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# California Beverage Container Recycling and Litter Reduction Study

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**Peter Berck and George Goldman, Principal Investigators**  
with the assistance of  
**Tim Beattie, Jeffrey LaFrance, Anna Gueorguieva, Aya  
Ogishi,  
Bruce McWilliams, and Peter Ho**

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# Comparison with Other States

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Chapter 2.

Anna Gueorguieva and Peter Berck

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# Outline

- 1) Distinctive Features of CA
  - 2) Lessons from Canada
  - 3) Good examples from the European Union
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# CRV

- CRV is California Redemption Value
  - Distributors pay 5c under 24 oz and 10c for larger bottles into a government fund for each container sent to a retailer.
  - When consumers return containers, they are paid a refund by weight that approximates the 5 and 10 cents
  - Aluminum, Glass, and Plastic beverage containers are covered.
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# Coverage

- ❑ 11 States have bottle bills
  - ❑ California has widest coverage, Maine and Hawaii are next
  - ❑ No dairy
  - ❑ 4 include wine and liquor
  - ❑ No items included in WIC program (e.g. juice in containers of 48 oz or greater) in CA
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# Lowest Deposit per Container

- Deposits for non-refillable containers in other states is at least 5 cents
  - States with higher deposits have higher recycling rates
  - Michigan – 10 cent deposit – 94% for 2000
  - Vermont – 5 cents, 15 for liquor – 90-95%
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# Producer Responsibility

- In California deposits go towards program administration
  - Massachusetts  
100% of unredeemed deposits to state  
+ additional handling fee
  - Oregon  
Unredeemed deposits returned to distributors
  - California closer to Massachusetts
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# Convenience of Return

- California is the only state where retail centers are not in the reclamation system
    - Curbside, Old Line recycling, drop off, and
    - “Convenience Centers”
      - Limited hours open
      - Within ½ mile of supermarkets
  - No need to sort containers by maker
    - Containers do not go back to distributor as in other states
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# Incentives on the Collection Side

- Recycled content law (same as Oregon)
  - Difference between supply and demand price of recycled material (processing fee)
  - Municipalities need to decrease waste by 50%
  - Handling fees  
CA 2.5 cents                      OR none      Others 1-3 c
  - No disposal of recyclables without approval
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# Lessons from Canada

- Large number of containers covered  
7 out of 11 provinces cover all containers but milk
  - Variation in deposit value for different type of containers due to difficulty of handling
    - beer and liquor – higher deposit
    - distinction between metal and plastic
    - refillable vs one-use
  - Point of Purchase non-refundable recycling fee (6 out of 11 provinces)
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# Programs for prevention and reuse of containers

- Compulsory refill containers  
Denmark – beer and soft drinks
  - Quotas for reuse containers  
Germany for beverages
  - Taxes on one-way containers
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# Container Recycling and Costs

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Chapter 3

Goldman and Ogishi

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# Average California Household Disposal Cost, 1999

**\$140/ton**

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## Table 2. Net Recycler Costs of Recycling CRV Aluminum Containers, 1999

Recycler Type <sup>1</sup>	Costs (\$/Ton)			Revenue (\$/Ton)	Net Costs (\$/Ton)	Net Costs (\$/Container)
	Recycler Costs	MRF Costs	Processor Costs	Scrap Value		
RC	361.83	0.00	73.81	923.64	-488.00	-0.0082
SS	553.06	0.00	73.81	923.64	-296.77	-0.0050
CS	168.53	30.00	73.81	923.64	-651.30	-0.011

1. RC: Recycling centers, SS: Supermarket sites, CS: Curbside programs

# Table 3. Net Costs of Recycling CRV Glass Containers, 1999

Recycler Type <sup>1</sup>	Costs (\$/Ton)			Revenue (\$/Ton)	Net Costs/ (\$/Ton)	Net Costs (\$/Container)
	Recycler Costs	MRF Costs	Processor Costs	Scrap Value		
RC	86.75	0.00	22.29	17.62	86.38	0.0237
SS	418.35	0.00	22.29	17.62	417.98	0.1148
CS	168.53	30.00	22.29	17.62	203.20	0.0551

# Table 4. Net Costs of Recycling CRV PET Containers, 1999

Recycler Type <sup>1</sup>	Costs (\$/Ton)			Revenue (\$/Ton)	Net Costs/ (\$/Ton)	Net Costs (\$/Container)
	Recycler Costs	MRF Costs	Processor Costs	Scrap Value		
RC	588.14	0.00	133.57	493.42	228.29	0.0116
SS	901.35	0.00	133.57	493.42	541.50	0.0276
CS	168.53	30.00	133.57	191.62	140.48	0.0072



# Table 5. Net Recycler Costs Weighted Average, 1999

Recycler Type 1	Costs (\$/Ton)			Revenue (\$/Ton)	Net Costs/ (\$/Ton)	Program Payments (\$/Ton)	Net Costs - Program Payments (\$/Ton)
	Recycler Costs	MRF Costs	Processor Costs	Scrap Value			
RC	186.34	0.00	42.09	267.95	-39.52	71.72	-111.24
SS	486.93	0.00	43.12	275.17	254.88	219.73	35.15
CS	168.53	30.00	34.85	87.93	145.45	388.87	-243.42

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# Conclusions

- We have estimated the net costs of recycling at recycling centers, curbside programs, and supermarket sites. Of the three, recycling centers have the lowest costs. Supermarket sites and curbside programs are usually more convenient, but have higher costs.
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# Statistical Estimates

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Chapter 4.

Peter Berck, Tim Beattie, Jeffrey  
Lafrance, and Anna Gueorguieva

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# Plan

- Use county by year by program returns and statewide sales
  - Estimate returns as function of income and CRV
  - Find out how increasing CRV affects program
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# County Recycling Model

Demand for beverages is a function of consumer income, prices for beverages (including disposal costs), prices of other goods, population, and environmental variables (temperature)

Higher beverage consumption when weather is hotter, income is higher, and/or prices are lower

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# County Population Dynamics

Variable	Description	Mean	Source
Nonmetro	Urbanization index, equals 1 if non-metropolitan area	0.32	US Department of Housing and Urban Development Income Limit Dataset Variable used: Metropolitan Statistical Area (MSA) <a href="http://www.huduser.org/datasets">http://www.huduser.org/datasets</a>
Pop	Population (in millions)	0.6151	Yearly data from RAND All race and age series <a href="http://ca.rand.org/stats/popdemo/popraceage.html">http://ca.rand.org/stats/popdemo/popraceage.html</a>
Density	Number of people (in tens of thousands, 10,000) per square mile	0.0519	Area obtained from: California State Association of Counties <a href="http://www.csac.counties.org/counties_close_up/county_web/county_mileage.html">http://www.csac.counties.org/counties_close_up/county_web/county_mileage.html</a>
ApptUnits	Suburbanization index: percent of dwellings that are multi-unit housing	0.20	California Department of Finance, Demographics Research Unit <i>City/County Population and Housing Estimates, 1991-2000, with 1990 Census Counts</i> . Sacramento, California, May 2000. <a href="http://www.dof.ca.gov/HTML/DEMOGRAP/drupubs.htm">http://www.dof.ca.gov/HTML/DEMOGRAP/drupubs.htm</a> Report E-5

# Economic and Weather

Variable	Description	Mean	Source
MFI	Median Family Income (in hundred thousand dollars, \$100,000)	0.2781	US Department of Housing and Urban Development Income Limit Dataset – Median Family Income for California <a href="http://www.huduser.org/datasets">http://www.huduser.org/datasets</a>
Unemp	Unemployment rate	5.12	RAND California Employment and Unemployment Statistics <a href="http://ca.rand.org/stats/economics/employment.html">http://ca.rand.org/stats/economics/employment.html</a>
AverTemp	Average Temperature (in thousand degrees F, 1,000 F)	0.0583	National Climactic Data Center Monthly Surface Data Element Type: MNTM Monthly mean temperature <a href="http://lwf.ncdc.noaa.gov/oa/ncdc.html">http://lwf.ncdc.noaa.gov/oa/ncdc.html</a>

# Program Characteristics

PS	Percent population served by curbside programs	0.47	California Department of Conservation, Division of Recycling FTP site – Data – Curbside. zip <a href="http://www.consrv.ca.gov/dor">http://www.consrv.ca.gov/dor</a> <a href="ftp://ftp.consrv.ca.gov/pub/dor/Data/">ftp://ftp.consrv.ca.gov/pub/dor/Data/</a>
Hours Average	Average number of hours per week (in thousand 1,000 hours) open for recycling centers	0.038	California Department of Conservation, Division of Recycling <a href="http://www.consrv.ca.gov/dor">http://www.consrv.ca.gov/dor</a>
rcpopdens	Number of Recycling Centers per county over time divided by population	41	California Department of Conservation, Division of Recycling FTP site—Data – Recycler.zip <a href="http://www.consrv.ca.gov/dor">http://www.consrv.ca.gov/dor</a> <a href="ftp://ftp.consrv.ca.gov/pub/dor/Data/">ftp://ftp.consrv.ca.gov/pub/dor/Data/</a>



# Prices and Constants

Variable	Description	Mean	Source
CRV	Container Redemption Value over time for California, adjusted for inflation with the consumer price index	0.031	California Department of Conservation, Division of Recycling <a href="http://www.consrv.ca.gov/dor">http://www.consrv.ca.gov/dor</a> CPI is from the US Department of Labor, Bureau of Labor Statistics <a href="http://www.bls.gov/cpi/">http://www.bls.gov/cpi/</a>
ScrapVal	Aluminum scrap value over time for California	30.98	California Department of Conservation, Division of Recycling <a href="http://www.consrv.ca.gov/dor">http://www.consrv.ca.gov/dor</a> American Metal Market Scrap Prices from the Recycling Manager services <a href="http://www.amm.com">http://www.amm.com</a>
_cons	constant		
-lq_i	Quarterly dummy for quarter i		

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## Consumers choose 4 disposal methods

- Return for Deposit at Recycling Centers
  - Return not for Deposit at Drop off
  - Curbside Pickup
  - All Other Means
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## Return for Deposit @ Recycling Centers

- Costs are time/effort to sort/return containers
  - Benefits are CRV and satisfaction (not landfill)
  - Value of Time increases with Income
  - Higher Income  $\Rightarrow$  Lower RFD
  - Lower Unemployment  $\Rightarrow$  Lower RFD
  - CRV and Scrap Value  $\Rightarrow$  Incentive for RFD
  - Population Density / # of Apartment Dwellers  
Proxy for ease of return or taste for recycling
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## Return not for Deposit @ Drop off

- Convenient. Will accept all types of recycling quickly.



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# Curbside Pickup

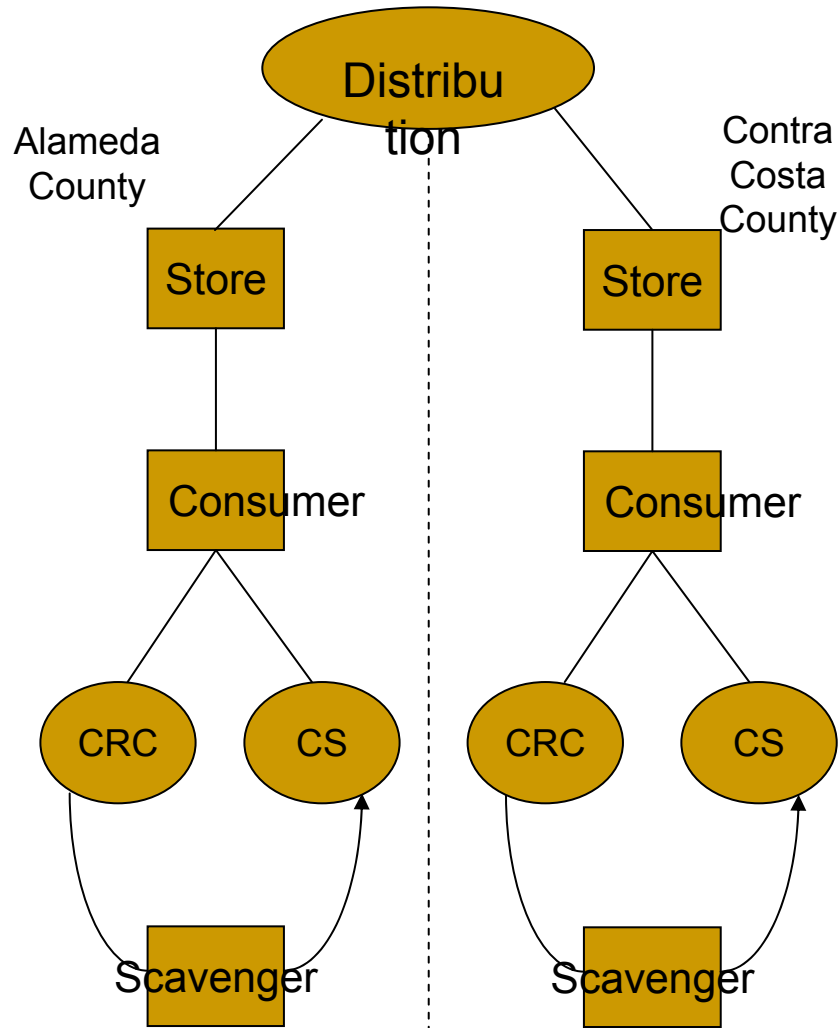
- Not initially widespread
  - Increased substantially over the sample period
  - $\Rightarrow$  Percent of households served by curbside is an important variable
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# All Other Means

- This mode of disposal is not directly measured
  - It is containers either landfilled or disposed improperly
  - It makes up the difference between the container sales by material and the total containers recycled through all programs
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Fig. 1. Flow Chart of Continuous Disposal



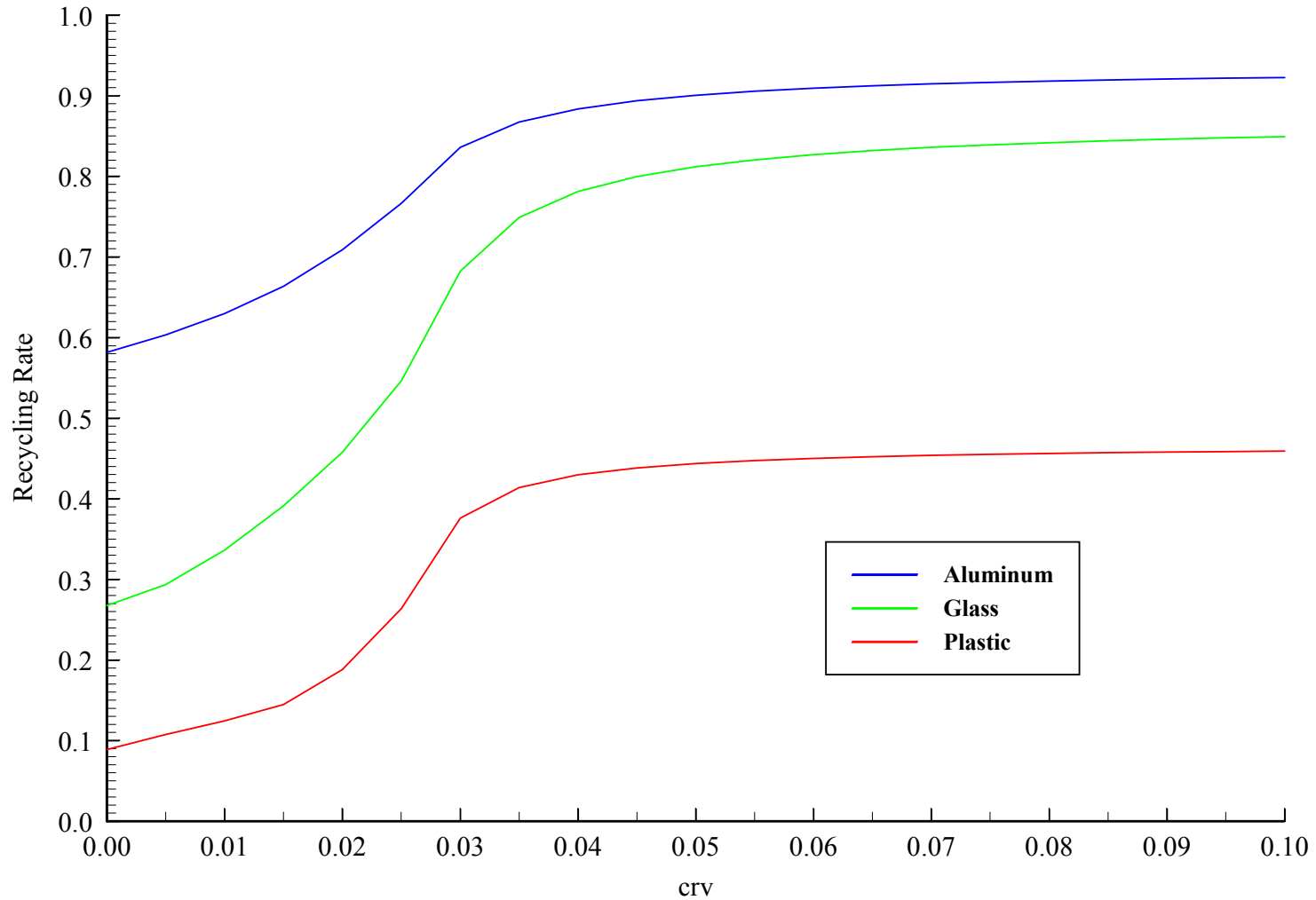
## Data by recycling mode, quarter, & county

- Total number of containers returned cannot exceed total containers sold
- Dependent variable is the % of the material returned by program by county divided by the State's % not returned
- Separate regression systems for each material type
- Estimation method is tobit, heteroscedastic corrected
- Estimating equations:

$$y_{ijt} = \frac{w_{ijt}}{1 - \sum_{k=1}^K \sum_{\ell=1}^3 w_{k\ell t}} = \mathbf{x}'_{ijt} \boldsymbol{\beta}_{ij} + u_{ijt}, \quad i=1, \dots, K, \quad j=1, 2, 3$$



## Predicted 2000 Quarterly Average Recycling Rates



**Table 2. Regression for Aluminum in Recycling Centers**

<b>y_al_crc</b>	<b>Coef.</b>	<b>Robust Std. Err.</b>	<b>t</b>	<b>p&gt; t </b>	<b>[95% Conf. Interval]</b>	
Nonmetro	-0.0625	0.0058	-10.87	0.000	-0.0738	-0.0512
_lq_2	-0.0762	0.0105	-7.25	0.000	-0.0968	-0.0556
_lq_3	-0.0463	0.0124	-3.73	0.000	-0.0707	-0.0219
_lq_4	-0.0148	0.0095	-1.55	0.121	-0.0335	0.0039
Pop	0.1340	0.0116	11.53	0.000	0.1110	0.1570
MFI	-0.0799	0.0481	-1.66	0.097	-0.1740	0.0144
AverTemp	0.6050	0.3910	1.55	0.122	-0.1620	1.3720
Density	-0.1790	0.0248	-7.20	0.000	-0.2270	-0.1300
CRV	8.2645	1.7436	4.74	0.000	4.8445	11.6846
ScrapVal	0.0023	0.0009	2.64	0.008	0.0006	0.0041
Hours Average	-0.5357	0.4633	-1.16	0.248	-1.4443	0.3730
rcpopdens	9.9552	3.1019	3.21	0.001	3.8709	16.0395
PS	0.0230	0.0067	3.42	0.001	0.0098	0.0361
Unemp	0.0019	0.0011	1.83	0.068	-0.0001	0.0040
ApptUnits	-0.0681	0.0263	-2.59	0.010	-0.1196	-0.0166
_cons	-0.2550	0.0532	-4.79	0.000	-0.3593	-0.1506

Table 8. Recycling Rates and Fund Transactions for Three CRV's

	.025/.05 CRV		
	Aluminum	Glass	PET
Recycling Rate*	77%	55%	36%
CRV Paid In	\$ 246,139	\$ 91,153	\$ 127,697
CRV Paid Out	\$ 188,678	\$ 49,807	\$ 46,586
Processing Fee Offset		\$ 26,845	\$ 20,066
Administrative Costs(2.5%)	\$ 4,717	\$ 1,245	\$ 1,165
Total	\$ 52,744	\$ 13,257	\$ 59,879
Total for Scenario		\$ 125,880	

.05/.10 CRV

	Aluminum	Glass	PET
Recycling Rate*	90%	81%	61%
CRV Paid In	\$ 492,279	\$ 182,307	\$ 255,394
CRV Paid Out	\$ 443,376	\$ 148,020	\$ 156,791
Processing Fee Offset		\$ 39,889	\$ 33,768
Administrative Costs(2.5%)	\$ 11,084	\$ 3,701	\$ 3,920
Total	\$ 37,819	\$ (9,303)	\$ 60,915
Total for Scenario		\$ 89,430	

.05/.05 CRV

Recycling Rate*	90%	80%	58%
CRV Paid In	\$ 477,432	\$ 171,196	\$ 186,187
CRV Paid Out	\$ 429,020	\$ 137,722	\$ 107,831
Processing Fee Offset		\$ 39,523	\$ 31,856
Administrative Costs(2.5%)	\$ 10,726	\$ 3,443	\$ 2,696
Total	\$ 37,686	\$ (9,492)	\$ 43,804
Total for Scenario		\$ 71,999	

Table 10. Effects of Repealing the Program: Recycling Rates by Material and Program Type

	Recycling Center	Drop-Off	Curbside	Total
Plastic	9%	0%	1%	10%
Glass	11%	0%	5%	16%
Aluminum	19%	0%	8%	28%

# Effect of Income

1% of Med. Fam income is about \$400. Recycling rate for deposit decreases about 1% for each \$400. Probably understates effects for \$110,000 incomes (Glass) Table shows change in recyc. rate

	Recyc center	dropoff	curbside	total
Median Family Income	-0.00977	0.000071	0.016176	0.006471

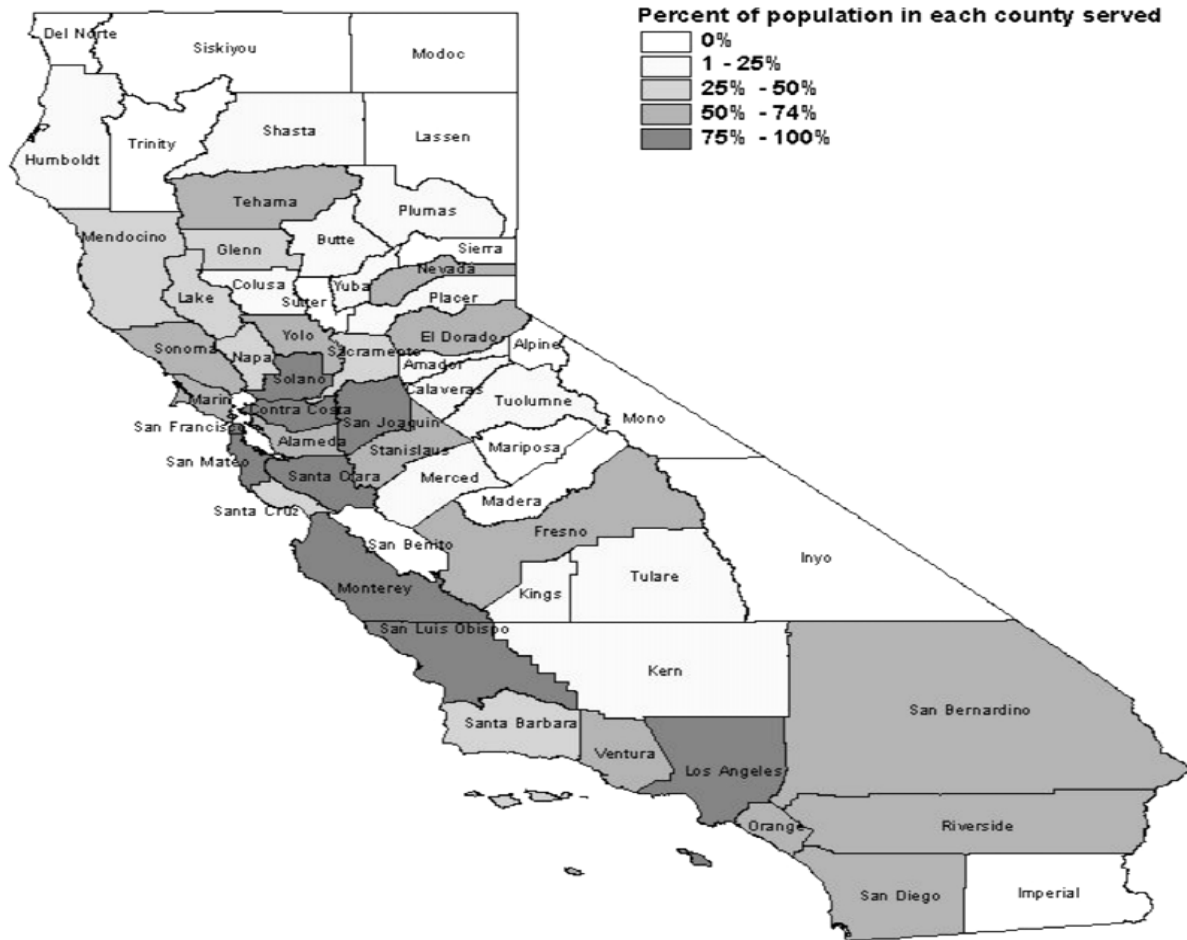
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# Effect of Income

- . For a 1% increase in mean family income the glass recycling rate at recycling centers decreases by one percent while the recycling rate at curbside increases by 1.6 percent. For aluminum the changes are a decrease of  $\frac{1}{2}$  percent and a curbside increase of 2 percent.
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# Map 1: Curbside recycling coverage



Source: California Department of Conservation, Division of Recycling.

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7. Makeup of Container Stream and  
Recycling Rate In and Out of the  
Program

A few Words on Expanding the  
Program

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# Sales Data

- Scanner data from supermarkets for selected markets by Nielsen (2002)
  - Custom audit of packaging and DOC codes
  
  - First, scaled the scanner data by the coverage of the custom audit
  - Second, scaled the data to the whole of California by using Beverage World numbers
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# Makeup of Container Stream

	Beer	100%	Juice	100%	Non-	Soft	Wine	TOTAL
2001		Fruit Juice	Blend	Fruit Juice	carbonated	Drink	Cooler	
		>46 oz		<46 oz	Water			
<b>Glass</b>								
Amber	1.55%					0.08%	0.01%	2.33%
Flint	0.01%						0.00%	0.04%
Green	0.48%			0.05%		0.02%	0.02%	1.97%
Other	1.25%	0.07%	0.62%	0.12%		0.92%	0.22%	5.94%
Total Glass	3.29%	0.07%	0.62%	0.18%		1.03%	0.26%	10.29%
<b>Metal</b>								
Aluminum	1.85%		0.03%	0.10%		21.34%		24.36%
Bi-metal	0.09%	0.09%	0.02%	0.07%				0.33%
Total Metal	1.94%	0.09%	0.05%	0.17%		21.34%		24.69%
<b>Paper</b>								
Paper		4.00%		0.68%				26.46%
Total Paper		4.00%		0.68%				26.46%
<b>Plastic</b>								
Resin # 1		3.86%	1.68%	0.31%	4.15%	13.70%		25.77%
Resin # 2		1.23%		0.37%	2.40%			11.96%
Resin # 4				0.07%				0.07%
Resin # 7		0.72%		0.03%				0.76%
Total Plastic		5.81%	1.68%	0.79%	6.55%	13.70%		38.57%
<b>TOTAL</b>	5.24%	9.97%	2.36%	1.82%	6.55%	36.07%	0.26%	100.00%

Table 3(c). 2001 Nielsen scanner data adjusted for sampling and for non-included sale points. Inflation factor derived by using Beverage World data. Total number of units (inflated):

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# Containers in and out

- Comparison of recycling rates of materials added to the program in 2000.
  - New additions: coffee and tea based drinks, juice blends, 100% fruit juice in <36 oz, non-carbonated water, non-carbonated soft drinks, sport drinks
  - 53% of all 2000 introductions were in PET, lion share to non-carbonated water
-

# Methodology

- Apparent recycling rate of the 2000 additions in 1999 (recycling rate “out” of the program)

$$Rate = \frac{\textit{progrret} \frac{2000ret}{\textit{progrret}}}{\textit{progsales} \frac{2000sales}{\textit{progsales}}}$$

- $2000ret = \% \textit{ juice out} * (\textit{Total Returns} - \textit{Redeemed} - \textit{Other non-program PET})$

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# Result

- 1999 recycling rate of 2000 additions = 12%
  - When these 1.3 billion containers were added to the program, the overall recycling rate fell from 62 to 32 percent
  - 2000 recycling rate of 2000 additions = 15 % if we assume constant recycling rate of program material
  - If we assume decreasing (= aluminum), then 17%
-