

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

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Motivation

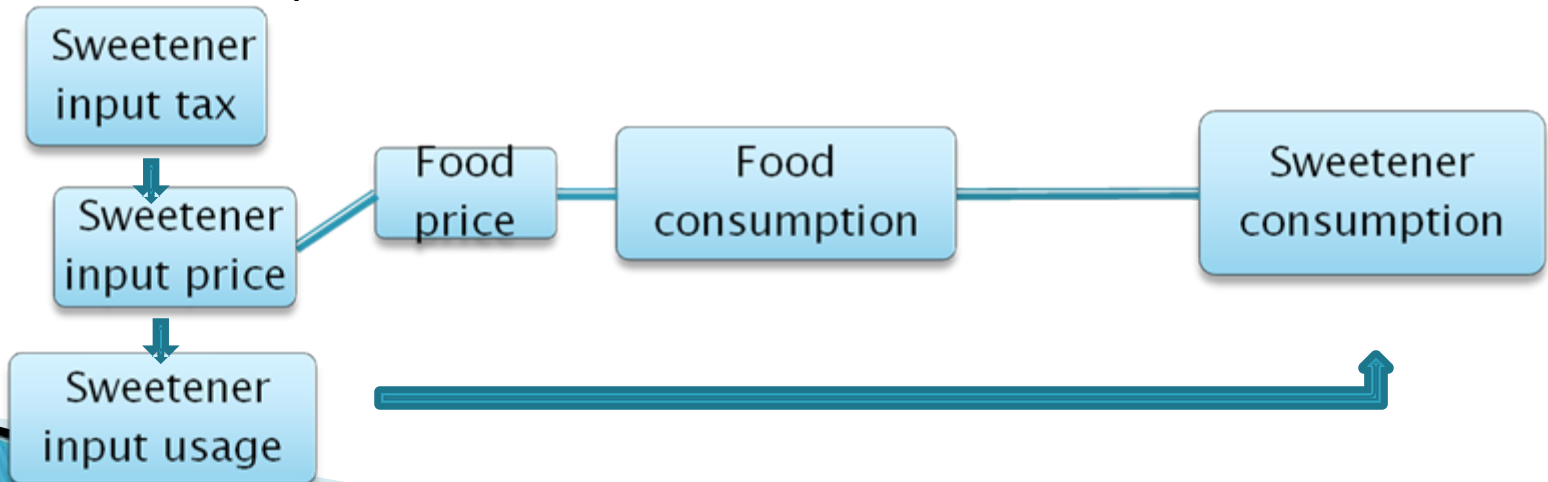
- ▶ High rates of obesity and overweight
 - 62% of Adults (age 20–74) are overweight/obese
- ▶ Contributors to increased calories (1970–2003):
 - Fats and oils (216 calories)
 - Refined grains (188 calories)
 - All sweeteners (76 calories)
 - (Farah and Buzby, 2005)
- ▶ Recent proposals
 - Tax snack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

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

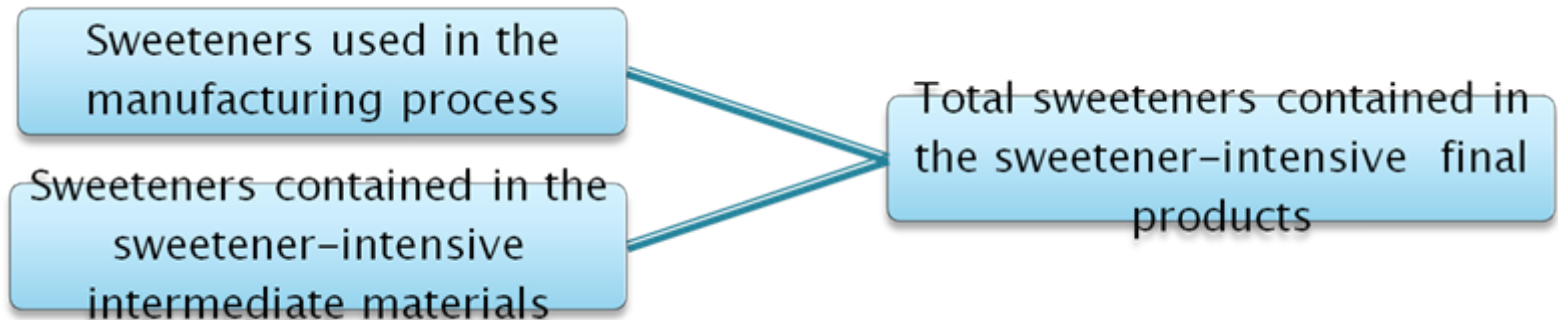
- ▶ Higher prices for some sweeteners cause substitution among sweeteners and raise the production cost of sweetener-intensive food
- ▶ Price of final good increases by the share weighted % change in input prices

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 |