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Predicting Impacts of Targeted Beverage Taxes: Research Challenges and Potential Solutions

Presented by

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Map of Beverage Tax Proposals

Source: Yale Rudd Center for Food Policy and Obesity

Research Questions Related to Targeted Beverage Taxes

- How much does a SSB tax reduce SSB consumption?
- Does a SSB tax reduce overall energy intake?
- Is SSB consumption addictive?
- How much does a SSB tax raise retail price of SSB?
- Is there a causal relationship between SSB consumption and health?
- Would there be unintended effects of a SSB tax?

Methodologies Used To Analyze the Impacts of Beverage Taxes

- Epidemiological analysis: examine the association between nutrition/health outcomes and *existing* soft drink sales tax.
  - **Pros**: a direct look at the effect of actual taxes on observed health outcomes.
  - **Cons**: existing tax rates are trivial (4% on average for states that tax soft drinks) making it unlikely to detect an effect
- Consumer demand analyses: estimate sensitivity of consumer beverage and food demand to retail price changes, and simulate the effect of a tax-induced price change on consumption.
  - **Pros**: much large variations in retail prices allowing for better identification of price effects
  - **Cons**: temporary price cuts by merchants and manufacturers and may have different effects on purchase behavior than permanent price changes due to taxes.

Data Sources Used in Targeted Beverage Tax Impact Research

- Restricted-access national health surveys with geocodes (e.g. NHANES, BRFSS)
- Researcher self-collected state and county tax rates on soft drinks and other foods
- The Nielsen Company's Proprietary Homescan data
  - Over 100 thousand households record and report purchase information at the UPC-level on a weekly basis using hand-held scanner
  - Each household in the static panel (the data used in scholarly research) is tracked for at least 10 months of the year
  - Cover 52 Nielsen markets and 9 remaining areas of the Continental United States
  - Available from 1998 to present
- Gladson Interactive's UPC-level nutrient database

Examples of the Epidemiological Approach

- Powell, Chriqui, and Chaloupka (2009): 1997-2006 Monitoring the Future surveys; no significant effect of tax on adolescent BMI.

- Fletcher, Frisvold, and Tefft (2009): 1990-2006 BRFSS; 1 percentage point increase in soft drink tax rate leads to a decline in BMI of 0.003 points.

- Fletcher, Frisvold, and Tefft. (2010): 1989-2006 NHANES; the moderate reduction in soda consumption caused by soda taxes is fully offset by increases in other caloric drinks.

Examples of the Consumer Demand Approach

- Finkelstein, Zhen, Nonnemaker, and Todd (2010): Nielsen 2006 Homescan; a 20% tax on store-sold SSBs would cause a decrease of 2,555 kcal/y per capita in beverage energy purchased.

- Dharmasena and Capps (2011): Nielsen 1998-2003 Homescan; the same 20% SSB tax would lead to 5,388 kcal/y per capita reduction in beverage energy.

- Lin, Smith, Lee, and Hall (2011): Nielsen 1998-2007 Homescan and 2003-2006 NHANES; a 20% tax on SSBs sold at stores and other away-from-home outlets would result in a 12,410 kcal/y per capita decline in beverage energy and 0.97 kg reduction in weight.

Addicted to Sugar-Sweetened Beverages?

The next 5 slides briefly review a study (Zhen, Wohlgenant, Karns and Kaufman, 2011, *AJAE*) examining the extent to which consumers develop habits over consumption of SSBs.

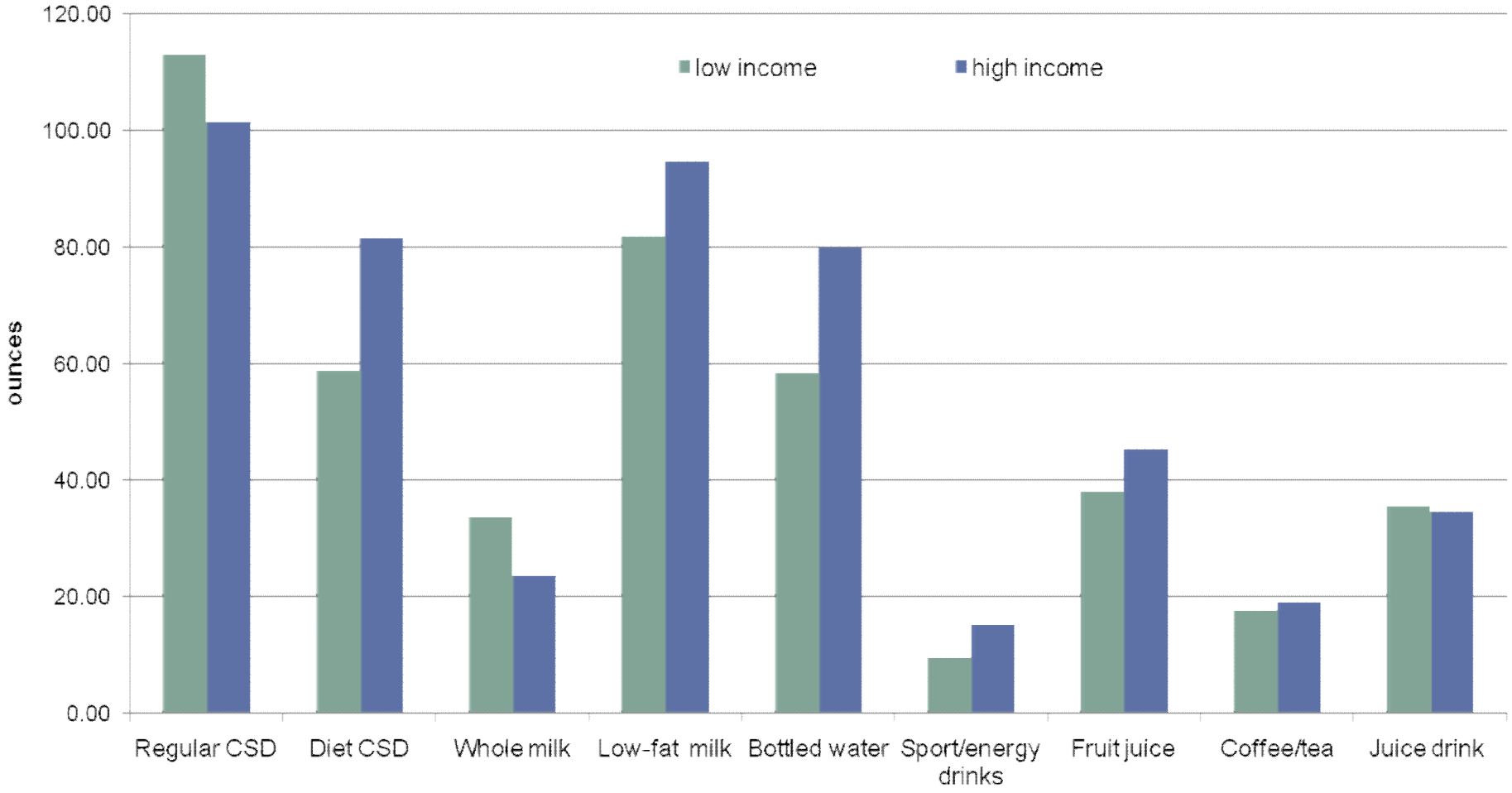
There are two main study objectives:

- Estimate and rank the degree of habits for 9 beverage categories.
- Examine whether there are important differences in beverage purchase behavior and the form of habit formation (i.e. rational vs. myopic) between low- and high-income households.

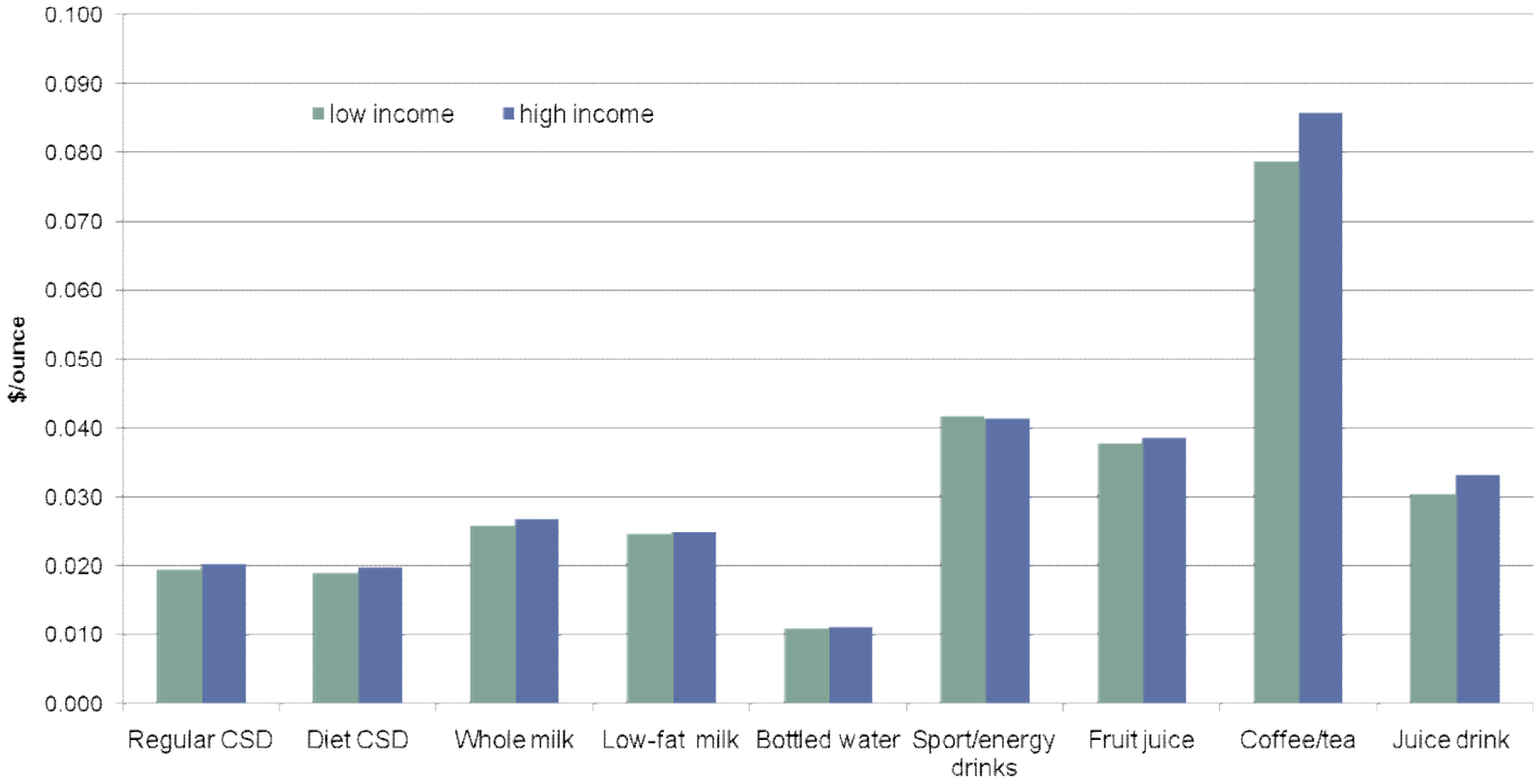
Household purchase data on 9 beverage categories come from:

- 2004-2006 Homescan in 25 largest Nielsen markets.

Per Capita Monthly Beverage Purchases by Category and Income Stratum



Unit Prices by Beverage Category and Income Stratum



The Demand Model: A Dynamic Almost Ideal Demand System

The basic concept is developed by Spinnewyn (1981)

Redefined quantity: $Z_{it} = \sum_{t=0}^{\infty} d_i^t q_{it-t} = q_{it} + d_i Z_{it-1}, \quad i = 1,...,9$

Utility-yielding service stock: $Z_{it}^* = Z_{it} - f_i Z_{it-1}$

Muellbauer and Pashardes (1992) applied it to the AIDS model:

$$w_{it}(\hat{p}_t, \hat{x}_t) = a_i + \sum_k g_{ik} \ln \hat{p}_{kt} + b_i [\ln \hat{x}_t - \ln a(\hat{p}_t)]$$

where $\hat{x}_t = \sum_{i=1}^{n} \hat{p}_{it} Z_{it}^*, \quad w_{it}(\hat{p}_t, \hat{x}_t) = \hat{p}_{it} Z_{it}^* / \hat{x}_t$,

For rational consumers: $\hat{p}_{it} = \frac{p_{it}(1 + r - d_i)}{1 + r - f_i}$; for myopic consumers $\hat{p}_{it} = p_{it}$

Comparing the Myopic with the Rational Habit Model

In-sample comparison:

	Log-likelihood		Vuong's LR test: rational vs. myopic
	Myopic	Rational	
Low income	−5076	−5077	−0.48
High income	−2021	−2015	7.01*

Out-of-sample comparison

	Mean squared forecast error		
	Static model	Myopic model	Rational model
Low income	6.49	5.36	5.33
High income	2.22	1.98	2.00

Estimated Degrees of Habits

	Myopic AIDS		Rational AIDS	
Category	Low income	High income	Low income	High income
Regular CSD	−0.42	−0.46	−0.37	−0.57
Diet CSD	−0.80	−0.67	−0.75	−0.66
Whole milk	−0.71	−0.62	−0.65	−0.62
Low-fat milk	−0.84	−0.76	−0.73	−0.73
Bottled water	−0.51	−0.53	−0.53	−0.47
Sports/energy drinks	−0.38	−0.47	−0.36	−0.46
Fruit juice	−0.65	−0.58	−0.62	−0.55
Coffee/tea	−0.45	−0.47	−0.38	−0.43
Juice drink	−0.43	−0.45	−0.67	−0.73

Note: The cumulative effect of lagged purchase measures the effect of a one-unit change in the purchase quantity on all future service stocks. A negative (positive) cumulative effect indicates habit persistence (durability).

Beyond Beverages: Predicting the Effects of Targeted Beverage Taxes on Other Foods

The next 6 slides provide an overview of an ongoing study (Zhen, Finkelstein, Nonnemaker, and Todd, 2011) funded by a grant from RWJF's Healthy Eating Research.

There are two main study objectives:

- Examine whether there are significant cross-price effects between sugar-sweetened beverages (SSBs) and other packaged foods.
- Simulate the effects of SSB taxes on quantities, energy and sodium levels purchased from 21 food categories.

The main data sources include:

- Household purchase data on 21 food categories from 2006 Homescan in 52 markets.
- Calorie and sodium information at the UPC level from Gladson supplemented with data from USDA's National Nutrient Database.

Quarterly Household-level Reported Purchases by Food Category and Income Stratum

	<130% poverty (N=3,472 HH)				>=130% poverty (N=25,112 HH)		
Categories	quantity (oz)	energy (kcal)	sodium (mg)		quantity (oz)	energy (kcal)	sodium (mg)
1. Regular soda	816	10,384	3,089		642	8,033	2,521
2. Sports/energy drinks	86	505	908		124	720	1,314
3. Whole/ reduced-fat milk	608	10,461	9,648		475	8,133	7,598
4. Skim milk	297	3,757	5,010		443	5,475	7,363
5. Cookies	61	8,253	5,907		58	7,758	5,728
6. Salty snacks	76	11,577	16,422		82	12,175	17,409
7. Frozen pizza	42	2,901	6,530		38	2,592	5,822
8. Fruit juice	279	4,150	430		341	5,043	501
9. Juice drinks	502	6,447	3,154		399	5,006	2,306
10. French fries	25	1,229	3,049		19	943	2,357
11. RTE cereals	91	9,610	13,593		98	10,173	13,976

Quarterly Household-level Reported Purchases by Food Category and Income Stratum (continued)

	<130% poverty (N=3,472 HH)				>=130% poverty (N=25,112 HH)		
Categories	quantity (oz)	energy (kcal)	sodium (mg)		quantity (oz)	energy (kcal)	sodium (mg)
12. Yogurt	57	1,339	917		81	1,835	1,278
13. Diet soda	515	1	1,901		634	1	2,323
14. Bottled water	476	28	115		600	44	190
15. Fruit-canned/dried	77	4,616	1,239		80	4,896	1,325
16. Vegetables-canned/dried	214	3,156	32,452		210	3,032	29,912
17. Frozen entrée	136	6,860	16,080		132	6,111	14,430
18. Canned soup	91	1,564	16,096		108	1,947	19,126
19. Candy	88	11,167	2,881		94	12,072	3,040
20. Ice cream	175	6,371	2,440		165	5,976	2,308
21. Sweet baked goods	76	7,916	7,564		70	6,890	7,039
Total	4,788	112,292	149,425		4,893	108,855	147,866

Unit Values by Food Category and Income Stratum

	Low income (<130% poverty level) N=3,472				High income (>=130% poverty level) N=25,112		
Categories	cents/oz	kcal/oz	mg/oz		cents/oz	kcal/oz	mg/oz
1. Regular soda	2.13	12.73	3.79		2.24	12.51	3.93
2. Sports/energy drinks	4.23	5.87	10.56		4.18	5.81	10.60
3. Whole/ reduced-fat milk	2.63	17.21	15.87		2.85	17.12	16.00
4. Skim milk	2.79	12.65	16.87		2.78	12.36	16.62
5. Cookies	15.51	135.30	96.84		18.80	133.76	98.76
6. Salty snacks	18.08	152.33	216.08		18.91	148.48	212.30
7. Frozen pizza	16.27	69.07	155.48		18.83	68.21	153.21
8. Fruit juice	4.01	14.87	1.54		4.26	14.79	1.47
9. Juice drinks	2.50	12.84	6.28		2.90	12.55	5.78
10. French fries	6.75	49.16	121.96		7.78	49.63	124.05
11. RTE cereals	15.47	105.60	149.37		16.42	103.81	142.61

Unit Values by Food Category and Income Stratum (continued)

	Low income (<130% poverty level) N=3,472				High income (>=130% poverty level) N=25,112		
Categories	cents/oz	kcal/oz	mg/oz		cents/oz	kcal/oz	mg/oz
12. Yogurt	8.34	23.49	16.09		8.72	22.65	15.78
13. Diet soda	2.12	0.00	3.69		2.14	0.00	3.66
14. Bottled water	1.55	0.06	0.24		1.50	0.07	0.32
15. Fruit-canned/dried	10.52	59.95	16.09		11.77	61.20	16.56
16. Vegetables-canned/dried	6.87	14.75	151.64		7.65	14.44	142.44
17. Frozen entrée	15.78	50.44	118.24		17.88	46.30	109.32
18. Canned soup	7.38	17.19	176.88		7.94	18.03	177.09
19. Candy	21.83	126.90	32.74		23.00	128.43	32.34
20. Ice cream	5.58	36.41	13.94		6.23	36.22	13.99
21. Sweet baked goods	15.44	104.16	99.53		17.14	98.43	100.56

The Demand Model: The EASI Demand System Applied to Censored Purchase Data

EASI (Lewbel and Pendakur, AER 2009) budget share equations:

$$w_i^* = \sum_{r=1}^{5} b_{ri} y^r + \sum_{l=1}^{L} g_{li} z_l + \sum_{j=1}^{J} a_{ij} \ln p_j + e_i \qquad i = 1,\ldots, J(=21)$$

$$y = \ln x - \sum_{j=1}^{J} w_j \ln p_j \quad w_i^* \qquad w_i$$

where , and are latent and observed budget shares.

Econ$w_i$ometric issues:

1. y is censored at$p_j$zero. e_i
2. , and possibly , are correlated with the error term .
3. Curse of dimensionality on large flexible demand systems.

Simulated Effects of a 0.5 cent/oz SSB Tax On Levels of Energy and Sodium Purchased

	Demand Specification I (w/o price instruments)	Demand Specification II (w price instruments)
SSB energy (kcal/quarter)	↓2,770 18.5 cans of Coke	↓2,121 14 cans of Coke
Overall energy (kcal/quarter)	↓2,703 18 cans of Coke	↓1,724 11.5 cans of Coke
SSB sodium (mg/quarter)	↓1,059 93 Lay's® Classic chips	↓836 74 Lay's® Classic chips
Overall sodium (mg/quarter)	↓90 8 Lay's® Classic chips	↑4,437 392 Lay's® Classic chips

Note: reported values are medians.

Conclusion

- A large targeted beverage tax is likely to reduce beverage energy intake, although the extent of the predicted reduction varies across studies.
- There is insufficient evidence to definitely predict whether such taxes would result in net reduction in energy intake or such taxes might have unintended effects on obesity and nutrition. More research is needed.
- Existing economic research indicates that consumers form habits over various beverage products, but the degree of habits is not strong enough to suggest addictive behavior at the population level.
- More research is needed to analyze food companies' pricing and advertising strategies in order to predict what would happen to the food environment (both price and non-price aspects) if a large beverage tax is passed.
- Finally, without a large beverage tax being actually passed, researchers can only speculate the likely effects of such taxes.

Thanks for your time. Questions and Suggestions?