

*Can “Easy” State Level Policies Influence
Children's Weight?
Evidence Using Soft Drink Taxes and
Vending Machine Bans*

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Big Picture

- Many potential policy interventions aimed at affecting population weight require large commitments of time and money
 - Changing the built environment
 - Scaling up behavioral or medical interventions
 - Informational campaigns
- Are there other sets of policies that might be “cheap and easy” to implement?
 - State taxation of certain foods/drinks
 - Vending machine bans in schools
- Timely policy question

Focus on Soft Drink Consumption

- Potential major factor in recent growth in obesity
 - Per capita soft-drink consumption has increased by 500% over 50 years
 - Currently, single largest contributor of energy intake (7%)

Soft Drink Consumption

- Could small decreases in consumption work?
- Evidence that affecting energy balances by only 100 calories per day (<1 can) could prevent weight gain in 90% of population (Hill et al. 2003)
- Demonstration that one extra sugary drink per day over 1.5 years increased odds of obesity in children by 60% (Ludwig et al. 2001)

Taxation

- “Sin Taxes”
- Standard economic theory predicts reduction in consumption
- More than 1/2 of states tax soft drinks
 - Extend Jacobson and Brownell (2000) data
 - Use “incremental” rates
- Issues
 - Small tax rates (~3%-5%)
 - May not be known to consumers (hidden)
 - Somewhat untargeted: often applies to diet soft drinks as well as healthy alternatives
 - Equity issue: regressive
- Timely
 - Maine recently discussed enactment (April 2008)
 - New York “obesity tax”

Evidence for Adults

- Fletcher, Frisvold, and Tefft (2008)
 - BRFSS data on adults
 - Big samples, most states, 15+ years
 - Use within-state variation over time
 - 25+ states have taxes, 20 change taxes over time period
 - Short term effect estimates
 - Findings
 - Small/moderate effects

$$bmi_{ist} = \beta_0 + \beta_1 X_{ist} + \beta_2 (Tax_{st}) + \tau_t + \mu_s + \varepsilon_{ist}$$

Example of State Tax Variation

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|----------------|-------|-------|-------|-------|-------|-------|
| Alabama | 4 | 4 | 4 | 4 | 4 | 4 |
| Arkansas | 4.625 | 4.625 | 5.125 | 5.125 | 5.781 | 6 |
| California | 7.25 | 7.188 | 7.25 | 7.25 | 7.25 | 7.25 |
| Connecticut | 6 | 6 | 6 | 6 | 6 | 6 |
| Idaho | 5 | 5 | 5 | 5 | 6 | 5.5 |
| Illinois | 7.25 | 7.25 | 7.25 | 7.25 | 7.25 | 7.25 |
| Indiana | 5 | 5 | 6 | 6 | 6 | 6 |
| Kansas | 4.9 | 4.9 | 5.1 | 5.1 | 5.3 | 5.3 |
| Louisiana | 3 | 3 | 3 | 2 | 0 | 0 |
| Maine | 5 | 5 | 5 | 5 | 5 | 5 |
| Minnesota | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 |
| Missouri | 1.125 | 1.125 | 1.125 | 1.125 | 1.125 | 1.125 |
| New York | 4 | 4 | 4.125 | 4.125 | 4.25 | 4.125 |
| North Carolina | 4 | 4 | 4.5 | 4.5 | 4.5 | 4.5 |
| Ohio | 5 | 5 | 5.5 | 5.5 | 6 | 5.75 |
| Oklahoma | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Tennessee | 7.9 | 7.9 | 8.9 | 8.9 | 8.9 | 8.9 |
| Texas | 6.25 | 6.25 | 6.25 | 6.25 | 6.25 | 6.25 |
| Utah | 4.75 | 4.75 | 4.75 | 4.75 | 4.75 | 4.75 |
| Virginia | 3 | 3 | 4 | 4 | 4 | 2.75 |
| Washington | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 |
| Wisconsin | 5 | 5 | 5 | 5 | 5 | 5 |
| Wyoming | 4 | 4 | 4 | 4 | 4 | 4 |

Adult Results

Table 2: The Impact of Soft Drink Taxes on BMI, Obese, and Overweight

| | BMI | BMI | Obese | Obese | Overweight | Overweight |
|---------------------------------|------------------------|------------------------|----------------------|----------------------|----------------------|----------------------|
| Total Soft Drink Tax Rate | -0.0029*** [0.0007] | | -0.0001 [0.0000] | | -0.0001 [0.0001] | |
| Incremental Soft Drink Tax Rate | | -0.0030*** [0.0007] | | -0.0001 [0.0001] | | 0.000 [0.0001] |
| Male | 0.571*** [0.046] | 0.571*** [0.046] | -0.014*** [0.003] | -0.014*** [0.003] | 0.136*** [0.004] | 0.136*** [0.004] |
| Age | 0.309*** [0.004] | 0.309*** [0.004] | 0.016*** [0.000] | 0.016*** [0.000] | 0.027*** [0.000] | 0.027*** [0.000] |
| Age Squared | -0.003*** [0.000] | -0.003*** [0.000] | -0.000*** [0.000] | -0.000*** [0.000] | -0.000*** [0.000] | -0.000*** [0.000] |
| Black | 1.852*** [0.076] | 1.852*** [0.076] | 0.113*** [0.005] | 0.113*** [0.005] | 0.138*** [0.005] | 0.138*** [0.005] |
| Hispanic | 1.085*** [0.158] | 1.085*** [0.158] | 0.058*** [0.010] | 0.058*** [0.010] | 0.108*** [0.016] | 0.108*** [0.016] |
| Observations | 1353719 | 1353719 | 1353719 | 1353719 | 1353719 | 1353719 |
| R-squared | 0.08 | 0.08 | 0.04 | 0.04 | 0.08 | 0.08 |

Notes: Heteroskedasticity-robust standards errors in parentheses that allow for clustering within states. Additional variables include state, year, and quarter fixed effects and state-specific time trends. Observations are weighted using the BRFSS survey weights in all regressions.

* significant at 10%; ** significant at 5%; *** significant at 1%

Limitations

- Small changes in taxes
 - What would happen with “big” changes?
 - New York’s proposal of 16-18%
 - Maine’s 20% proposal (repealed)
- Estimates of short run effects
 - Though we find no long term effects in other specifications
- “Black box” effects

Evidence for Children

- ECLS-K, 5th Grade Wave
 - Nationally representative sample of Kindergarteners (1998/9) followed through 8th grade
 - Information on state of residence, soft drink consumption and weight

ECLS-K Descriptive Statistics

| Variable | Mean | Std Dev | Min | Max |
|---------------------------------------|-------|---------|-----|-----|
| Any Soda (Last Week) | 0.84 | 0.36 | 0 | 1 |
| Number of Sodas (Last Week) | 4.25 | 5.66 | 0 | 20 |
| Any Soda in School (Last Week) | 0.13 | 0.34 | 0 | 1 |
| Number of Sodas in School (Last Week) | 0.32 | 1.42 | 0 | 20 |
| BMI | 20.67 | 4.75 | 8 | 58 |
| BMI Z-score | 0.64 | 1.15 | -8 | 3 |
| Overweight | 0.40 | 0.49 | 0 | 1 |
| Obese | 0.22 | 0.41 | 0 | 1 |
| Days Exercise (Last Week) | 3.78 | 1.93 | 0 | 7 |
| Can Buy Soda at School | 0.38 | 0.49 | 0 | 1 |
| Vending Machine at School | 0.27 | 0.44 | 0 | 1 |
| State Ban on Vending Machine | 0.13 | 0.33 | 0 | 1 |
| Male | 0.52 | 0.49 | 0 | 1 |
| White | 0.57 | 0.49 | 0 | 1 |
| Black | 0.16 | 0.37 | 0 | 1 |
| Hispanic | 0.19 | 0.40 | 0 | 1 |
| Asian | 0.03 | 0.17 | 0 | 1 |
| Other Race | 0.04 | 0.21 | 0 | 1 |
| Maternal Education | 13.27 | 2.48 | 8 | 21 |
| Family Income | 6.04 | 4.85 | 0.5 | 20 |
| Married Household | 0.62 | 0.49 | 0 | 1 |
| Rural Status | 0.21 | 0.40 | 0 | 1 |

Results for 5th Grade Children

| Outcome | # Sodas | # Sodas | Any Soda | Any Soda |
|----------------------|----------------------|----------------------|---------------------|---------------------|
| Specification | OLS | OLS | OLS | OLS |
| Xs | Ind/Sch | Ind/Sch/State | Ind/Sch | Ind/Sch/State |
| Tax Rate | -0.088*** (0.032) | -0.053 (0.039) | -0.002 (0.001) | 0.001 (0.002) |
| Male | 0.950*** (0.149) | 0.939*** (0.148) | 0.016** (0.007) | 0.015** (0.007) |
| Child Age | 0.718*** (0.178) | 0.685*** (0.179) | 0.028*** (0.008) | 0.025*** (0.008) |
| Black | 0.331 (0.352) | 0.124 (0.359) | -0.034** (0.017) | -0.040** (0.017) |
| Hispanic | -0.091 (0.272) | -0.025 (0.276) | 0.000 (0.012) | 0.005 (0.012) |
| Maternal Education | -0.172*** (0.035) | -0.168*** (0.035) | 0.000 (0.002) | 0.000 (0.002) |
| Married Parents | -0.154 (0.194) | -0.145 (0.193) | 0.023** (0.010) | 0.023** (0.010) |
| School Mom Education | -0.178* (0.106) | -0.142 (0.109) | -0.003 (0.005) | -0.005 (0.005) |
| School % Married | -1.096** (0.527) | -0.953* (0.528) | 0.018 (0.024) | 0.019 (0.023) |
| State Income | | 0.033 (0.166) | | -0.014* (0.008) |
| State BMI | | 0.449* (0.249) | | 0.005 (0.012) |
| Constant | 4.674* (2.506) | -3.999 (7.857) | 0.570*** (0.117) | 0.170 (0.381) |
| Observations | 9679 | 9679 | 9679 | 9679 |
| R-squared | 0.027 | 0.030 | 0.006 | 0.008 |

Control Variables: Other Race, Income, Mom Employment Status, Number of Siblings, Maternal Age, Parent Health, State % Hispanic, State % Black, State Mom Ed, School Income, School % Other Race, School % Black, School % Hispanic, Public School, Urban/Rural

Limitations

- Small taxes
- Children
 - Single cross section of 5th graders

Ongoing Work on Taxation

- Restricted NHANES
 - Dietary recall module
 - Food and beverages consumed
 - Caloric intake, sugars
 - Measured height/weight
 - Children of all ages
 - Small samples
- Youth Risk Behavior Survey (YRBS)
 - Grades 9-12
 - Large samples
 - Self reported weight
 - Substitution of juice

2nd Topic: Vending Machine Bans

■ Background

- 2000, 25% of elementary schools sold soft drinks through vending machines
- Between 2000-2004, two states enacted bans for elementary schools (Arkansas and California)
- 2006, percentage of elementary schools with vending machines is 16%
- But...a host of other types of restrictions (hours, content, etc.) as well as points of access

Vending Machine Bans

■ Issues

■ Substitution Patterns

- School vs. home consumption

- What do kids drink instead of soda?

■ Multiple outlets for purchase (in and out of school)

■ Revenue for school

ECLS-K Descriptive Statistics

| Variable | Mean | Std Dev | Min | Max |
|---------------------------------------|-------|---------|-----|-----|
| Any Soda (Last Week) | 0.84 | 0.36 | 0 | 1 |
| Number of Sodas (Last Week) | 4.25 | 5.66 | 0 | 20 |
| Any Soda in School (Last Week) | 0.13 | 0.34 | 0 | 1 |
| Number of Sodas in School (Last Week) | 0.32 | 1.42 | 0 | 20 |
| BMI | 20.67 | 4.75 | 8 | 58 |
| BMI Z-score | 0.64 | 1.15 | -8 | 3 |
| Overweight | 0.40 | 0.49 | 0 | 1 |
| Obese | 0.22 | 0.41 | 0 | 1 |
| Days Exercise (Last Week) | 3.78 | 1.93 | 0 | 7 |
| Can Buy Soda at School | 0.38 | 0.49 | 0 | 1 |
| Vending Machine at School | 0.27 | 0.44 | 0 | 1 |
| State Ban on Vending Machine | 0.13 | 0.33 | 0 | 1 |
| Male | 0.52 | 0.49 | 0 | 1 |
| White | 0.57 | 0.49 | 0 | 1 |
| Black | 0.16 | 0.37 | 0 | 1 |
| Hispanic | 0.19 | 0.40 | 0 | 1 |
| Asian | 0.03 | 0.17 | 0 | 1 |
| Other Race | 0.04 | 0.21 | 0 | 1 |
| Maternal Education | 13.27 | 2.48 | 8 | 21 |
| Family Income | 6.04 | 4.85 | 0.5 | 20 |
| Married Household | 0.62 | 0.49 | 0 | 1 |
| Rural Status | 0.21 | 0.40 | 0 | 1 |

ECLS-K Descriptive Statistics (2)

| Variable | Vending Machines N~3,000 | | No Vending Machines N~7,600 | |
|---------------------------------------|-----------------------------|-----------|--------------------------------|-----------|
| | Mean | Std. Dev. | Mean | Std. Dev. |
| Any Soda (Last Week) | 0.86 | 0.35 | 0.84 | 0.37 |
| Number of Sodas (Last Week) | 4.11 | 5.39 | 4.35 | 5.77 |
| Any Soda in School (Last Week) | 0.26 | 0.44 | 0.08 | 0.28 |
| Number of Sodas in School (Last Week) | 0.59 | 1.81 | 0.22 | 1.22 |
| BMI | 20.95 | 4.99 | 20.61 | 4.68 |
| BMI (z-score) | 0.69 | 1.18 | 0.63 | 1.13 |
| Overweight | 0.41 | 0.49 | 0.40 | 0.49 |
| Obese | 0.23 | 0.42 | 0.21 | 0.41 |
| Days Exercised (Last Week) | 3.88 | 1.90 | 3.77 | 1.93 |
| Can Buy Soda at School | 0.70 | 0.46 | 0.27 | 0.44 |
| Vending Machine at School | 1.00 | 0.00 | 0.00 | 0.00 |
| Male | 0.54 | 0.50 | 0.52 | 0.50 |
| White | 0.60 | 0.49 | 0.56 | 0.50 |
| Black | 0.15 | 0.35 | 0.17 | 0.37 |
| Hispanic | 0.18 | 0.38 | 0.20 | 0.40 |
| Asian | 0.02 | 0.16 | 0.03 | 0.17 |
| Other Race | 0.04 | 0.20 | 0.04 | 0.20 |
| Maternal Education | 13.32 | 2.42 | 13.28 | 2.47 |
| Family Income (\$10,000s) | 6.14 | 4.96 | 6.00 | 4.82 |
| Married Household | 0.64 | 0.48 | 0.61 | 0.49 |
| Rural Status | 0.29 | 0.45 | 0.18 | 0.39 |

Predictors of Soda Consumption

| Outcome | All Soda | School Soda |
|--------------------|----------------------|---------------------|
| Obese (lag) | -0.171 (0.194) | 0.040 (0.051) |
| Overweight (lag) | -0.105 (0.155) | -0.044 (0.041) |
| Male | 0.706*** (0.113) | 0.025 (0.031) |
| Age | 0.521*** (0.132) | 0.070** (0.035) |
| Black | 0.232 (0.261) | 0.371*** (0.101) |
| Hispanic | -0.086 (0.207) | 0.014 (0.044) |
| Family Income | -0.022 (0.016) | 0.001 (0.003) |
| Maternal Education | -0.131*** (0.026) | -0.014** (0.007) |
| Married Family | -0.146 (0.144) | -0.075* (0.041) |
| Maternal Fulltime | 0.177 (0.148) | 0.038 (0.036) |
| Maternal Parttime | -0.040 (0.168) | 0.060 (0.045) |
| Parent Health | 0.159** (0.071) | 0.005 (0.017) |
| Rural | -0.095 (0.193) | 0.117* (0.070) |
| Urban | -0.290* (0.154) | -0.081** (0.041) |
| Public School | -0.166 (0.170) | -0.075 (0.053) |
| Observations | 9283 | 9283 |
| R-squared | 0.026 | 0.021 |

Effects of Soft Drink Consumption

Preliminary 2SLS Evidence

$$weight = \beta X + \delta soda + \varepsilon$$

$$soda = \alpha X + \lambda Bans + \nu$$

| Outcome | BMI | BMI | Overweight | Overweight | Obese | Obese |
|---------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Instrument | State Ban | State Ban | State Ban | State Ban | State | State |
| Specification | State Ban | State Xs | State Ban | State Xs | Ban | Ban |
| | | | | | State | State |
| | | | | | Xs | Ban |
| Any Soda at School | 4.601** (1.870) | 2.180 (1.484) | 0.186 (0.228) | -0.057 (0.206) | 0.249 (0.202) | 0.002 (0.172) |
| BMI Lag | 1.116*** (0.009) | 1.114*** (0.008) | | | | |
| Overweight Lag | | | 0.791*** (0.007) | 0.788*** (0.007) | | |
| Obese Lag | | | | | 0.816*** (0.009) | 0.815*** (0.008) |
| Any Soda Away from School | 1.170** (0.465) | 0.563 (0.372) | 0.053 (0.057) | -0.008 (0.052) | 0.058 (0.050) | -0.004 (0.043) |
| Constant | 0.524 (0.825) | 0.399 (2.140) | 0.251** (0.101) | 0.144 (0.304) | 0.200** (0.087) | -0.116 (0.230) |
| Observations | 9283 | 9283 | 9283 | 9283 | 9283 | 9283 |
| R-squared | 0.768 | 0.836 | 0.602 | 0.614 | 0.585 | 0.621 |
| F-Statistic | 11.971 | 9.987 | 11.959 | 9.966 | 11.975 | 10.000 |

Issue

- No Kids from Arkansas are in ECLS-K Data
 - So only able to compare California vs. US
- We will be using 8th grade wave to use new vending machine bans since 2004

Suggestive Evidence by Gender

$$weight = \beta X + \delta soda + \varepsilon$$

$$soda = \alpha X + \lambda Bans + \nu$$

| Outcome | BMI State | Overweight | Obese State | BMI State | Overweight | Obese State |
|---------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Instrument | Ban | State Ban | Ban | Ban | State Ban | Ban |
| Specification | State Xs | State Xs | State Xs | State Xs | State Xs | State Xs |
| Sample | Females | Females | Females | Males | Males | Males |
| Any Soda at School | 4.112* (2.496) | 0.061 (0.289) | 0.240 (0.268) | 0.516 (1.608) | -0.206 (0.289) | -0.201 (0.214) |
| BMI Lag | 1.111*** (0.012) | | | 1.116*** (0.010) | | |
| Overweight Lag | | 0.793*** (0.011) | | | 0.784*** (0.010) | |
| Obese Lag | | | 0.797*** (0.014) | | | 0.831*** (0.011) |
| Any Soda Away from School | 0.984 (0.610) | 0.018 (0.071) | 0.047 (0.065) | 0.199 (0.414) | -0.039 (0.074) | -0.047 (0.055) |
| Constant | 1.696 (3.465) | 0.313 (0.375) | 0.149 (0.340) | -1.635 (2.614) | -0.068 (0.440) | -0.460 (0.368) |
| Observations | 4593 | 4593 | 4593 | 4661 | 4661 | 4661 |
| R-squared | 0.782 | 0.620 | 0.576 | 0.861 | 0.598 | 0.607 |
| F-Statistic | 6.179 | 6.130 | 6.169 | 8.030 | 8.035 | 8.044 |

Heterogeneous Effects

| Sample | Coefficient | Std Error | P-Value |
|-----------------|-------------|-----------|---------|
| Males | | | |
| Quartile = 0.15 | 2.41 | 2.92 | 0.41 |
| Quartile = 0.25 | 1.71 | 3.91 | 0.66 |
| Quartile = 0.35 | 2.84 | 4.76 | 0.55 |
| Quartile = 0.50 | 4.87 | 7.15 | 0.50 |
| Quartile = 0.65 | 7.43 | 6.84 | 0.28 |
| Quartile = 0.75 | 8.24 | 7.47 | 0.27 |
| Quartile = 0.85 | 10.93 | 10.31 | 0.29 |
| Quartile = 0.95 | 13.12 | 17.70 | 0.46 |
| Females | | | |
| Quartile = 0.15 | 3.33 | 1.18 | 0.01 |
| Quartile = 0.25 | 3.08 | 1.53 | 0.05 |
| Quartile = 0.35 | 3.52 | 1.57 | 0.03 |
| Quartile = 0.50 | 5.19 | 2.31 | 0.03 |
| Quartile = 0.65 | 5.74 | 3.47 | 0.10 |
| Quartile = 0.75 | 7.58 | 5.30 | 0.15 |
| Quartile = 0.85 | 10.47 | 14.84 | 0.48 |
| Quartile = 0.95 | 15.60 | 18.69 | 0.40 |

Conclusions

- Examined effects of “easy” state policies to curb child obesity
 - Taxation
 - Vending machine bans
- Findings suggest that small changes in these policies may have no effect
 - Taxes are typically small and potentially unknown to consumers
 - Vending machine bans may not adequately shift soft drink consumption toward more healthy alternatives
- But, what about large changes in these policies?

Future Directions

- Ongoing work
 - NHANES, YRBS
- Second RJWF grant application
 - Taxation
 - Ohio as a case study
 - Largest soft drink tax increase in US history (59% in 1993-4)
 - Vending Bans
 - Incorporate data on recent restrictions
 - Junk Food
 - Taxes and bans