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Supplementary appendix

This appendix formed part of the original submission and has been peer reviewed. We post it as supplied by the authors.

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SUPPLEMENTARY APPENDIX

Supplement to: “Effects of a healthy checkout ordinance on the sale of soft drinks and confectionery in Berkeley, CA, USA: a quasi-experimental study”

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Supplemental Methods

The primary difference-in-differences model was:

$$Y_{st} = \alpha_s + \lambda_t + \beta(Berkeley_s \times Post_t) + \varepsilon_{st}$$

where Y_{st} is sales volume for store s in year-quarter t, α_s denotes store fixed effects (i.e., indicators), λ_t denotes year-quarter effects, and β is the difference-in-differences estimates denoting the estimated change in Berkeley relative to the comparison cities after implementation. The year-quarter fixed effects flexibly controlled for seasonal, pandemic-related, secular, and other temporal changes common to Berkeley and the comparison cities, including common linear or nonlinear trends. We calculated Huber-White sandwich standard errors clustered by ZIP code to account for within-area correlation over time.

To assess pre-policy trends and changes in the association over time following implementation, we estimated the following event-study model:

$$Y_{st} = \alpha_s + \lambda_t + \sum_{k \neq -1} \beta_k [Berkeley_s \times 1(t - T_0 = k)] + \varepsilon_{st}$$

where T_0 denotes the quarter of implementation, k indexes quarters relative to implementation, and $1(t - T_0 = k)$ is an indicator for relative quarter k. The quarter immediately preceding implementation $(k = -1)$ was omitted as the reference period. Each coefficient β_k therefore represents the difference in sales between Berkeley and the comparison cities in relative quarter k, compared with the corresponding difference in the quarter immediately before implementation. Coefficients for quarters before implementation were used to assess whether Berkeley and the comparison cities showed evidence of differential pre-policy changes, based on their direction, magnitude, precision, and overall pattern rather than the statistical significance of individual coefficients alone. Coefficients for quarters after implementation describe the timing and evolution of the estimated policy association. Event-study models used the same store and year-quarter fixed effects and ZIP code-clustered Huber-White standard errors as the primary models.

Supp Table A1. City socio-demographic characteristics, 2020

		Comparator Cities		
Characteristic	Berkeley	Davis	Oakland	Sacramento
Population	124,321	66,850	440,646	524,943
Female (%)	51.0%	52.9%	51.3%	51.2%
Age (years, median)	31.3	28.1	37.2	35.4
Under 18 years old (%)	12.4%	16.0%	19.1%	22.3%
18-64 years old (%)	72.4%	70.1%	66.9%	63.9%
≥ 65 years old (%)	15.2%	13.9%	14.0%	13.8%
Race/ethnicity (%)				
Non-Hispanic White	50.2%	51.1%	27.3%	30.3%
Non-Hispanic Black	7.6%	2.3%	20.8%	12.6%
Non-Hispanic Asian	19.9%	21.9%	15.9%	19.5%
Hispanic or Latino	13.7%	17.0%	28.8%	28.8%
Multiple Races or Other	8.6%	7.7%	7.2%	8.8%
Education (% with ≥ Bachelor's)	15.8%	16.9%	17.7%	11.2%
Median household income ($)	$91,259	$75,394	$80,143	$65,847
Poverty (% below level)	4.3%	5.8%	10.9%	11.2%
Unemployment rate (%)	17.8%	27.8%	14.6%	15.7%
Households with children (%)	5.2%	6.3%	6.0%	6.7%

Note: This table reports the socio-demographic characteristics of the four cities in our analytic sample from 2020, the year prior to Berkeley's Healthy Checkout Ordinance being implemented. The data are drawn from the 2020 Decennial Census and the 2020 American Community Survey 5-year estimates.

Supp Table A2. Coverage of identified chain retailers in the Circana analytic sample, by city and store type

City or geography	Store type	Identified chain locations, n	Circana analytic stores, n	Coverage, %
Berkeley	Supermarkets	6	3	50
	Drugstores	8	6	75
	Mass merchandisers	2	2	100
	Total	**16**	**11**	**69**
Davis	Supermarkets	7	2	29
	Drugstores	4	2	50
	Mass merchandisers	1	1	100
	Total	**12**	**5**	**42**
Oakland	Supermarkets	18	6	33
	Drugstores	17	14	82
	Mass merchandisers	1	1	100
	Total	**36**	**21**	**58**
Sacramento	Supermarkets	62	8	13
	Drugstores	42	20	48
	Mass merchandisers	15	6	40
	Total	**119**	**34**	**29**
Comparison cities combined	Supermarkets	87	16	18
	Drugstores	63	36	57
	Mass merchandisers	17	8	47
	Total	**167**	**60**	**36**
All four cities	Supermarkets	93	19	20
	Drugstores	71	42	59
	Mass merchandisers	19	10	53
	Total	**183**	**71**	**39**

Note: Identified chain locations were based on 2020 Data Axle historical business listings cross-checked against the study team's early-2021 sampling frame. The denominator included standalone locations of recognized chain supermarkets, drugstores, and food-selling mass merchandisers. The early-2021 team frame was given primacy for operating status because it was closest to baseline; Data Axle was used to

identify additional candidates. Temporary closures were retained, and stores were excluded for status only when a permanent pre-baseline closure or post-baseline opening was documented. One Seafood City and two Viva supermarket locations in Sacramento were excluded after team review. Dollar stores, convenience stores, independent retailers, embedded pharmacy counters, duplicate or non-retail records, and general merchandise stores without substantial food retailing were excluded. Coverage was calculated as Circana analytic stores divided by identified chain locations. Counts approximate the relevant chain-store universe because available data did not consistently establish store floor area, linear feet of food sold, exact municipal boundaries, or eligibility under Berkeley's Healthy Checkout Ordinance.

Supp Table A3. Sensitivity analyses of the impact of Berkeley's Healthy Checkout Ordinance on volume sales of soda

		No holidays (1)	Enforcement date with interim period (2)	Excluding COVID-19 onset (2020 Q1-Q2) (3)
All stores	ATT	-1,108	-2,322	-3,381**
	(CI)	(-2,769 to 553)	(-5,279 to 634)	(-6,623 to -139)
	[%]	[-14.5%]	[-21.7%]	[-33.7%]
Smaller products	ATT	-77	-36	-115
	(CI)	(-205 to 51)	(-222 to 150)	(-313 to 83)
	[%]	[-11.0%]	[-3.7%]	[-12.0%]
Larger products	ATT	-1,031	-2,286	-3,266**
	(CI)	(-2,606 to 545)	(-5,171 to 599)	(-6,392 to -141)
	[%]	[-14.9%]	[-23.6%]	[-36.0%]
Supermarkets	ATT	-5,845**	-11,298***	-13,670***
	(CI)	(-10,413 to -1,277)	(-19,028 to -3,567)	(-21,770 to -5,571)
	[%]	[-31.5%]	[-44.0%]	[-56.3%]
Smaller products	ATT	-431***	-552***	-628***
	(CI)	(-577 to -285)	(-715 to -388)	(-835 to -420)
	[%]	[-39.7%]	[-35.7%]	[-42.1%]
Larger products	ATT	-5,414**	-10,746***	-13,043***
	(CI)	(-9,935 to -893)	(-18,417 to -3,074)	(-21,078 to -5,007)
	[%]	[-30.9%]	[-44.5%]	[-57.2%]
Drugstores	ATT	538*	930**	617
	(CI)	(-40 to 1,117)	(28 to 1,832)	(-189 to 1,422)
	[%]	[16.4%]	[21.3%]	[13.8%]
Smaller products	ATT	-39	60**	-46
	(CI)	(-90 to 12)	(11 to 109)	(-118 to 25)
	[%]	[-6.7%]	[8.1%]	[-5.8%]
Larger products	ATT	577**	870**	663*
	(CI)	(20 to 1,134)	(3 to 1,736)	(-92 to 1,419)
	[%]	[21.4%]	[24.0%]	[18.0%]
Mass merchandisers	ATT	-811	-1,440	-3,654*
	(CI)	(-2,924 to 1,302)	(-5,105 to 2,225)	(-7,722 to 414)
	[%]	[-19.3%]	[-20.1%]	[-69.3%]
Smaller products	ATT	147	152	142
	(CI)	(-503 to 798)	(-786 to 1,090)	(-798 to 1,082)
	[%]	[30.0%]	[17.4%]	[22.8%]
Larger products	ATT	-958	-1,591	-3,796*
	(CI)	(-3,286 to 1,370)	(-5,195 to 2,013)	(-8,015 to 422)
	[%]	[-25.8%]	[-25.3%]	[-81.7%]

Note: This table shows difference-in-differences estimates of the Healthy Checkout Ordinance's association with soda sales. The average treatment effect on the treated (ATT) is the change in volume sales of soda per store-quarter, in liters, for three specifications: (1) excluding four-week reporting intervals containing Halloween, Valentine's Day, Easter, or Christmas; (2) treating the interval between implementation and enforcement as pre-enforcement; and (3) excluding the first two quarters of 2020, which encompassed the initial stockpiling and stay-at-home period following COVID-19 onset. Rows show estimates overall and stratified by store type and package size. The 95% CI is in parentheses, and the ATT expressed as a percentage of the pre-HCO mean in Berkeley is in brackets. Significance: *p<0.10, **p<0.05, ***p<0.01.

Supp Table A4. Sensitivity analyses of the impact of Berkeley's Healthy Checkout Ordinance on volume sales of candy

		No holidays (1)	Enforcement date with interim period (2)	Excluding COVID-19 onset (2020 Q1-Q2) (3)	No seasonal candy (4)
All stores	ATT	183**	233**	139	47
	(CI)	(17 to 350)	(16 to 449)	(-99 to 377)	(-146 to 240)
	[%]	[13.7%]	[10.8%]	[7.0%]	[2.6%]
Smaller products	ATT	-14	-34	-38	-35
	(CI)	(-59 to 30)	(-78 to 11)	(-101 to 24)	(-92 to 23)
	[%]	[-8.5%]	[-13.6%]	[-17.1%]	[-15.9%]
Larger products	ATT	197***	266***	177*	82
	(CI)	(65 to 330)	(80 to 452)	(-16 to 370)	(-70 to 233)
	[%]	[17.0%]	[13.9%]	[10.0%]	[5.2%]
Supermarkets	ATT	-97	42	-286	-308
	(CI)	(-427 to 233)	(-338 to 423)	(-858 to 285)	(-717 to 101)
	[%]	[-5.2%]	[1.5%]	[-10.3%]	[-12.0%]
Smaller products	ATT	-90***	-122***	-150***	-142***
	(CI)	(-151 to -30)	(-177 to -67)	(-245 to -55)	(-216 to -68)
	[%]	[-33.6%]	[-34.8%]	[-41.0%]	[-39.1%]
Larger products	ATT	-7	164	-136	-166
	(CI)	(-298 to 284)	(-179 to 508)	(-643 to 370)	(-544 to 212)
	[%]	[-0.4%]	[6.7%]	[-5.7%]	[-7.5%]
Drugstores	ATT	42	84	89	81
	(CI)	(-71 to 154)	(-134 to 301)	(-62 to 239)	(-46 to 208)
	[%]	[3.3%]	[4.0%]	[4.7%]	[4.9%]
Smaller products	ATT	-3	-5	5	-6
	(CI)	(-31 to 26)	(-39 to 30)	(-26 to 36)	(-35 to 23)
	[%]	[-1.6%]	[-1.9%]	[2.3%]	[-2.9%]
Larger products	ATT	44	88	84	87*
	(CI)	(-43 to 131)	(-97 to 273)	(-41 to 209)	(-15 to 188)
	[%]	[4.0%]	[4.8%]	[5.0%]	[6.0%]
Mass merchandisers	ATT	1,169***	943***	913***	396**
	(CI)	(747 to 1,591)	(392 to 1,493)	(538 to 1,288)	(88 to 705)
	[%]	[155.3%]	[64.6%]	[82.0%]	[36.1%]
Smaller products	ATT	70***	-14	-20	33
	(CI)	(22 to 118)	(-80 to 52)	(-86 to 45)	(-24 to 90)
	[%]	[158.7%]	[-16.2%]	[-34.4%]	[57.1%]
Larger products	ATT	1,100***	957***	933***	363**
	(CI)	(692 to 1,507)	(395 to 1,518)	(519 to 1,347)	(15 to 712)
	[%]	[155.1%]	[69.7%]	[88.5%]	[34.9%]

Note: This table shows difference-in-differences estimates of the Healthy Checkout Ordinance's association with candy sales. The average treatment effect on the treated (ATT) is the change in volume sales of candy per store-quarter, in kilograms, for four specifications: (1) excluding four-week reporting intervals containing Halloween, Valentine's Day, Easter, or Christmas; (2) treating the interval between implementation and enforcement as pre-enforcement; and (3) excluding the first two quarters of 2020, which encompassed the initial stockpiling and stay-at-home period following COVID-19 onset; and (4) removing seasonal candy products. Rows show estimates overall and stratified by store type and package size. The 95% CI is in parentheses, and the ATT expressed as a percentage of the pre-HCO mean in Berkeley is in brackets. Significance: *p<0.10, **p<0.05, ***p<0.01.

Supp Table A5. Primary and inverse-coverage-weighted estimates of the association of Berkeley's Healthy Checkout Ordinance with volume sales of soda and candy

		Primary unweighted estimate	Inverse-coverage-weighted estimate
Panel A. Soda			
All products	ATT	-2,478*	-6,259***
	(CI)	(-5,228 to 272)	(-10,250 to -2,267)
	[%]	[-23.4%]	[-49.5%]
Smaller products	ATT	-95	-332***
	(CI)	(-276 to 86)	(-521 to -143)
	[%]	[-9.8%]	[-32.0%]
Larger products	ATT	-2,383*	-5,927***
	(CI)	(-5,018 to 252)	(-9,798 to -2,056)
	[%]	[-24.7%]	[-51.1%]
Panel B. Candy			
All products	ATT	220**	96
	(CI)	(21 to 420)	(-167 to 359)
	[%]	[10.4%]	[4.3%]
Smaller products	ATT	-29	-49
	(CI)	(-84 to 26)	(-114 to 17)
	[%]	[-11.6%]	[-17.9%]
Larger products	ATT	249***	145
	(CI)	(83 to 415)	(-83 to 373)
	[%]	[13.3%]	[7.4%]

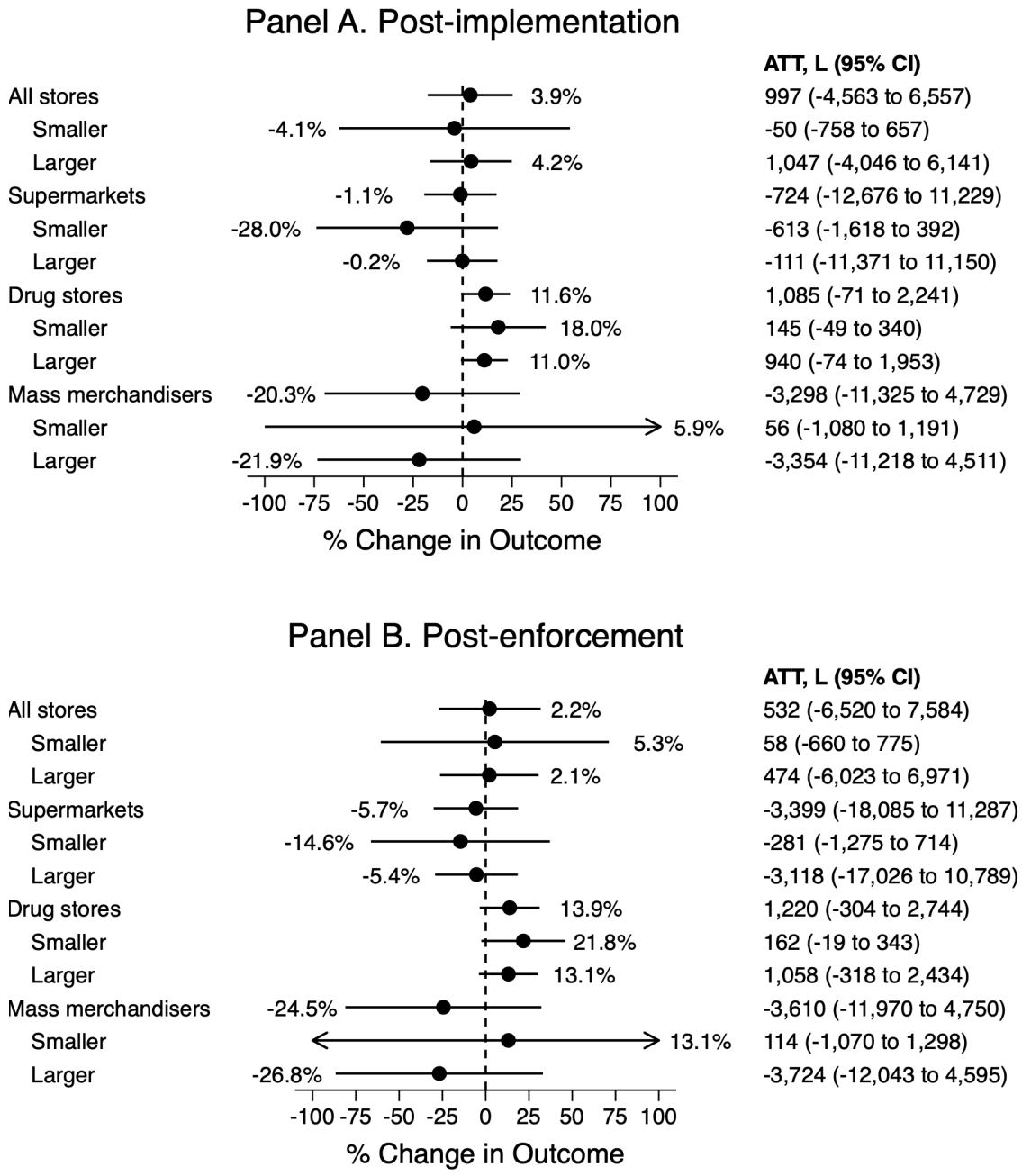
Note: This table shows difference-in-differences estimates of the Healthy Checkout Ordinance's association with sales per store-quarter following implementation. Primary estimates weight analytic stores equally. Inverse-coverage-weighted estimates use the ratio of identified chain locations to analytic stores within each study group and store type, based on the chain-store universe in Supp Table A2. Weighted estimates approximate the average change across that universe and do not represent all stores subject to the ordinance or city-wide sales. The average treatment effect on the treated (ATT) is shown in liters for soda and kilograms for candy. The 95% CIs are in parentheses, and the ATT expressed as a percentage of the weighted pre-HCO mean in Berkeley is shown in brackets. Models included store and year-quarter fixed effects and Huber-White standard errors clustered by ZIP code.

Supp Table A6. Tests of heterogeneity in the association of Berkeley's Healthy Checkout Ordinance with volume sales of soda and candy, by store type

Policy timing	Product group	Supermarket ATT (95% CI)	Drugstore ATT (95% CI)	Mass merchandiser ATT (95% CI)	Joint p-value	S vs D p-value	S vs M p-value	D vs M p-value
Panel A. Soda (L per store-quarter)								
Implementation	All products	-10,966 (-17,874 to -4,059)	748 (-113 to 1,609)	-2,433 (-5,228 to 362)	0.0008	0.0016	0.034	0.040
	Smaller products	-533 (-707 to -360)	-30 (-100 to 39)	89 (-679 to 857)	<0.0001	<0.0001	0.12	0.75
	Larger products	-10,433 (-17,270 to -3,596)	778 (-27 to 1,583)	-2,522 (-5,482 to 439)	0.0013	0.0023	0.048	0.046
Enforcement	All products	-15,771 (-24,818 to -6,724)	846 (-105 to 1,797)	-4,412 (-8,155 to -669)	0.0003	0.0007	0.026	0.011
	Smaller products	-673 (-854 to -491)	19 (-41 to 80)	99 (-819 to 1,017)	<0.0001	<0.0001	0.10	0.86
	Larger products	-15,099 (-24,054 to -6,143)	827 (-73 to 1,726)	-4,511 (-8,345 to -678)	0.0005	0.0010	0.036	0.013
Panel B. Candy (kg per store-quarter)								
Implementation	All products	-147 (-614 to 320)	102 (-47 to 251)	1,235 (859 to 1,612)	<0.0001	0.30	<0.0001	<0.0001
	Smaller products	-132 (-206 to -57)	-2 (-36 to 32)	36 (-20 to 91)	0.0023	0.0041	0.0006	0.28
	Larger products	-16 (-437 to 406)	104 (-15 to 223)	1,200 (810 to 1,589)	<0.0001	0.57	0.0002	<0.0001
Enforcement	All products	-163 (-653 to 327)	106 (-89 to 300)	668 (276 to 1,059)	0.016	0.29	0.021	0.0048
	Smaller products	-156 (-228 to -83)	-5 (-43 to 32)	-31 (-102 to 41)	0.0035	0.0009	0.018	0.55
	Larger products	-7 (-455 to 441)	111 (-49 to 271)	699 (298 to 1,099)	0.013	0.60	0.037	0.0035

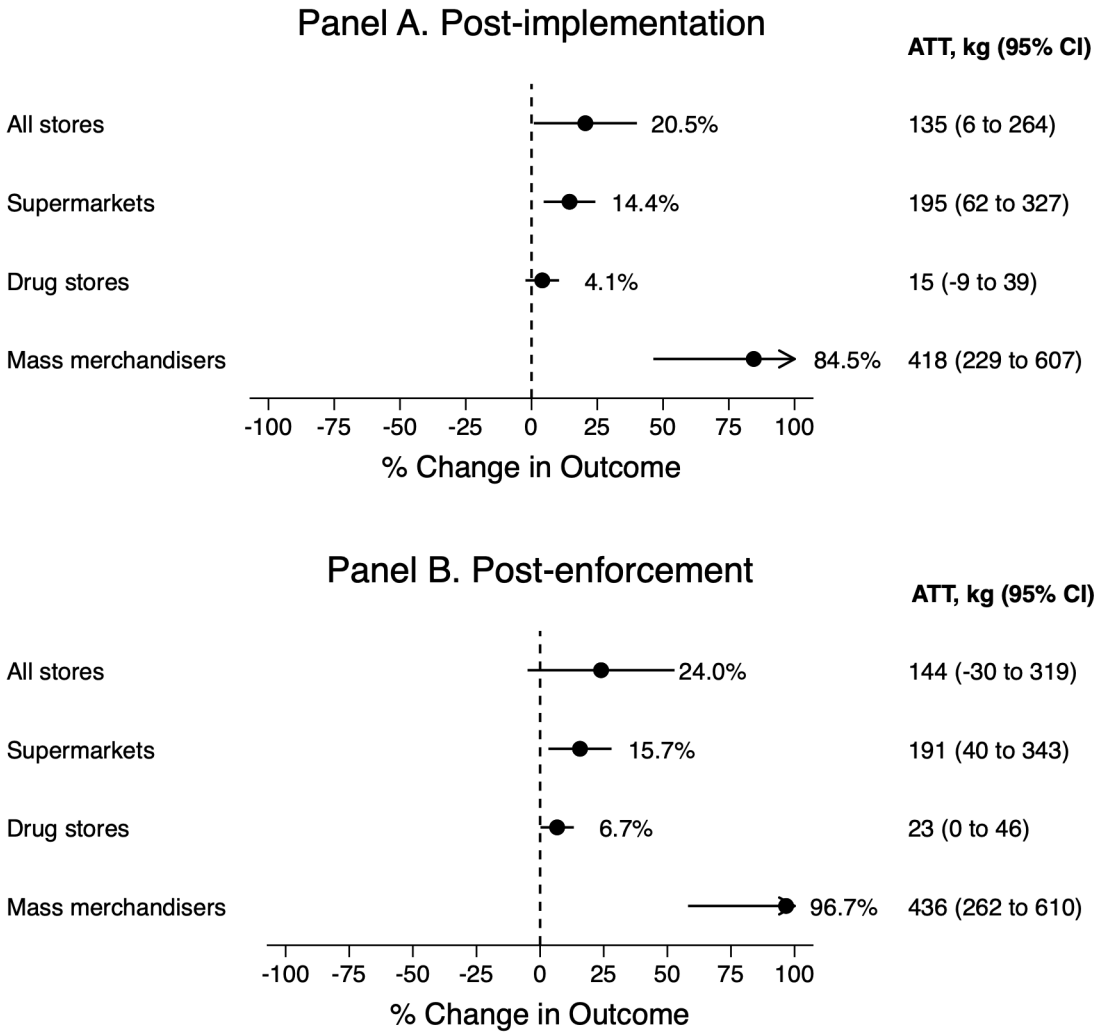
Note: Estimates are from pooled difference-in-differences models that included separate interactions between Berkeley and the post-policy indicator for each store type, store fixed effects, and store type-by-year-quarter fixed effects. The joint p-value tests equality of the three store-type-specific estimates; pairwise p-values test equality between the indicated store types. Store-type-specific estimates presented in Figures 1 and 2 were estimated in models stratified by store type; therefore, their 95% CIs may differ slightly from those shown here. Huber-White sandwich standard errors were clustered by ZIP code. All models included 1420 store-quarter observations. ATT = average treatment effect on the treated; D = drugstore; M = mass merchandiser; S = supermarket.

Supp Figure A1. Impact of Berkeley's Healthy Checkout Ordinance on volume sales of bottled water



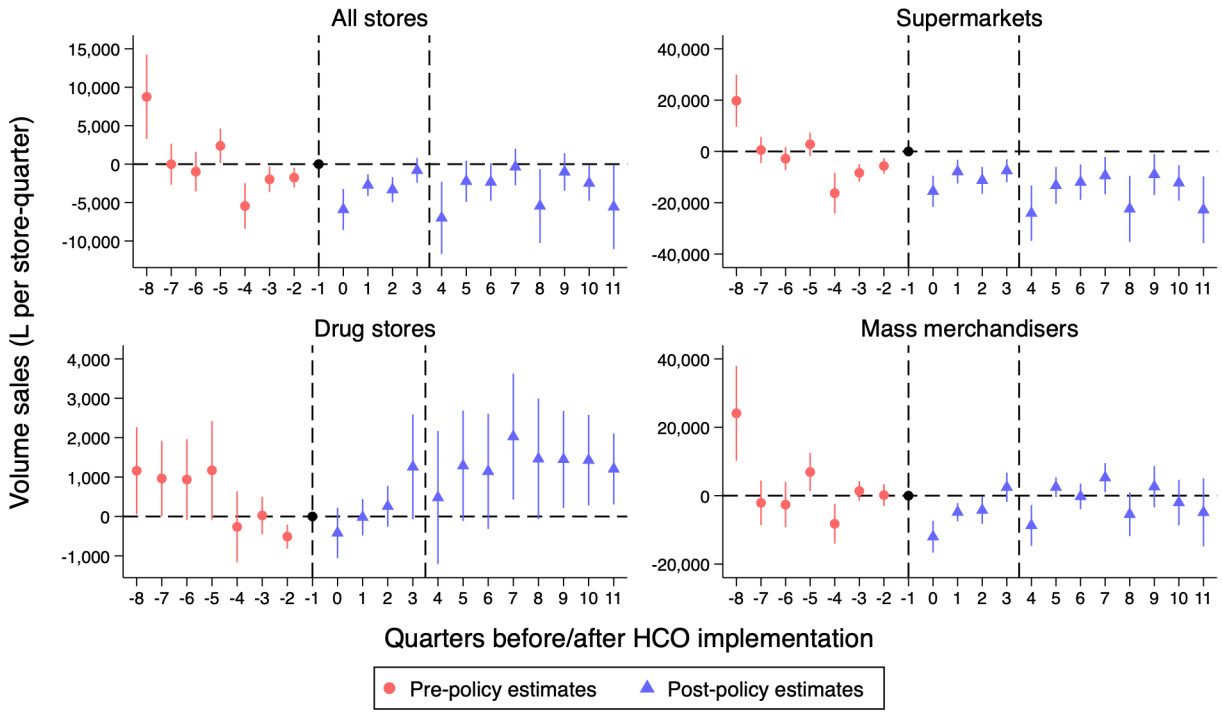
Note: This figure shows difference-in-differences estimates of the Healthy Checkout Ordinance's association with bottled water sales following implementation (Panel A) and following enforcement (Panel B). Estimates are shown for all stores and by store type among all products, smaller products, and larger products. The percent change in outcome reflects the average treatment effect on the treated (ATT) relative to the pre-HCO mean in Berkeley. Error bars are 95% confidence intervals, with arrows indicating truncated bars. The secondary y-axis shows the ATT in liters, with 95% CI.

Supp Figure A2. Impact of Berkeley's Healthy Checkout Ordinance on volume sales of snack nuts and seeds



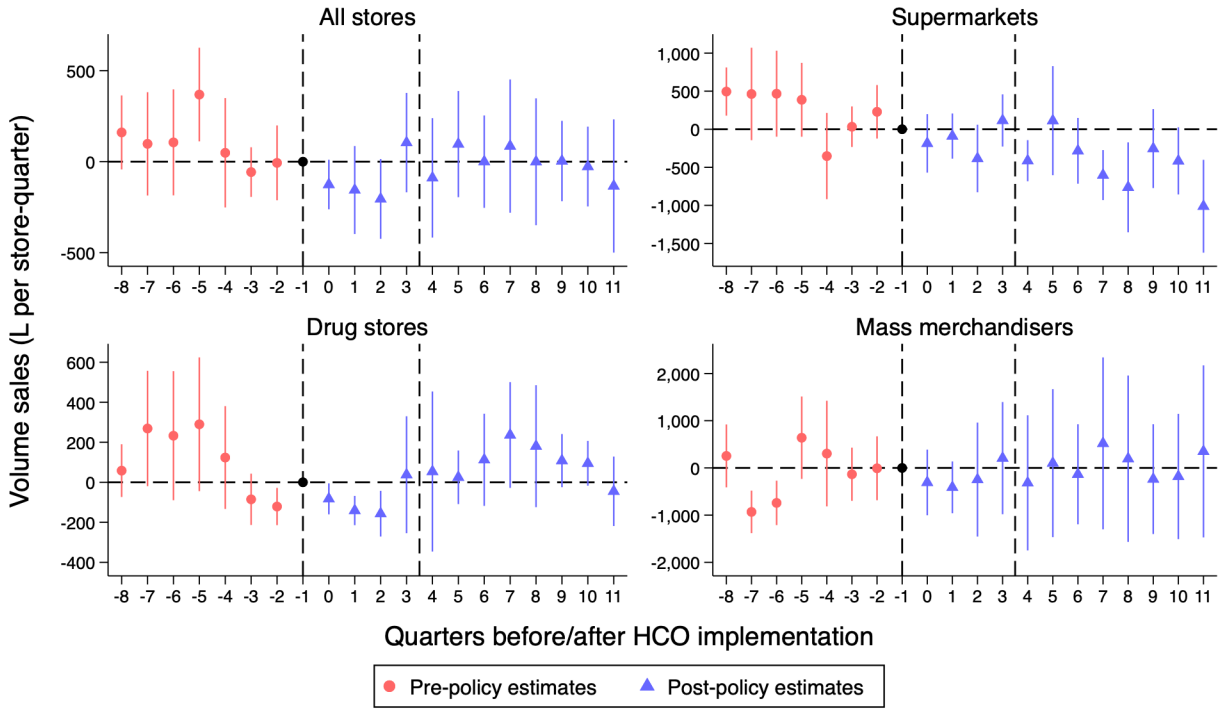
Note: This figure shows difference-in-differences estimates of the Healthy Checkout Ordinance's association with snack nuts and seeds sales following implementation (Panel A) and following enforcement (Panel B). Estimates are shown for all stores and by store type among all products, smaller products, and larger products. The percent change in outcome reflects the average treatment effect on the treated (ATT) relative to the pre-HCO mean in Berkeley. Error bars are 95% confidence intervals, with arrows indicating truncated bars. The secondary y-axis shows the ATT in kilograms by weight, with 95% CI.

Supp Figure A3. Time-varying effects of Berkeley's Healthy Checkout Ordinance on volume sales of soda (all products)



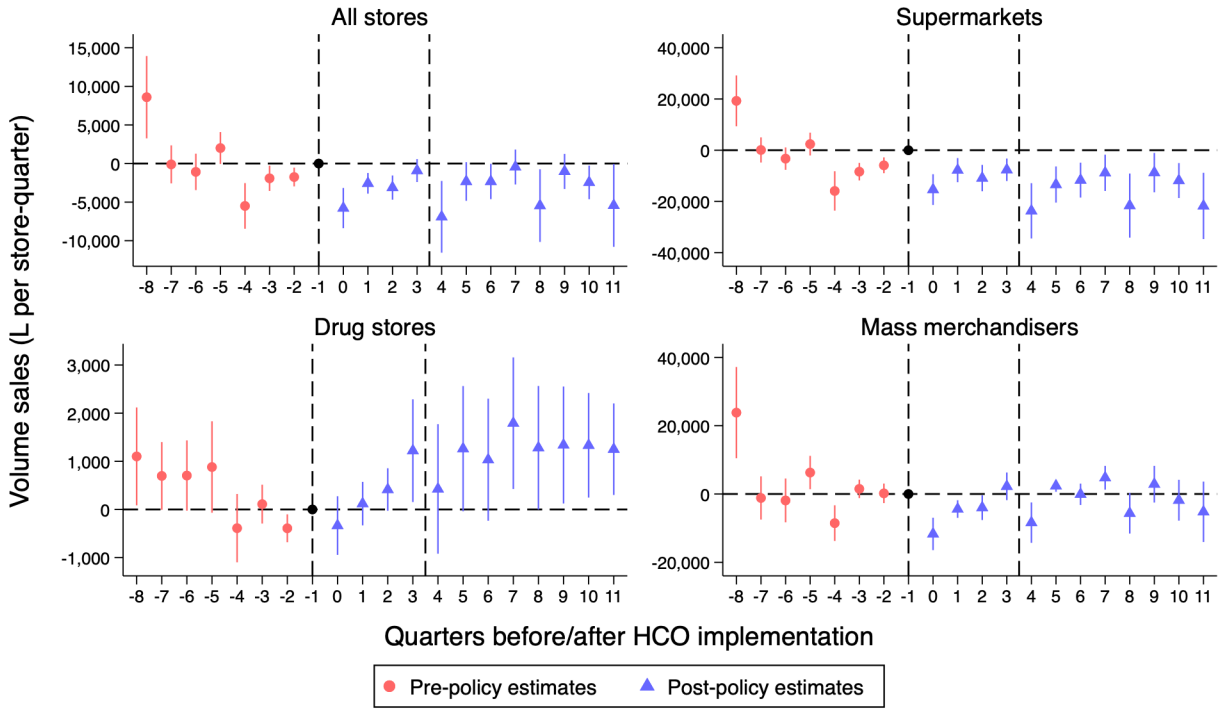
Note: This plot shows changes in volume sales of soda per store, in liters, based on an event-study difference-in-differences regression with fixed effects for store and year-quarter. Quarterly estimates are relative to the quarter before Berkeley's Healthy Checkout Ordinance was implemented. The left dotted line corresponds to the date of implementation, and the right dotted line corresponds to the date of enforcement. The spikes represent the 95% CI from robust standard errors clustered by ZIP code.

Supp Figure A4. Time-varying effects of Berkeley's Healthy Checkout Ordinance on volume sales of soda (smaller packages)



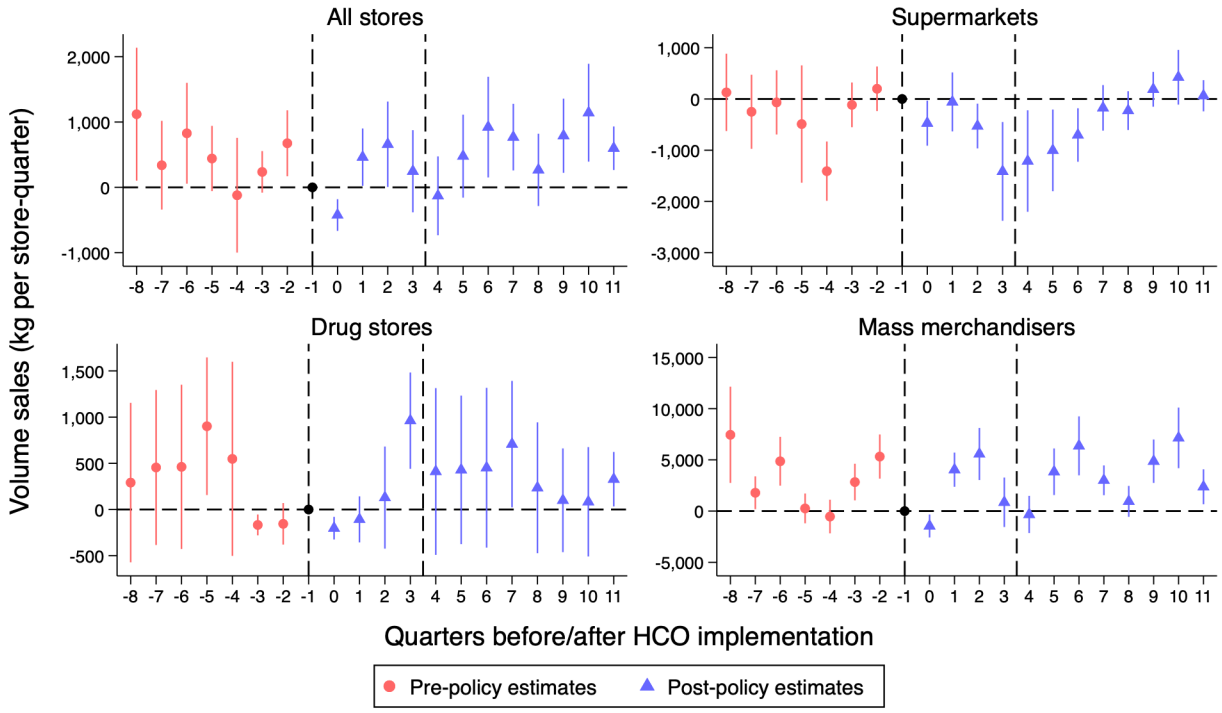
Note: This plot shows changes in volume sales of soda per store, in liters, based on an event-study difference-in-differences regression with fixed effects for store and year-quarter. Quarterly estimates are relative to the quarter before Berkeley's Healthy Checkout Ordinance was implemented. The left dotted line corresponds to the date of implementation, and the right dotted line corresponds to the date of enforcement. The spikes represent the 95% CI from robust standard errors clustered by ZIP code.

Supp Figure A5. Time-varying effects of Berkeley's Healthy Checkout Ordinance on volume sales of soda (larger packages)



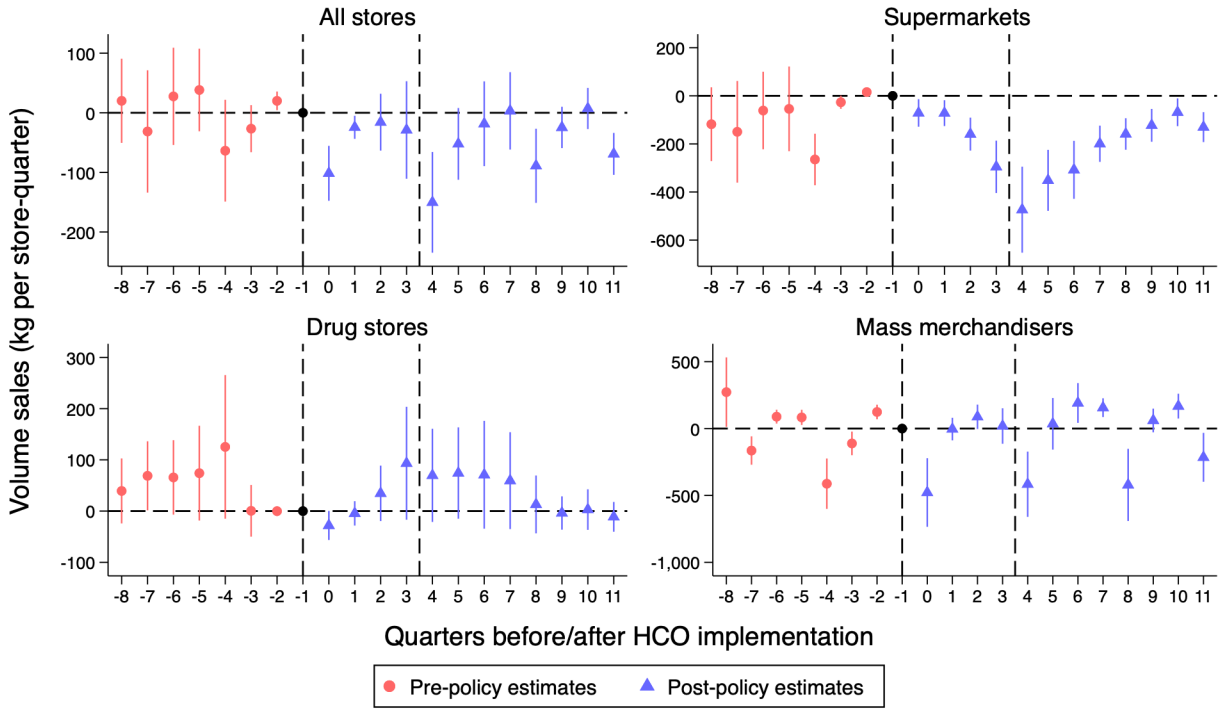
Note: This plot shows changes in volume sales of soda per store, in liters, based on an event-study difference-in-differences regression with fixed effects for store and year-quarter. Quarterly estimates are relative to the quarter before Berkeley's Healthy Checkout Ordinance was implemented. The left dotted line corresponds to the date of implementation, and the right dotted line corresponds to the date of enforcement. The spikes represent the 95% CI from robust standard errors clustered by ZIP code.

Supp Figure A6. Time-varying effects of Berkeley's Healthy Checkout Ordinance on volume sales of candy (all products)



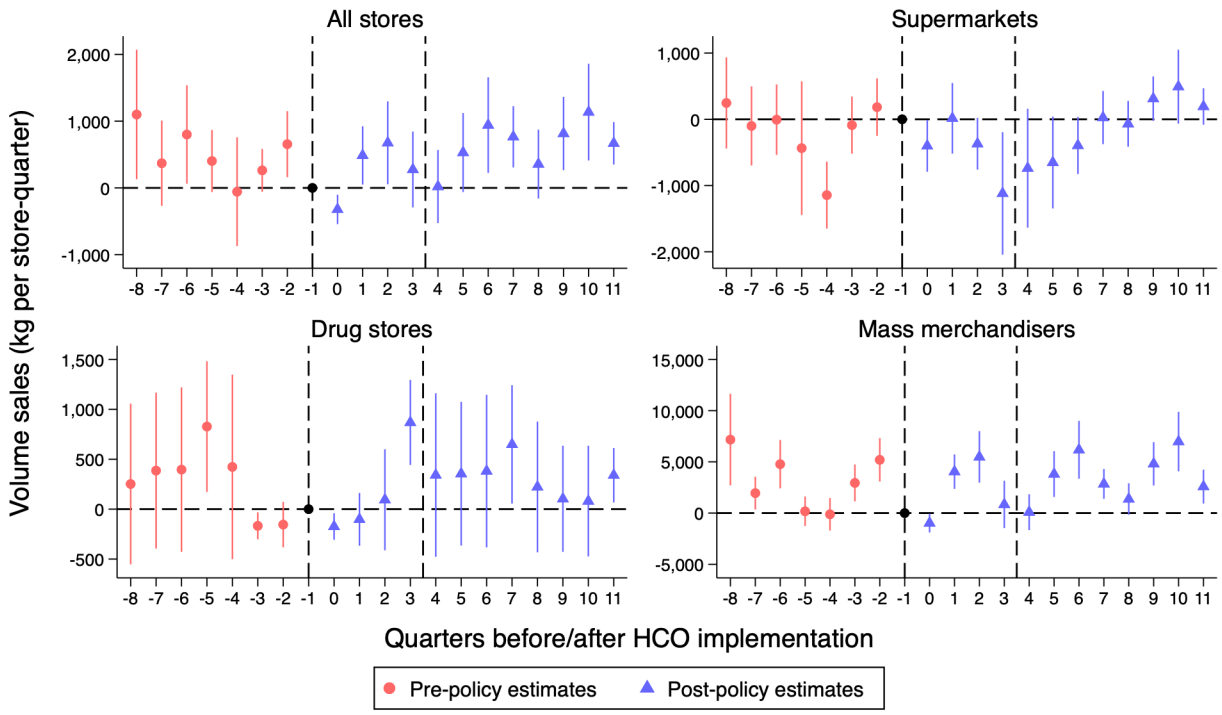
Note: This plot shows changes in volume sales of candy per store, in kilograms, based on an event-study difference-in-differences regression with fixed effects for store and year-quarter. Quarterly estimates are relative to the quarter before Berkeley's Healthy Checkout Ordinance was implemented. The left dotted line corresponds to the date of implementation, and the right dotted line corresponds to the date of enforcement. The spikes represent the 95% CI from robust standard errors clustered by ZIP code.

Supp Figure A7. Time-varying effects of Berkeley's Healthy Checkout Ordinance on volume sales of candy (smaller packages)



Note: This plot shows changes in volume sales of candy per store, in kilograms, based on an event-study difference-in-differences regression with fixed effects for store and year-quarter. Quarterly estimates are relative to the quarter before Berkeley's Healthy Checkout Ordinance was implemented. The left dotted line corresponds to the date of implementation, and the right dotted line corresponds to the date of enforcement. The spikes represent the 95% CI from robust standard errors clustered by ZIP code.

Supp Figure A8. Time-varying effects of Berkeley's Healthy Checkout Ordinance on volume sales of candy (larger packages)



Note: This plot shows changes in volume sales of candy per store, in kilograms, based on an event-study difference-in-differences regression with fixed effects for store and year-quarter. Quarterly estimates are relative to the quarter before Berkeley's Healthy Checkout Ordinance was implemented. The left dotted line corresponds to the date of implementation, and the right dotted line corresponds to the date of enforcement. The spikes represent the 95% CI from robust standard errors clustered by ZIP code.