	SARCAN
	Recovery Data -refillable beer	Brewers Association of Canada - 2001 Statistical bulletin - (1 HL = 292. bottles)
Manitoba	Recovery Data - refillable Beer	Brewers Association of Canada - 2001 Statistical bulletin - (1 HL = 292. bottles)
	Recovery Data - non-refillable beer	Brewers Association of Canada - 2001 Statistical bulletin - (1 HL = 292. bottles)
Ontario	Recovery Data - refillable Beer	Brewers Association of Canada - 2001 Statistical bulletin - (1 HL = 292. bottles) and Brewers of Ontario
	Recovery Data - non-refillable beer	Brewers Association of Canada - 2001 Statistical bulletin - (1 HL = 292. bottles) and Brewers of Ontario
Quebec	Recovery Data - soft-drinks	Recyc-Quebec - Annual Report 2002 & Sales/Recovery data for soft-dr and beer
	Recovery Data - refillable beer	Brewers Association of Canada - 2001 Statistical bulletin - (1 HL = 292. bottles) and Brewers of Ontario
Nova Scotia	Recovery Data - non-refillables	Resource Recovery Fund Board
	Recovery Data - refillable beer	Brewers Association of Canada - 2001 Statistical bulletin - (1 HL = 292. bottles)
New Brunswick	Recovery Data - non-alcohol	Encorp Atlantic
	Recovery Data - Liquor	Provincial Government
	Recovery Data -refillable beer	Brewers Association of Canada - 2001 Statistical bulletin - (1 HL = 292. bottles)
Newfoundland	Recovery Data - non-refillables	Multi-Materials Stewardship Board 2002
	Recovery Data - refillable beer	Brewers Association of Canada - 2001 Statistical bulletin - (1 HL = 292. bottles)