THE IMPACT OF SNAP PARTICIPATION ON SALES OF CARBONATED SODA

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Abstract

This study estimates the effect of SNAP participation on carbonated soda sales. Sugar-Sweetened Beverages (SSBs) are the largest source of added-sugar in the US and are one of the main reasons for rampant obesity in the county. To make matters worse, most SSBs are eligible for purchase with SNAP benefits which makes low-income household particularly vulnerable to obesity. I exploit variation arising from the Great Recession of 2008 to test whether participation induces households to increase carbonated soda consumption. In addition, I explore the role of state and county sales taxes on the relationship between SNAP and soda sales. Results show SNAP participation has a non-trivial positive effect on carbonated soda sales. However, sales taxes on soda do not exert any influence on this relationship.

I. Introduction

Sugar-Sweetened Beverages (SSBs) have been attributed as one of the main culprits that lead to obesity, especially among low-income households because SSBs are the largest source of calories and added-sugar in the US. Center for Disease Control and Prevention (CDC) reports that among adult men and women, and girls aged 2 to 19 years, the largest proportion of total daily calories consumed from SSBs is among households with income less than or equal to 130% of Federal Poverty Guidelines (FPG). The proportion consistently tapers off with higher income groups such that households with income over 350% of FPG consume the lowest proportion. In addition, non-Hispanic blacks and Hispanics consume the highest daily calories of SSBs on average relative to other races and Hispanic origin status (Rosinger *et al*., 2017). Trends in obesity rates are in consonance with trends in SSB consumption. Obesity is especially prevalent among low-income households as more than 33 percent of adults who earn less than $15,000 per year are classified as obese relative to about 25% of those who earn at least $50,000 per year (Levi *et al*., 2011). Similarly, non-Hispanic blacks have the highest rates of obesity compared to individuals of other races and Hispanic origin (Ogden *et al*., 2010).

Exacerbating the effect of obesity is the addictive nature of sugar as shown in recent studies. That is, individuals who regularly consume excessive sugar can develop a habit such that utility in future periods is a function of sugar consumption in previous periods. Zhen et al. (2011) show that households exhibit habit formation to SSBs such as carbonated soda, sports and energy drinks, fruit juices, etc. As a result, SSBs may have a long term effect on obesity and reducing consumption might be hindered by the habit forming properties of sugar.

Given the disproportionate prevalence of obesity and SSB consumption among disadvantaged socioeconomic groups, it is plausible that SNAP participation might be the facilitator of SSB consumption among low income households. Most SSBs (including carbonated soda beverages and sugar-sweetened fruit juices) are eligible for purchase with SNAP benefits. Moreover, SSBs are less costly when purchased with SNAP benefits relative to cash because, in general, SNAP exempts all purchases from state and county sales taxes. SNAP benefits may be even less fungible with cash in states that impose a grocery tax on food and/or a sugar tax on SSBs. As a result, SNAP participants face a lower price of SSBs relative to non-participants to the extent that benefits are utilized. It is important to note that the tax exemption does not apply to cash purchases made by SNAP participants. Therefore, SNAP only partially offsets the cost of purchasing SSB products.

The results of this study show that SNAP participation leads to an increase in SSB consumption. While the benefit transfer is meant to target food insecurity and encourage healthy eating, including carbonated soda in the list of eligible products negates that goal. If SNAP beneficiaries use their extra benefits for consumption of unhealthy calories, it not only defeats the purpose of making low-income households food insecure but it also exacerbates the obesity epidemic that is already quite severe. The results of this study also show that sales taxes on soda do not influence the relationship between SNAP participation and soda sales. In other words, eliminating the tax exemption on soda might not have a tangible impact on soda consumption.

The rest of the paper is organized in the following way: Section II provides a short review of literature, section II discusses research design, section IV gives an overview of data, section V presents the empirical model, and section VI explains results and policy implications. Finally, section VII concludes and is followed by an appendix of tables and figures in section VIII.

II. Literature Review

Recent literature in economics and public health has looked into household demand for macronutrients such as carbohydrates (including sugar) and protein (Bray and Popkin, 1998; Richards *et al*., 2007; Bruijn *et al.*, 2008). In addition, researchers have shown evidence of changes in Food At Home (FAH) and Food Away From Home (FAFH) resulting from participation in SNAP (Hoynes and Schanzenbach, 2009; Beatty and Tuttle, 2015). However, only a handful of studies examine the link between SNAP and SSB consumption. Those that do show only mixed evidence of whether this relationship exists. Some studies depict a positive relationship (Andreyeva *et al.*, 2012; Bleich *et al.*, 2013; Leung *et al.*, 2012; Nguyen *et al.*, 2014; Watt *et al.*, 2013) while others show no effect (Todd and Ver Ploeg, 2014; Fernandes, 2012). Of the studies mentioned, only one study (Andreyeva *et al.*) considers grocery store sales of SSBs as a measure of consumption. However, Andreyeva *et al.* include only SNAP participants with a history of WIC participation and only one grocery store chain in the New England area in their sample. This study adds to literature by considering the impact of SNAP participation on retail sales of SSBs using a nationally representative sample generated from a large store-level scanner dataset, and by employing a novel source of variation to identify the causal impact of SNAP participation on retail SSB sales.

III. Research Design

I exploit state-level variation arising from the Great Recession of 2008 to identify the effect of SNAP participation on carbonated soda consumption. The occurrence of the recession caused changes in SNAP caseloads due to two major reasons. First, household income fell sharply due to which households that were previously ineligible for benefits qualified for SNAP. Second,

there was considerable variation in how states reacted to the economic downturn. States that were traditionally more lenient towards participation in SNAP readily adopted a series of policies that eased the eligibility criteria. States that have historically been more conservative in regards to SNAP participation had a more restrained response in terms of SNAP participation. As a result, changes in SNAP caseloads happened at drastically different rates in each group. This study relies on the second source of state-level variation in SNAP caseloads and explicitly removes the confounding effect of the first source.

A. Factor Analysis

I hypothesize that an underlying common factor explains state adoption of policies to ease eligibility. These policies include a range of options that either directly eliminate hurdles to eligibility (for example, broad-based categorical eligibility, removal of vehicle restriction in the asset test, and extending participation to include noncitizen immigrants) or simplify the administrative process of participation (for example, use of biometric technology for identification, accepting online applications, and adoption of simplified reporting). I identify a measure of "willingness" using factor analysis that determines each state's readiness to ease eligibility and I construct an index to rank states based on their willingness score. States high on the scale are those that were more open to implementing these policies while states low on the scale are those that largely refused to adopt the same policies after the start of the Great Recession. Therefore, willing states represent the treatment group and unwilling states comprise the control group in this analysis.

The results of the factor analysis delineate several factors that explain policy adoption, however, only the first two factors have an eigenvalue greater than 1. In addition, the first factor

explains an overwhelming amount, about 53%, of variation in state-level policy adoption while the second factor explains only about 34%. These results indicate that while there may be multiple factors that influence state level policy adoption, the majority of the variation is explained by one factor. I term this factor "willingness" and disregard the rest of the factors. Note that by assumption the factors obtained from factor analysis are orthogonal to each other. That is, the second factor explains residual variation in policy adoption after accounting for the first factor and is therefore uncorrelated with willingness. It is also important to note that the willingness factor might represent other state characteristics that might influence its readiness to adopt these policies. However, this does not pose an issue for the research design as long as other characteristics are not correlated with carbonated soda consumption except through changes in SNAP participation. To the best of my knowledge, literature does not identify any such characteristic and therefore we can safely rely on the first factor for ranking. Factor analysis is conducted separately for years 2007 and 2008. It is important to compare pre-recession and post-recession results as willingness might change with the occurrence of the recession. In other words, states that experienced a more severe economic downturn may become more willing relative to the prerecession period. However, the results do not vary drastically between factor analyses conducted for the two years. Most states retain their relative ranking on the index.

Figure 1 shows a map of states included in the analysis categorized by their ranking on the willingness index. I choose an arbitrary threshold on the index that roughly equally divides the states into two cohorts. States above the threshold are classified as treatment states and those below are classified as control states. With some clear exceptions (such as Texas and Tennessee), the 2008 willingness map aligns well with each state's political majority in the 2008 presidential election. Not surprisingly, most states in the Midwest and South that were characterized as

having a conservative majority in 2008 also rank low on the willingness index. Similarly, most coastal states (especially those in the New England region) had a liberal majority in 2008 and ranked high on the willingness index. Table 1 shows growth rates of SNAP participation and soda sales for each cohort. The treatment group comprises of 24 states and the control group comprises of 24 states and the District of Columbia.

B. Difference-In-Difference

I use a Difference In Difference (DID) model to determine the causal effect of SNAP participation on carbonated soda consumption. Based on ranking of the willingness index, each state is assigned to either the treatment or the control group. Intuitively, the treatment group is likely to exhibit a greater increase in SNAP participation following the economic downtown in 2008 because it had a more relaxed eligibility criteria relative to the control group. Therefore, the difference in the carbonated soda consumption of the treatment group and the control group can be attributed to SNAP participation.

The validity of the DID research design is contingent on whether the parallel trends assumption is satisfied. That is, to obtain unbiased estimates we must ensure that pre-treatment trends in SNAP participation and carbonated soda consumption are similar across the two cohorts. Figure 3 shows trends in aggregate SNAP participation in each group, indexed to the year 2008. As is clear from the figure, the two cohorts experienced very similar changes in total SNAP caseloads before the occurrence on the Great Recession of 2008. However, this trend is disturbed in 2008 as the recession causes SNAP participation to rise at a faster rate in the treatment group versus the control group. The divergence between the two groups widens steadily with time. In addition, I observe analogous trends in carbonated soda consumption in the

two cohorts. Figure 4 shows changes in weekly-aggregated carbonated soda consumption for states in the treatment and control groups indexed to the year 2008. Carbonated soda consumption moved in relative lockstep in the two cohorts prior to 2008 and is followed by a stark deviation after the advent of the economic downturn. The divergence in carbonated soda consumption corresponds with the divergence in participation in the two groups. This indicates that the parallel trends assumption is satisfied and lends credence to the DID research design.

The biggest strength of the DID methodology is that it allows us to control for selection on unobservables. There might exist unobservable differences between the treatment and control groups that confound the effect of SNAP participation on carbonated soda consumption. For example, households in the treatment group might have a higher preference for carbonated soda than households in the control group. Since preferences are unobservable it is nearly impossible to explicitly control for this effect by including them in the vector of explanatory variables. However, DID allows us to remove baseline differences such as household preference through the inclusion of state-specific fixed effects. Similarly, time-variant factors that may influence soda consumption but are similar across states can be removed with time-specific fixed effects.

A possible source of bias that is not directly accounted for in the DID model is the effect of income. It is likely that states experienced the consequences of the Great Recession of 2008 at different levels of severity. Some states might experience a sharp decline in median income at the immediate forefront of a recession while others may see a gradual and less severe economic downturn. As a result, to the extent that income influences store-level carbonated soda the estimates obtained from DID will be biased. I circumvent this issue by adding median county income as an explanatory variable in the empirical specification. This removes the confounding effect of income on carbonated soda consumption arising from the economic downturn. The

inclusion of income is expected to have a positive effect on the estimate of SNAP participation on soda sales because it removes downward bias on the coefficient.

IV. Data

Store-level data is obtained from Nielsen RetailScan, a large and nationally representative scanner-generated dataset that includes weekly information on pricing, volume, and store attributes. The dataset is available for years 2006 to 2015 and provides detailed information on product and store characteristics (including geography) for a litany of SSBs. Moreover, it covers 61 geographic areas (52 major markets and 9 Census Divisions) and includes SSB sales from grocery, drug, mass merchandiser, and other stores. It represents more than half of the total sales volume of grocery and drug stores and 30 percent of mass merchandiser sales volume. The level of detail afforded by the data and the years available make it ideal for estimating the model specified below.

Among SSBs, this study focuses on the sales of carbonated soda. This category represents the majority of SSB sales and is most often associated with high amounts of high fructose corn syrup. In addition, carbonated soda is readily available from a variety of outlets such as grocery stores, gas stations, convenience stores, and vending machines relative to other SSBs products such as sugar-sweetened fruit juices.

Sales tax data is collected from a variety of sources. Detailed state-level soda taxes for each sample year is obtained from Bridging the Gap research program (Bridging The Gap). This resource provides accurate tax information for each state including tax applied on food and soda and including tax exemptions. The soda tax is equal to the sum of the general state sales tax and additional soda specific tax that may be applied at the state or county level. It is equal to the state

sales tax only if no additional tax is levied on soda. While almost all states impose a non-zero sales tax (exceptions include Alaska, Delaware, Montana, New Hampshire, and Oregon), several states choose to exempt grocery food which may or may not include carbonated soda.

Counties may choose to impose additional taxes on food, called grocery taxes, which may include carbonated soda. In 2014, 16 states imposed grocery taxes at the state level, county level, or both. While only a handful of counties add a grocery tax to the state sales tax, most county level grocery taxes are imposed in southern states (as shown in Figure 2) where obesity seems to be especially prevalent. Due to lack of access to historical data, I use county-level grocery taxes for the year 2014. However, there is generally limited, if any, variation in county taxes over time. In addition, counties may choose to exempt carbonated soda from the grocery tax or exclude carbonated soda from the grocery tax exemption. This information is not available, therefore, I rely on the assumption that carbonated soda is treated the same as grocery food at the county level. I conduct a series of sensitivity checks to determine the strength of this assumption and find nearly identical estimates for the DID model.

Combined grocery tax data are obtained mainly from Tax-Rates.org, augmented with data from Sale-tax.com and state and county departments of taxation websites. There is considerable cross-sectional variation in combined state and county level taxes on grocery food. They ranged from 0% in most of the country to 9% (4% state plus 5% county) in Tuscaloosa County, Alabama in 2014. Moreover, the average grocery tax in counties that do not exempt groceries is about 4.2%. Figure 2 shows a map of combined state and county level soda taxes for the year 2014.

Table 2 provides summary statistics by cohort for the sample used in this model. From the table, weekly county-level soda sales are considerably higher and median income is slightly

higher in treatment counties relative to counties in control states. In addition, counties in the treatment group are substantially more populous than counties in the control group. Counties in the treatment states have an average population size that is about twice the population size of counties in the control states. It is not surprisingly that larger counties comprise the treatment group because they generally have a greater proportion of SNAP beneficiaries. They are also more likely to adopt policies to ease the eligibility criteria because they are more likely to have better access to administrative resources such as biometric technology and ability to accept online applications. Finally, soda taxes are somewhat similar in the two cohorts. Table 3 provides descriptive evidence for the influence of participation on soda sales. The third column shows the difference in average weekly county-level soda sales in the treatment and control states before and after the occurrence of the recession. While soda sales increased in both cohorts, treatment states experienced an increase of $4,483 while control states experienced an increase of $1,151. That is, stores in the treatment states experienced a change in soda sales of $3,331 higher than stores in the control states.

V. Empirical Model

The research design discussed above gives rise to the following Difference in Difference specification:

$$SodaSales_{isct} = \varphi Treat_s * Recession_t + \theta MedInc_{ct} + \rho Pop_{ct} + \tau Tax_{ct} + \mu_s + \partial_t + \varepsilon_{isct}$$

where the outcome variable represents weekly county-level sales of carbonated soda for store i located in state s and county c and observed in year t. The variable of interest is the interaction between the variables $Treat_s$ and $Recession_t$ and the coefficient φ determines the effect of treatment on sales of carbonated soda. The variable $Treat_s$ equals 1 if store i is located in a state

classified as treatment state according to the willingness index and equals 0 otherwise. The variable $Recession_t$ equals 1 if store i is observed at any time period after January 1, 2008 (the presumed start of the Great Recession) and equals zero otherwise. $MedInc_{ct}$ is a measure of county-level income and Pop_{ct} measures county population for each sample year. The two variables, $MedInc_{ct}$ and Pop_{ct}, are essential for unbiased estimation of the DID model because they control for channels other than SNAP participation through which the Great Recession may influence soda sales. Finally, Tax_{ct} represents combined state and county level soda tax, μ_s and ∂_t represent state and year level fixed effects, and ε_{isct} is the error term.

VI. Results and Discussion

The estimates from the DID model are shown in Table 4. Columns I and II of the table contain results from the model estimated using a full sample of county-week observations. Columns III, IV, and V show results from estimation conducted on a subsample of counties with median income less than $45,533, the average for counties in the full sample. Columns I through IV include results from models that use state and year level fixed effects while the results in column V include county and year-level fixed effects.

I start with a parsimonious model (column I) that includes income and population as covariates but not soda tax. The coefficient shows no effect of SNAP participation on soda sales. Column II includes soda tax as an additional explanatory variable. The magnitude and significant of the coefficient does not change much leading to the conclusion that soda tax has little to no effect on the relationship between SNAP participation and soda sales. The main shortcoming of the first two specifications is that they consider soda sales in all counties in the country. Because treatment occurs at the state-level, the effects of the recession on each county within a state

might be heterogeneous. To target counties that had the highest exposure to treatment, I restrict the sample to include only low-income counties. A county is defined as low-income if the median income in that county falls below the average median income of the full sample which is $45,533. While this is a somewhat arbitrary threshold, results are robust to different measures of low-income. Columns III, IV, and V show results from the model estimated on this restricted sample. As expected, the model in column III has a highly significant estimate of treatment on soda sales. SNAP participation leads to an increase of $1,355 in weekly county-level soda sales in treatment counties relative to control counties. The inclusion of soda tax attenuates the estimate towards zero and inflates the standard error leading to a lower level of statistical significance as shown in column IV. Column V adds county-level fixed effects instead of the state-level fixed effects used in previous specifications. This drastically inflates the standard errors of the estimate making it insignificant at the 10% confidence level. This provides evidence that county-level unobservable factors influence the effect of SNAP on soda sales. The full results for all specifications are given in Table 5.

The effect of income and population is worth noting. Income invariably exerts a downward bias on the estimates because treatment is defined as states that adopted policies to expand SNAP participation. These states likely experienced greater income declines from the recession than the rest of the country. Adding county-level median income removes the confounding effect of income and increases the magnitude of φ. Population, on the other hand, has the opposite effect. Controlling for county-level population changes leads to a sharp decline in the magnitude of the coefficient. This is expected because in times of economic hardships, low-income households may migrate to states that provide more generous welfare benefits relative to their current state of residence. While mobility of low-income households is restricted,

several Metropolitan Statistical Areas (MSAs) in the US span multiple states. Within-MSA interstate migration is comparably simple and economical. As a result, aggregate county-level carbonated soda may increase in treatment states simply due to a greater proportion of migrants. Excluding population as a covariate will, therefore, inflate the effect of SNAP participation on soda sales. Results show that controlling for population does have a tangible effect on the magnitude of φ which is an indication of interstate migration during recession.

While the estimated effect of $1,355 may initially seem extraordinarily high, a back-of-the-envelope calculation proves that is not the case. I use estimates of annual county-level SNAP benefits and annual state-level SNAP participation estimates from the SNAP Data System of USDA's Economic Research Service to compare changes in soda consumption to changes in SNAP benefits. The calculation is shown in Table 6 in the Appendix. A 1% increase in weekly county-level SNAP benefits between 2008 and 2012 was accompanied by a 0.08% increase in consumption of soda over the same period. In addition, Table 7 presents the differences in SNAP benefits between the two cohorts post-recession relative to pre-recession. The difference between average weekly county-level SNAP benefits disbursed in the treatment and control group increased by about $144,942 in the period after the recession. The Food and Nutrition Service (FNS) of the USDA reports that SNAP households spent about 5.4% of their total food expenditure on soft-drinks and 9.3% of their food expenditure on SSBs in 2011 (Garasky *et al.*, 2016). As a result, the increase in benefits is expected to increase soda sales in the treatment states relative to control states by about $7,827 (5.4% of $144,942) and total SSB consumption by about $13,480 (9.3% of $144,942). Relative to these numbers, the $1,355 estimate obtained from the DID model is modest.

A. Soda Tax

To further explore the effect of tax on the relationship between SNAP participation and soda consumption, I estimate two additional specifications of the model. The results of these specifications are shown in columns VI and VII in Table 5. In column VI, the DID model is estimated on a subsample of states with zero county-level grocery taxes. The sample contains stores in areas where there are no local taxes on soda and the estimates reflect the impact of state-level soda taxes only. The results show an insignificant estimate of $1,695 for the interaction term. Column VII shows results from a triple difference model that interacts the tax variable with treatment and recession indicators. The estimate of the triple interaction term shows the effect of the combined soda tax on the relationship between treatment (SNAP participation) and soda sales. In other words, it depicts that a one percentage point increase in the combined soda tax will lead to a decrease of about $92 on the effect of SNAP participation on soda sales in the treatment group relative to the control group. The sign of the coefficient is the opposite of what we would expect but the estimate is highly insignificant.

The DID estimates show that soda taxes play little to no role in the relationship between SNAP participation and soda sales. Two major factors might explain this result. First, literature has shown sales taxes (taxes applied at the cash register) are not as salient as other types of taxes such as excise taxes (Chetty *et al.*, 2009; Zheng *et al*., 2013; Chen *et al*., 2015). As a result, even when consumers receive a sales tax exemption through SNAP, their demand for soda does not change by a significant amount. Second, the combined sales tax causes only a marginal change in the price of soda. There is substantial county-level variation in the tax, however, most counties and states do not impose a "disfavored" tax on soda. That is, soda is generally subject to the same amount of sales tax as other items (food or non-food) and no soda-specific tax is imposed.

Consequently, SNAP participation may not generate a large enough price trade-off to have a tangible effect on consumption. As a result, the tax exemption only partially explains the increase in soda sales for the treatment group and the impact of SNAP participation on soda sales can be attributed to positive income shock from benefits. The effect of income is particularly strong, especially when low-income counties are considered as shown in columns III and IV in Table 5.

An important implication of this result is that policy-makers cannot rely on soda taxes to discourage consumption by low-income households. Since soda sales are relatively unresponsive to sales taxes, eliminating the tax exemption will have only a minor effect. Other policy interventions such as removing carbonated soda from the list of SNAP-eligible items may be more effective in encouraging households to make healthy eating choices. More work is required to determine the extent to which the SNAP restriction inhibits purchases of certain food items and how the removal of this restriction may influence sales of carbonated soda. However, this study provides initial insights into the efficacy of different policies to combat excessive consumption of SSBs by low-income households.

VII. Conclusion

I estimate a Difference In Difference model to determine the impact of SNAP participation on consumption of carbonated soda employing store-level data from Nielsen RetailScan. I create a willingness index based on state-level adoption of policies to ease the SNAP eligibility criteria in the wake of the Great Recession of 2008. Stores are assigned to the treatment group if they reside in states that were high on the willingness index and to the control group if they reside in states lower on the willingness index. I use the occurrence of the Great Recession of 2008 as a natural

experiment to identify the effect of treatment on sales of carbonated soda. The results show that SNAP participation increases weekly county-level soda consumption by about $1,355 in low-income counties but exhibits no statistically significant effect in high-income counties. State and local soda taxes elicit a very small effect on the relationship between SNAP and soda consumption. Therefore, the majority of the increase can be attributed to positive income shock from the SNAP in-kind transfer.

References

Andreyeva, T., Luedicke, J., Henderson, K. E., & Tripp, A. S. (2012). Grocery store beverage choices by participants in federal food assistance and nutrition programs. *American journal of preventive medicine*, *43*(4), 411-418.

Beatty, T. K. M., and Tuttle, C. J. (2015). Expenditure Response to In-Kind Transfers: Evidence from the Supplemental Nutrition Assistance Program. *American Journal of Agricultural Economics, 97*(2), 390-404.

Bleich, S. N., Vine, S., & Wolfson, J. A. (2013). American adults eligible for the Supplemental Nutritional Assistance Program consume more sugary beverages than ineligible adults. *Preventive medicine*, *57*(6), 894-899.

Bray, G. A., & Popkin, B. M. (1998). Dietary fat intake does affect obesity!. *The American journal of clinical nutrition*, *68*(6), 1157-1173.

Bridging The Gap. State Sales Taxes on Soda, Bottled Water, and Snack Foods [Data File]. Retrieved from http://www.bridgingthegapresearch.org/research/sodasnack_taxes/

Bruijn, G. J., Kroeze, W., Oenema, A., & Brug, J. (2008). Saturated fat consumption and the theory of planned behaviour: Exploring additive and interactive effects of habit strength. *Appetite*, *51*(2), 318-323.

Chen, X., H. M. Kaiser, and B. J. Rickard. 2015. "The Impacts of Inclusive and Exclusive Taxes on Healthy Eating: An Experimental Study." *Food Policy* 56:13-24.

Chetty, R., A. Looney, and K. Kroft. 2009. "Salience and Taxation: Theory and Evidence." *American Economic Review* 99(4):1145-1177.

Fernandes, M. M. (2012). Effect of the Supplemental Nutrition Assistance Program (SNAP) on frequency of beverage consumption among youth in the United States. *Journal of the Academy of Nutrition and Dietetics*, *112*(8), 1241-1246.

Garasky, S., Mbwana, K., Romualdo, A., Tenaglio, A., and Roy M. (2016). *Foods Typically Purchased by SNAP Households*. Prepared by IMPAQ International, LLC for USDA, Food and Nutrition Service, November 2016.

Hoynes, H. W., and Schanzenbach, D. W. (2009). Consumption Responses to In-Kind Transfer: Evidence from the Introduction of the Food Stamp Program. *American Economic Journal: Applied Economics, 1*(4), 109-139.

Leung, C. W., Ding, E. L., Catalano, P. J., Villamor, E., Rimm, E. B., & Willett, W. C. (2012). Dietary intake and dietary quality of low-income adults in the Supplemental Nutrition Assistance Program. *The American journal of clinical nutrition*, ajcn-040014.

Levi, J., Segal, L. M., St Laurent, R., Kohn, D., (2011). F as in fat: how obesity threatens America's future 2012. Retrieved March 16, 2017 from http://www.tfah.org/assets/files/TFAH2011FasInFat10.pdf

Nguyen, B. T., Shuval, K., Njike, V. Y., & Katz, D. L. (2014, September). The Supplemental Nutrition Assistance Program and dietary quality among US adults: findings from a nationally representative survey. In *Mayo Clinic Proceedings* (Vol. 89, No. 9, pp. 1211-1219). Elsevier.

Ogden C. L., Lamb, M. M., Carroll M. D., Flegal K. M. (2010) Obesity and socioeconomic status in adults: United States 1988–1994 and 2005–2008. NCHS data brief no 50. Hyattsville, MD: National Center for Health Statistics. Retrieved March 16, 2017 from https://www.cdc.gov/nchs/products/databriefs/db50.htm

Richards, T. J., Patterson, P. M., & Hamilton, S. F. (2007). Fast food, addiction, and market power. *Journal of Agricultural and Resource Economics*, 425-447.

Rosinger, A., Herrick, K., Gahche, J., Park, S., Frank, S. (2017). QuickStats: Percentage of Total Daily Kilocalories Consumed from Sugar-Sweetened Beverages Among Children and Adults, by Sex and Income Level — National Health and Nutrition Examination Survey, United States. MMWR Morb Mortal Wkly Rep 2017; 66:181.

Todd, J. E., & Ver Ploeg, M. (2014). Caloric beverage intake among adult supplemental nutrition assistance program participants. *American journal of public health*, *104*(9), e80-e85.

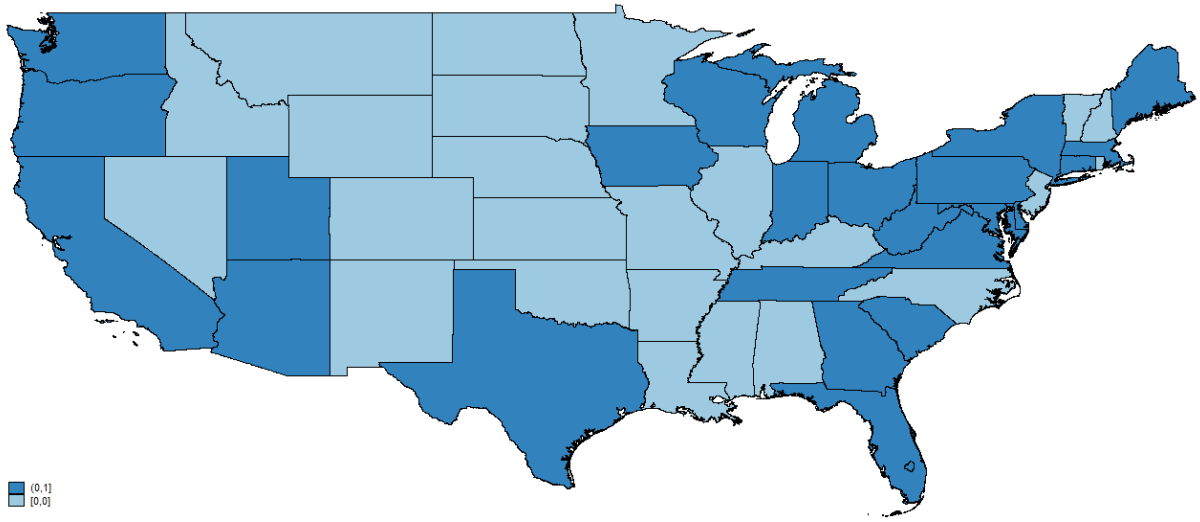
Watt, T. T., Appel, L., Roberts, K., Flores, B., & Morris, S. (2013). Sugar, stress, and the supplemental nutrition assistance program: Early childhood obesity risks among a clinic-based sample of low-income hispanics. *Journal of community health*, *38*(3), 513-520.

Zhen, C., Wohlgenant, M. K., Karns, S., & Kaufman, P. (2011). Habit formation and demand for sugar-sweetened beverages. *American Journal of Agricultural Economics*, *93*(1), 175-193.

Zheng, Y., E.W. McLaughlin, and H.M. Kaiser. 2013. "Taxing Food and Beverages: Theory, Evidence, and Policy." *American Journal of Agricultural Economics* 95(3):705-723.

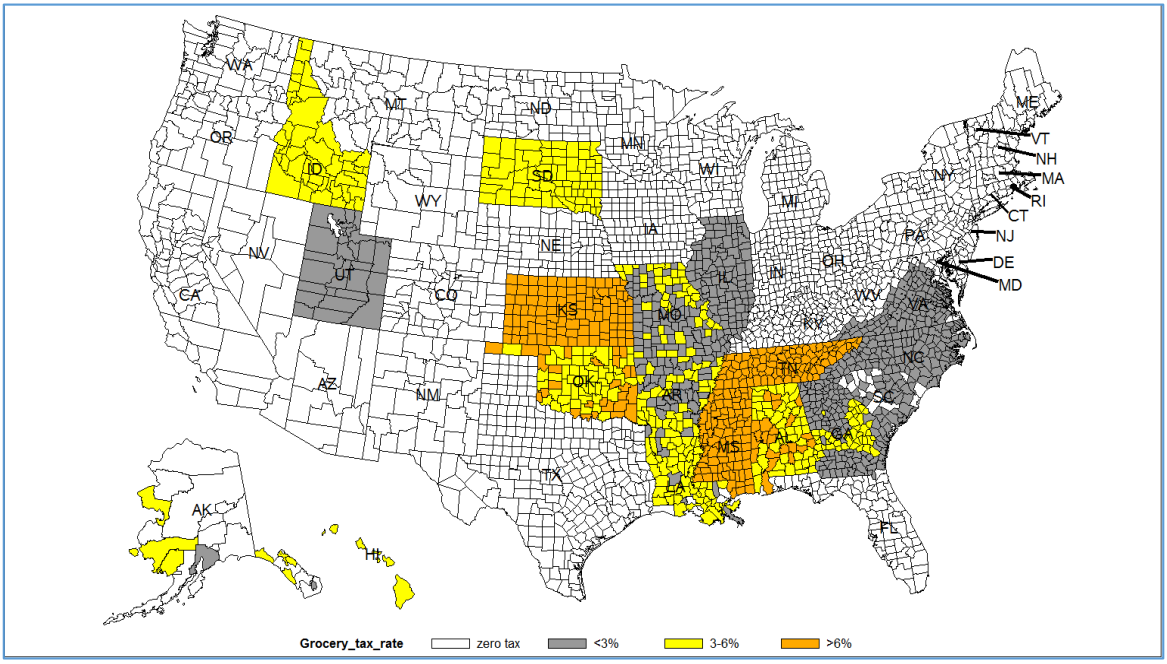
VIII. Appendix

Figure 1: Treatment and Control States by Index of Willingness, 2008



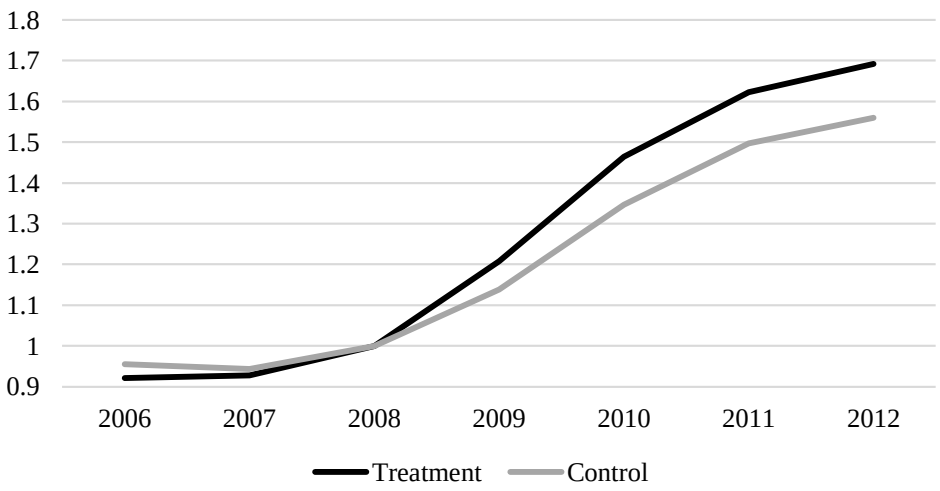
Note: Dark-colored states are more willing (treatment) states and light-colored states are less willing (control) states.

Figure 2: Combined State and Local Grocery Tax by County, 2014



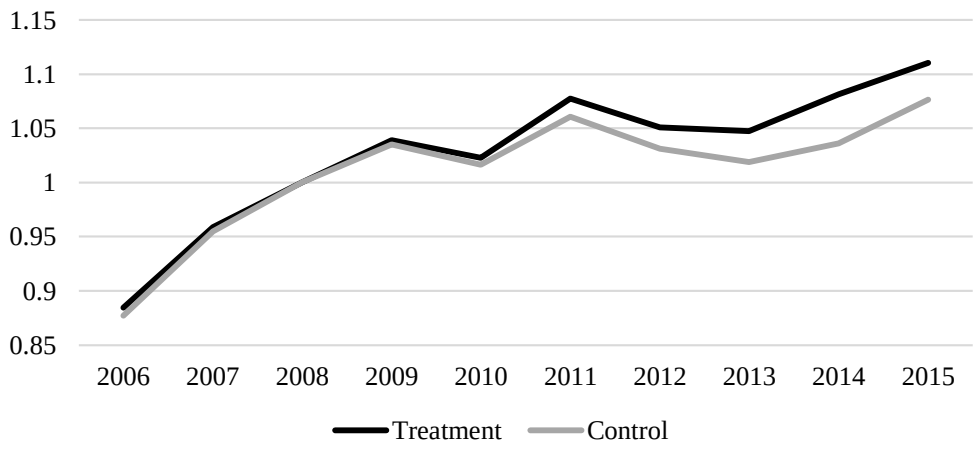
Sources: tax-rates.org, www.sale-tax.com, and state and local departments of taxation.

Figure 3: SNAP Participation by Cohort Indexed to 2008, 2006 to 2012



Note: A complete list of states in the treatment and control group is given in Table 1.

Figure 4: Carbonated Soda Sales by Cohort Indexed to 2008, 2006 to 2015



Note: A complete list of states in the treatment and control group is given in Table 1.

Table 1: Growth in SNAP Participation and Carbonated Soda Sales by Cohort, 2008 to 2012

Treatment States	SNAP Participation	Soda Sales	Control States	SNAP Participation	Soda Sales
Washington	91%	4%	Wyoming	52%	16%
New York	58%	7%	South Dakota	65%	28%
Texas	59%	2%	Oklahoma	47%	36%
Wisconsin	98%	34%	Idaho	133%	5%
California	79%	-9%	New Hampshire	84%	7%
Pennsylvania	51%	4%	Arkansas	33%	19%
Massachusetts	70%	7%	New Mexico	83%	16%
Arizona	79%	-10%	North Carolina	76%	3%
Tennessee	45%	8%	Alabama	59%	6%
Maryland	99%	-3%	Missouri	35%	23%
Florida	130%	-1%	Montana	57%	6%
Oregon	74%	4%	Colorado	94%	8%
Delaware	99%	-1%	Nevada	146%	-6%
South Carolina	47%	8%	Vermont	73%	5%
West Virginia	25%	23%	Kentucky	34%	20%
Virginia	68%	4%	Minnesota	83%	-1%
Indiana	46%	9%	Mississippi	48%	10%
Georgia	87%	11%	Nebraska	46%	17%
Connecticut	79%	13%	Louisiana	20%	-6%
Utah	106%	21%	Illinois	44%	-8%
Michigan	46%	11%	New Jersey	89%	1%
Iowa	58%	9%	Kansas	62%	17%
Maine	46%	6%	District of Columbia	58%	18%
Ohio	57%	14%	Rhode Island	104%	1%
			North Dakota	21%	50%

Table 2. Summary Statistics by Cohort		
	Treatment	**Control**
Weekly Soda Sales	$50,005	$27,518
Median Income	$46,022	$43,595
Population	152,975	78,727
Mean Soda Tax	4.2%	3.9%
Mean Soda Tax if Positive	5.4%	5.0%

Table 3: Change in Average Weekly County-Level Soda Sales by Cohort

	Pre-recession	Post-recession	Difference
Treatment	$46,399	$50,881	$4,483
Control	$26,581	$27,732	$1,151
Difference	$19,818	$23,149	$3,331

Table 4. Difference In Difference Estimates on Sales of Carbonated Soda

	(I)	(II)	(III)	(IV)	(V)
Treatment*Recession ($)	1668	1599	1355***	1133*	1837
	(1132)	(1141.74)	(491)	(676)	(2421)
Income	Yes	Yes	Yes	Yes	Yes
Population	Yes	Yes	Yes	Yes	Yes
Tax	No	Yes	No	Yes	Yes
Observations	1,167,492	1,167,296	699,201	699,005	699,005

* p<0.10, ** p<0.05, *** p<0.01

Note 1: Standard errors for all specifications are multi-way clustered by state and year

Note 2: Specifications in columns (I) through (IV) include state and year fixed effects while column (V) includes county and year fixed effects.

Table 5. Difference In Difference Estimates on Sales of Carbonated Soda (Full Results)

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)
Treat*Recession ($)	1668	1599	1355***	1133*	1837	1695	2150
	(1132)	(1141.74)	(491)	(676)	(2421)	(1404)	(2141)
Median Household Income	0.362**	0.362**	0.891***	0.890***	0.507**	0.237	0.202
	(0.15)	(0.15)	(0.3)	(0.29)	(0.2)	(0.188)	(0.171)
Population	0.337***	0.337***	0.242***	0.242***	0.244***	0.322***	0.334***
	(0.02)	(0.02)	(0.04)	(0.04)	(0.05)	(0.021)	(0.023)
Tax	-	626	-	1626	-216	-1174	836
	-	(780)	-	(1070)	(475)	(1179)	(723)
Treat*Soda Tax	-	-	-	-	-	-	395
	-	-	-	-	-	-	(1301)
Tax*Recession	-	-	-	-	-	-	31.2
	-	-	-	-	-	-	(229)
Treat*Tax* Recession	-	-	-	-	-	-	-92
	-	-	-	-	-	-	(430)
	-	-	-	-	-		
Constant	27122***	29689***	34590***	41345***	11365**	-4809	-5489
	(4098)	(5403)	(8479)	(10094)	(5043)	(7912)	(6479)
Observations	1,167,492	1,167,296	699,201	699,005	699,005	730,708	1,167,296

* p<0.10, ** p<0.05, *** p<0.01

Note 1: Standard errors for all specifications are multi-way clustered by state and year

Note 2: All specifications include include state and year fixed effects with the exception of column (V) which includes county and year fixed effects

Table 6. Average Weekly County-Level Change in Soda Sales Relative to SNAP Benefits

	Pre-recession	Post-recession	Difference	Percentage Change
SNAP benefits	$187,558	$347,145	$159,587	85.1%
Soda sales	$38,054	$40,779	$2,726	7.16%
Percentage change in soda sales relative to 1% increase in SNAP benefits				0.08%

Note: SNAP benefit data is obtained from the SNAP Data System of the Economic Research Service, USDA. Soda sales are estimated from Neilsen RetailScan Dataset.

Table 7. Change in Average Weekly County-Level SNAP Benefits by Cohort

	Pre-recession	Post-recession	Difference
Treatment	$253,285	$482,896	$229,610
Control	$116,960	$201,629	$84,668
Difference	$136,325	$281,267	$144,942

Note: All estimates are obtained from the SNAP Data System of the Economic Research Service, USDA