

Estimation of the impact of a tax on sweeteners and final products

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Motivation

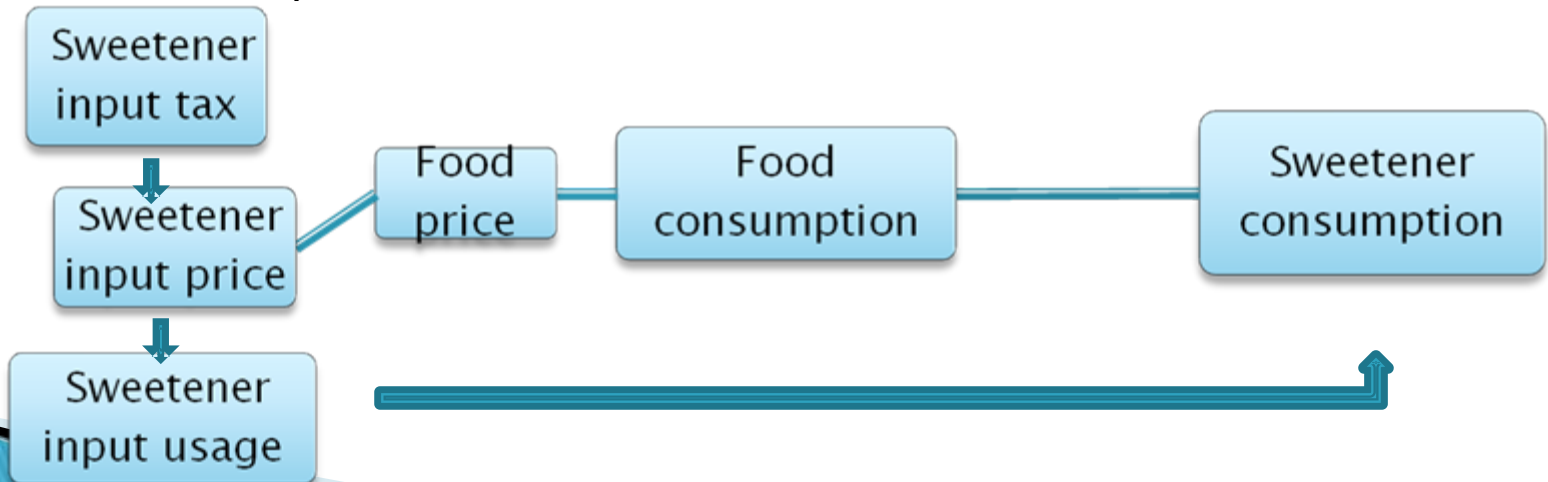
- ▶ High rates of obesity and overweight
 - 62% of Adults (age 20–74) are overweight/obese
- ▶ Contributors to increased calories (1970–2003):
 - Fats and oils (216 calories)
 - Refined grains (188 calories)
 - All sweeteners (76 calories)
 - (Farah and Buzby, 2005)
- ▶ Recent proposals
 - Tax snack foods or fat/content
 - Tax soft drinks

Policy Mechanisms

- ▶ Sweet tax on the consumption level



- ▶ Sweet tax on the production level



Policy Mechanisms

- ▶ A sweet tax applied at two levels: consumption or production (input) level
- ▶ Approach
 - ▶ Set added sweetener consumption as the policy target and minimize the associated welfare loss
 - ▶ Estimate the effect on consumption and changes in welfare
- ▶ Findings
 - Both tax approaches can be effective but are regressive
 - Effects are “small” in magnitude
 - An input tax causes less welfare loss to consumers than a consumption tax

Model

- ▶ Added sweeteners market
 - Assume an infinite supply in the added sweeteners markets
 - added sweeteners' prices remain constant
- ▶ Sweetener-intensive foods market
 - Producers and food processors: Supply of sweetener-intensive foods
 - Consumers: Demand for the sweetener-intensive foods
 - Jointly estimate supply and demand to evaluate consumer welfare changes

Producers' Side

- ▶ Assumptions: changes in production cost are fully transmitted to the consumer level as under perfect competition
- ▶ Marginal cost change is proportional to the input prices' change
- ▶ The price setting for the final product in each industry is set with constant markup coefficient θ
- ▶ So
$$d(\ln P) = d\left(\ln \frac{MC}{1-\theta}\right) = d(\ln MC) - d \ln(1-\theta) = d(\ln MC) = \sum_k s_k d \ln w_k$$
- ▶ Where s_k is the cost share of input k and w_k is the input prices

Producers' Side

- ▶ The input price of sweetener changes due to tax is

$$d \ln w_k = \frac{dw_k}{w_k} = dt_k = t_k$$

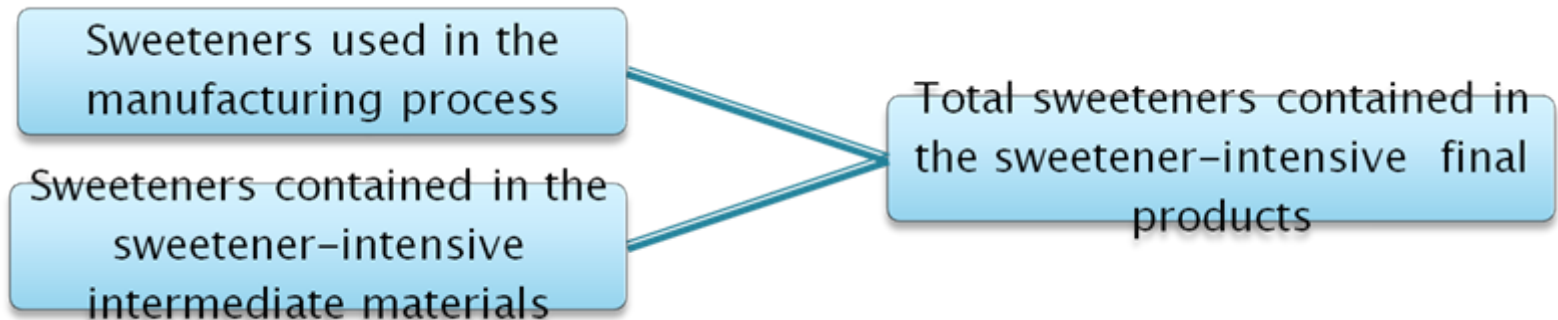
- ▶ Higher prices for some sweeteners cause substitution among sweeteners and raise the production cost of sweetener-intensive food
- ▶ Price of final good increases by the share weighted % change in input prices

Consumers' Side and Welfare

- ▶ The LinQuad incomplete demand system to derive consumer demand equations and welfare evaluations
- ▶ Food demand, own-, cross-price elasticities
 - All households
 - Disaggregated households, weighted to sum to total
- ▶ Evaluate welfare change with tax imposed on
 - Final good
 - Input factor
- ▶ Estimate equivalent variation (EV) as welfare change

Data and Calibration: Production of Sweetener-Intensive Foods

- ▶ Cost share of sweeteners in the food production as share of the materials consumed by each industry (2002 data)
 - Economic Census Industry Series Report (U.S. Dept of Commerce)
- ▶ Account for inputs from materials of some industries used as intermediate inputs by other industries (for high sweetener use materials)



Categories of the Sweeteners in the U.S. Food Manufacturing Industry

Sweeteners Group	Material code	Materials consumed
Sugars	31131001	Sugar, cane and beet (sugar solids)
	31131005	Sugar, cane and beet (sugar solids), excluding brown
	31131009	Brown sugar, cane and beet (sugar solids)
	31131100	Raw cane sugar (converted to 96 percent basis)
	11193000	Sugar cane
	11199100	Sugar beets
Corn sweeteners	31122101	Corn syrup
	31122103	High fructose corn syrup (HFCS) (solids)
	31122105	Fructose corn syrup (50 percent or less) (solids)
	31122107	Fructose corn syrup (50 percent or more) (solids)
	31122111	Glucose syrup (corn syrup), conventional and regular (solids)
	31122117	Crystalline fructose (dry fructose)
	31122119	Dextrose and corn syrup, including corn syrup solids (dry weight)
Other sweeteners	31100003	Other natural sweeteners
Artificial sweeteners	32510053	Sugar substitutes (mannitol, sorbitol, etc.)
	32510057	Artificial sweeteners (solids)

Cost Shares of Sweeteners in Nine Target Sweetener-Intensive U.S. Food Manufacturing Industry

Food	Cost Shares of Sweeteners (%)				
	Sugars	Corn Sweeteners	Other	Artificial	Total
Milk	0.5	0.7	0.0	0.0	1.2
Cheese	0.0	0.1	0.0	0.0	0.1
Ice cream / yogurt	1.1	1.0	0.0	0.0	2.2
Breakfast cereal / Bakery	1.9	0.4	0.3	0.0	2.6
Soft drink	0.2	3.4	0.1	0.1	3.8
Juice	0.2	0.7	0.0	0.0	0.9
Sweetener products	10.8	1.0	0.1	0.5	12.4
Processed fruits/vegs	0.2	0.8	0.0	0.0	1.0
Condiments / Spices	0.3	0.2	0.3	0.0	0.8

Consumption Data

- ▶ Calibrated the 2002 Economic Census Industry Series Reports (Manufacturing) value of shipments to consumption
- ▶ Ratio of adjustment: ratio of food disappearance data to the production data
 - Food availability dataset (USDA/ERS, 2008)
- ▶ This adjustment ratio also used to convert the sweeteners usage in the manufacturing sector to the sweeteners consumption

Demand parameters

- ▶ Income elasticity and price elasticity
 - The USDA/ERS Commodity & Food Elasticity Database
 - Chouinard, Davis, LaFrance, and Perloff (2009)
- ▶ Income
 - 2002 Consumer Expenditure Survey, BLS
- ▶ Price
 - All the final food prices are initially set at \$1 per unit.

Results:

Simulation and welfare evaluation

- ▶ Consumption tax and input tax designed to reach the same target of
 - reduce quantity of all sweeteners by 10%
 - minimize the associated market welfare loss to all households

- ▶ We simulate four types of policy shocks
 - a tax on the price of final products
 - a tax on the price of caloric sweeteners
 - a tax on the price of all sweeteners
 - tax on the price of individual sweeteners

Results

- ▶ Per capita consumption is highest ($> \$100$) on breakfast cereal/bakery; soft drinks; condiments; and milk/milk products
- ▶ Ad valorem tax on final products
 - 39% tax on sweetener products with 20% reduction in consumption
- ▶ Tax on caloric sweetener inputs
 - Sugars at 27%
 - Corn sweetener at 43%
 - Increase of final good price of less than 1%
 - Highest final good price increase (1%) on soft drinks


Real Expenditure Changes and Welfare Losses for Nine Sweetener-Intensive Foods

	All households	Households by quintiles				
		Lowest 20%	Second 20%	Third 20%	Fourth 20%	Highest 20%
Tax on the price of Final Products						
Real expenditure change (%)	1.9	0.5	1.1	1.8	2.2	2.7
Per capita EV (dollars)	-31.0	-29.0	-27.4	-30.1	-31.2	-35.0
EV/Income (%)	0.2	0.6	0.3	0.2	0.12	0.1
Tax on the price of Caloric Sweeteners						
Real expenditure change (%)	0.3	0.	0.2	0.3	0.3	0.4
Per capita EV (dollars)	-6.0	-5.9	-5.5	-5.7	-6.0	-6.5
EV/Income (%)	0.0	0.1	0.1	0.0	0.0	0.0

Summary


- ▶ To reach a target 10% reduction of sugar equivalent sweeteners
 - Change in welfare (EV) as % of income is “small” ($<0.2\%$)
 - Average loss in welfare is
 - \$6 per capita with tax on sweetener inputs
 - \$31 per capita with tax on final products
 - Lowest income group has higher share of income loss
 - Tax on Caloric Sweeteners leads to large decreases in consumption of “Sweetener products” and “Soft drinks”

Limitations and Extensions

- ▶ Ignore longer run health benefits derived from reduced sweetener consumption
 - Overstate the loss in welfare and the regressive nature of the tax
 - ▶ Don't account for substitution between the added sugar and fat component, or sector-specific effects
 - ▶ Don't account for difference between food at home and food away from home
 - ▶ Only demographic variable is income
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Thank you! Questions?

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Per Capita Income and Food Expenditure Distribution among Nine Sweetener-Intensive Foods (Dollars)

	Quintiles of income					
	All households	Lowest 20%	Second 20%	Third 20%	Fourth 20%	Highest 20%
Population (billion)	0.28	0.04	0.05	0.06	0.06	0.07
Average annual income after taxes	18773.60	4857.46	9406.96	14214.37	20019.16	35049.03
Annual food expenditure (per capita)	726.13	702.63	679	691.40	731.25	793.57
Milk	100.44	104.98	107.31	95.18	99.59	98.18
Cheese	65.55	60.44	56.54	62.73	66.77	75.57
Ice cream / yogurt	27.39	25.26	23.62	26.21	27.90	31.58
Breakfast cereal / Bakery	149.78	150.03	141.06	138.98	148.90	164.84
Soft drink	118.41	114.12	109.23	112.87	120.07	129.86
Juice	42.96	41.98	40.55	40.33	42.70	47.40
Sweetener products	87.56	86.58	79.50	85.20	87.20	95.78
Processed fruits and vegetables	29.39	28.84	27.74	28.36	29.48	31.53
Condiments / Spices	104.65	90.40	93.45	101.54	108.64	118.83
Sweeteners						
All Sweeteners (sugar equivalent)	105.69	103.83	97.85	101.28	105.85	115.37
Sugars	61.90	61.21	56.96	59.54	61.73	67.67
Corn Sweeteners	54.81	53.41	51.24	52.26	55.22	59.63
Other Sweeteners	2.86	2.72	2.63	2.71	2.89	3.17
Artificial Sweeteners	0.54	0.53	0.49	0.52	0.54	0.59