Local Food Prices, SNAP, The National School Lunch and School Breakfast Programs, and Nutritional Outcomes

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Abstract:
The Supplemental Nutrition Assistance Program (SNAP, formerly food stamps) is one of the most important elements of the social safety net. Unlike most other safety net programs, SNAP varies little across states and over time, which creates challenges for quasi-experimental evaluation. Notably, SNAP benefits are fixed across 48 states; but local food prices vary, leading to geographic variation in the *real* value of SNAP benefits. In this study, we provide estimates that leverage variation in local food prices across markets to examine effects of (real) SNAP benefit generosity on on nutrition. We link cross-sectional data on local food prices to food acquisition data, control for observables, and use the Oster (2016) method of bounding our estimates with assumptions about the relative degree of selection into treatment on observables and unobservables. We find that children in market regions with higher SNAP purchasing power have small improvements in nutritional intake, while adults see higher levels of obesity.

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1 Introduction

The Supplemental Nutrition Assistance Program (SNAP, formerly the Food Stamp program) is the largest food assistance program and one of the largest safety net programs in the United States.[1] SNAP plays a crucial role in reducing poverty for children in the U.S., with only the EITC (combined with the Child Tax Credit) raising more children above poverty (Renwick and Fox 2016). Eligibility for the program is universal in that it depends only on a family's income and assets; in 2015, 1 in 7 Americans received SNAP benefits (Ziliak 2015).

SNAP's primary goals are to improve food security among low-income households, reduce hunger, and increase access to a healthful diet.[2] The extant literature demonstrates that the program succeeds in reducing food insecurity among recipient households (see, e.g., Yen et al. 2008; Nord and Golla 2009; Mykerezi and Mills 2010; Ratcliffe, McKernan, and Zhang 2011; Shaefer and Gutierrez 2011; Schmidt, Shore-Sheppard, and Watson 2016 and the recent review by Hoynes and Schanzenbach 2016). Nonetheless, rates of food insecurity among SNAP households remain quite high, raising the question of whether SNAP benefits are adequate to meet the nutritional needs of recipients (Coleman-Jensen et al. 2014). Indeed, evidence regarding how SNAP benefits impact recipients' nutrition is more mixed (see, e.g., Yen (2010); Gregory et al. (2013)).[3]

Our study provides some of the first evidence on the impact of variation in the *generosity* of SNAP benefit levels on nutrition. Estimating the causal relationship between SNAP and nutrition is difficult because SNAP benefits and eligibility rules are legislated at the federal level and do not vary across states, leaving few opportunities for quasi-experimental analysis driven by state or local variation, as has occurred for other forms of social insurance such as Medicaid. Past research on the effects of Food Stamps on various health outcomes has addressed this methodological challenge by analyzing the rollout of the food stamp program across counties in the 1960s and 1970s (Currie and Moretti 2008, Almond, Hoynes, and Schanzenbach 2011, and Hoynes, Schanzenbach, and Almond

[1]SNAP benefits paid in 2016 amounted to more than 66 billion dollars. The program has also grown dramatically in the years since 1996 welfare reform, with benefits paid out almost tripling in real terms over the years in this study (1999-2010).

[2]See, for example, the most recently amended authorizing legislation, the Food and Nutrition Act of 2008, available at https://fns-prod.azureedge.net/sites/default/files/snap/Food-And-Nutrition-Act-2008.pdf.

[3]Evidence regarding the relationship between SNAP participation and obesity is also mixed. Leung (2013 ADD TO BIB) finds associations with increased child obesity, but selection into participation is a concern. Kaushal (2007 ADD TO BIB) found no increase in obesity for low-education unmarried mothers, using the changes in immigrant eligibility that were part of the 1996 welfare reform as an exogenous source of variation in SNAP participation.

2016), by using recent state changes in application procedures (e.g. allowing online applications, whether there is a finger printing requirement) as instruments for SNAP participation (Schmeiser 2012, Gregory and Deb 2015, Ziliak 2015), or by.studying variation in eligibility for SNAP generated by welfare reform legislation in the 1990s (East 2016).

In this study, we identify and leverage a new source of plausibly exogenous variation in the relative generosity of SNAP benefits: variation in the *real value of SNAP benefits* due to geographic differences in local food prices.[4] Importantly, the SNAP benefit formula is fixed across the 48 states (benefits are higher in Alaska and Hawaii) even though the price of food varies significantly across the country (Todd et al. 2010; Todd, Leibtag, and Penberthy 2011).[5,6] Though SNAP benefits are implicitly adjusted for variation in the cost of living through allowed deductions (e.g., for housing, and child care) in the calculation of net income, the limited available evidence indicates these adjustments are not sufficient to equalize *real* benefits, particularly in high cost areas (Breen et al. 2011).

Higher area food prices, and consequently lower SNAP purchasing power, may impact SNAP recipients' nutrition if households respond by purchasing and consuming lower quantities of food, or if they purchase less expensive foods of lower nutritional quality. Using new, nationally representative data from the USDA's Food Acquisition and Purchase Survey (FoodAPS), we link data on SNAP recipients' food acquisitions to local food prices to study the effect of variation in "SNAP purchasing power" on nutrition in SNAP households. Our measure of regional food prices is the cost of the Thrifty Food Plan (TFP), a nutrition plan that was constructed by the USDA to represent a nutritious diet at minimal cost and is the basis for maximum legislated SNAP benefits (i.e., maximum benefits are set to its national average cost).[7] We relate several nutrition outcomes to

[4]Note that we cannot say anything about the effect of SNAP per se; all our estimates are based on *relative* real values of benefits due to food price variation.

[5]Studying data from the Quarterly Food at Home Price Database (QFAHPD), the authors find that regional food prices vary from 70 to 90 percent of the national average at the low end to 120 to 140 percent at the high end.

[6]Across the continental U.S., maximum benefits vary only with family size. So, in 2016 a family of three would be eligible for a maximum benefit of $511/month, regardless of the local cost of living.

[7]The FoodAPS constructed a similar cost measure at the individual store level using Information Resources Inc. data; we use this measure to construct a local TFP cost faced by SNAP households.The measure is referred to as a "basketprice" in the FoodAPS dataset, since the price measure is constructed differently than the national TFP (e.g. the TFP is based on the shopping patterns of low income shoppers and assumes shoppers by the least-cost subcategory of items within each category. We use the "low_basketprice" variable throughout, which uses prices from the lowest quintile of each food category. The average low basketprice of all IRI stores in the data is XXX.XX, while the statutory TFP from the time was $144.

the purchasing power of SNAP benefits (i.e., the ratio of the national SNAP maximum benefit to the local TFP price faced by a household), controlling extensively for a number of individual-level and region characteristics, including non-food prices in the area. To evaluate the robustness of our estimates to omitted variables bias, we rely on the Oster (2016) method, (similar to that of Altonji, Elder, Taber 2005) and report bounds on our estimates under the assumption that selection on unobservables is equally as strong as selection on observables. When applying this approach, we find evidence that estimates based solely on geographic variation in SNAP likely are lower bounds for the true causal impact of SNAP on healthy eating behaviors and health outcomes.

Our study contributes to the growing body of evidence on the SNAP program and its effects in a few key ways. First, we provide new evidence on the relationship between relative SNAP benefit generosity and the nutrition of the SNAP population. Our findings indicate that children in market regions with higher food prices (lower purchasing power of SNAP) have marginally worse nutritional incomes, though the effect is not large. We find that a 10 percent increase in SNAP purchasing power raises child Healthy Eating Index (HEI) scores by approximately 1.4 points (a 3 percent increase, relative to a baseline mean HEI score of 47.9 for this sample). This effect is driven, in part, by a positive relationship between higher SNAP purchasing power and children's vegetable intake, as reflected by their HEI-vegetable subcomponent scores. SNAP generosity does not appear to affect child obesity. Among adults, HEI scores are generally not affected by SNAP purchasing power, but obesity rates are higher for those facing lower area food prices. We also investigate these findings with higher income samples as a placebo test.

Second, we identify a new source of quasi-experimental variation in SNAP generosity with which to estimate causal impacts of variation in SNAP benefits. By studying variation in the real value of SNAP benefits (or SNAP "purchasing power"), we provide policy-relevant estimates that can shed light on the effect of varying legislated benefit levels on SNAP recipients' nutrition. In related work, Bronchetti, Christensen, and Hoynes (2017) use market-group level food price data from the QFAHPD to study the effects of variation in SNAP purchasing power on health care utilization and health outcomes for children in SNAP households. To our knowledge, the only other research we are aware of to link variation in food prices to outcomes for SNAP recipients is Gregory and Coleman-Jensen (2013), which shows that a 10% (close to one standard deviation) increase in food prices leads to a 3 percentage point increase in food insecurity.

The paper proceeds as follows. The next section describes our data on regional food prices and nutrition, and Section 3 lays out our empirical approach. Section 4 presents our main results regarding the impact of SNAP purchasing power on nutrition, as well as the results of robustness checks. Section 5 concludes.

2 Data

Our study is one of the first to use data from the Food Acquisition and Purchase Survey (FoodAPS), a nationally-representative survey conducted by the U.S. Department of Agriculture's Economic Research Service (USDA-ERS). Below we describe how we use household- and individual-level FoodAPS data to analyze HEI scores and other nutritional outcomes for SNAP children and adults, and how we link SNAP recipients' nutritional outcomes to local-area TFP food prices using data from the FoodAPS Geography Component (FoodAPS-GC). We supplement our analysis with regional Consumer Price Indices (CPIs) to control for variation in local prices of non-food items.

2.1 FoodAPS Data on SNAP Households and Nutrition

We use household- and individual-level data from FoodAPS to study how the nutritional intake of SNAP recipients is impacted by variation in local food prices (and thus, in the purchasing power of their SNAP benefits). The FoodAPS was conducted by the USDA-ERS between April 2012 and mid-January 2013 and contains detailed information on the food purchases and acquisitions of nearly 5,000 households, as well as information on their demographic characteristics, income/employment, and SNAP participation. SNAP participant households are oversampled by the survey: of the 4,826 households in the dataset, 1,581 (41 percent) reported receiving SNAP benefits at the time of interview. The primary focus of the survey was a detailed tracking of all food acquired by the household (both quantities and expenditures) from all sources over a one-week period.

We analyze the effects of SNAP purchasing power on nutrition for samples of children (ages 2 through 17) and adults in SNAP-recipient households, i.e., households that report having received

SNAP in the past 30 days (and whose self-report is verified by comparison to administrative data).[8] Our samples contain 1,065 SNAP-recipient children and 2,350 SNAP adults, respectively.

For both samples, we study several nutritional outcomes, including: HEI scores for total diet, fruit, and vegetables (described further below); the percentage of calories from added sugars, solid fat, and alcohol; grams of added sugars in the diet. For or the sample of adults, we add alcohol consumption (measured in grams) as well as indicators for obesity and overweight.

The HEI is a measure of diet quality used by the USDA to monitor conformance to dietary guidelines among the U.S. population, and particularly among the low-income subpopulation. The index is valid for anyone two years old or older, so we limit our sample accordingly. The index was originally developed by the USDA's Center for Nutrition Policy and Promotion (CNPP) in 1995 and was significantly updated in 2005 and, to a lesser degree, in 2010. The HEI-2010 contains 12 components that sum to a maximum score of 100 points; the average estimated HEI score for the U.S. population is currently 59 out of 100. The index assesses diet quality from two perspectives: adequacy (dietary components to increase) and moderation (dietary components to decrease). The standards for scoring dietary intake are density-based (e.g., per 1000 calories or as a percent of total calories). For the adequacy components, this means that higher levels of intake receive higher scores; whereas for the moderation components, increasing levels of intake receive lower scores. That is, for all components, higher scores indicate closer conformance with recommended dietary guidelines (Guenther et al., 2013).

We construct individual-level HEI scores for each child and adult in our samples using the entire week's worth of data in the FoodAPS. The HEI is on a percent of total calories basis, so it is relatively straightforward to calculate household or individual scores (or other level of aggregation) for whatever time period of interest. The HEI is designed for actual nutritional consumption, but for food at home (FAH), we must make do with acquisition and not consumption, as this is all the FoodAPS contains. We also assume that each individual consumes all FAH foods, as there is no data on which household member consumed which FAH foods. For food away from home (FAFH), we can identify which person ate which meal, so we assign food to individuals, though we are still

[8] FoodAPS contains multiple indicators of SNAP participation for each household, including participation as reported in the initial interview (SNAPNOWREPORT) and reported SNAP participation status that is revised per the match to administrative data (SNAPNOWHH). We use the latter measure as our indicator for participation in the program to define our samples of interest.

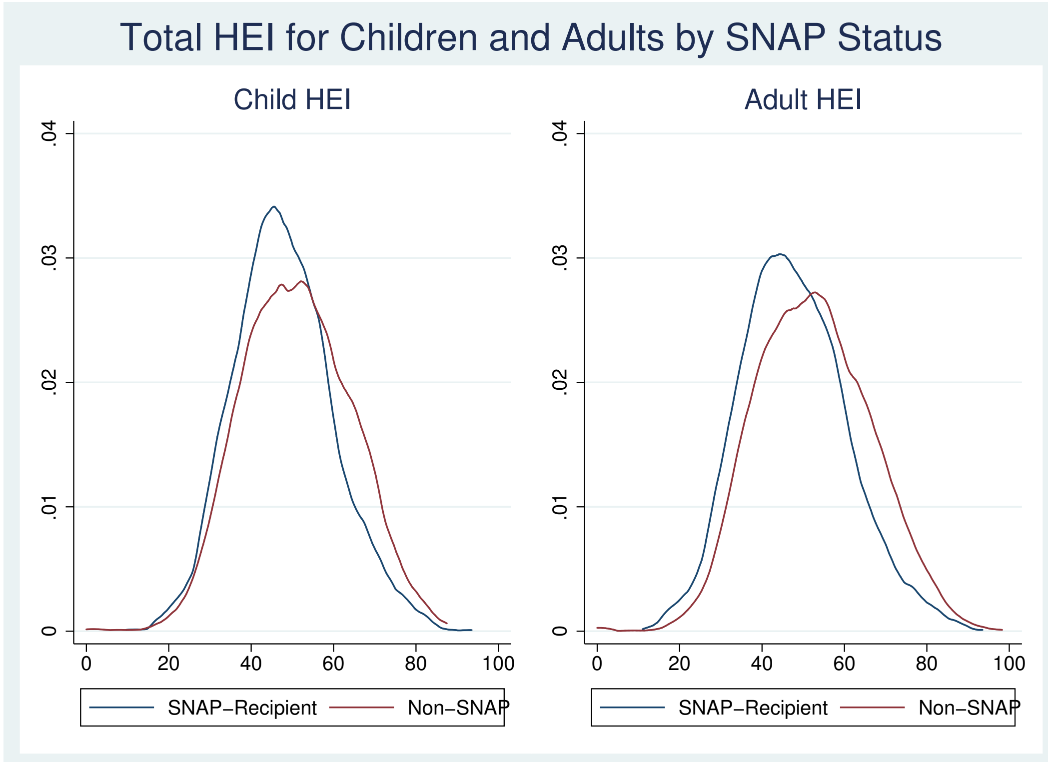

Figure 1: Density of Individual HEI Scores

not able to assign specific parts of meals to specific individuals and thus assign entire meals.[9]. Density plots of total HEI score are shown in Figure 1, separately for adults and children. Radar plots of each constituent subcomponent are shown in Figure 2, separately for children and adults. The figures shows that SNAP recipients' HEI scores are lower than those of non-recipients, and though some subcomponents (e.g. total protein) have nearly identical average scores, there is only one subcomponent (fatty acids, for children) on which SNAP recipients outperform non-recipients.

Table 1 displays summary statistics for SNAP recipient children and adults, along with those for children and adults who do not participate in the program. Perhaps not surprisingly, nearly all nutritional outcomes are better, on average for non-SNAP individuals than for those who receive SNAP. Non-SNAP children and adults have higher HEI scores, consumer fewer calories from added

[9]For FAFH this is done using the FAFH Event dataset and the ATEPNUMX variables, where X refers to the person identifier in each household. The FAH Event dataset has an indicator for who acquired the food (WHOGOTPNUM), but since children don't do much of their own grocery shopping, we don't consider this particularly relevant.

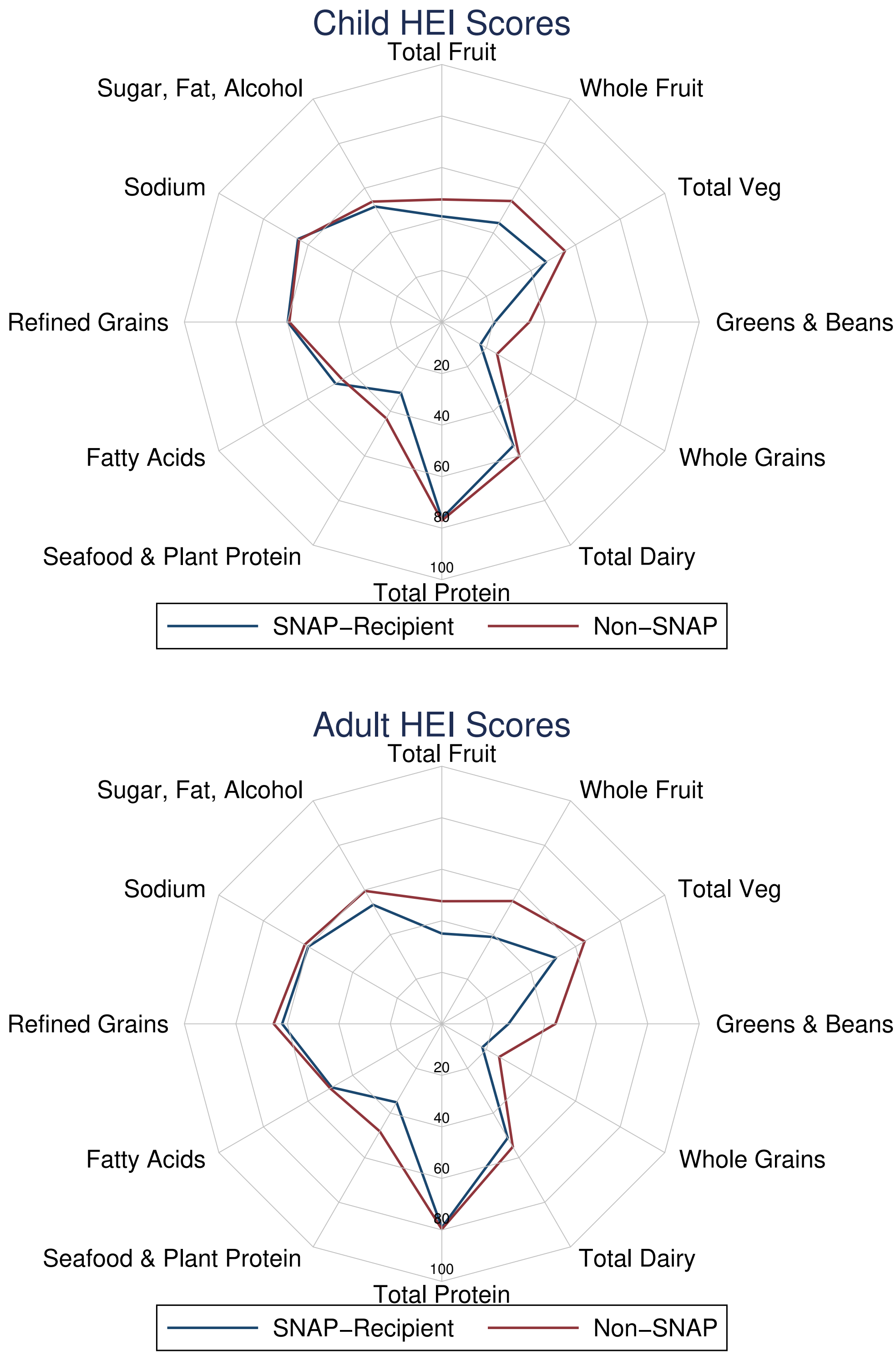

Figure 2: Summary of Individual HEI Subcomponent Scores

sugars, solid fats, and alcohol, and are less likely to be overweight and obese. Unsurprisingly, income, education, and food security are all lower, on average, for the SNAP samples.

2.2 Local Cost of the Thrifty Food Plan (TFP)

The Thrifty Food Plan (TFP) is a market basket of foods that represents a nutritious diet at minimal cost and serves as the basis for establishing the maximum Supplemental Nutrition Assistance Program (SNAP) benefit.[10] The plan is constructed by the USDA, and specifies foods and quantities of foods to represent a nutritious diet at a minimal cost. In 2012, when the FoodAPS survey was conducted, the U.S. average weekly TFP cost was $144 for a family of four with two adults and two children (ages 6-8 and 9-11).[11]

The FoodAPS-GC contains retail food price data compiled by researchers at the University of Illinois and the University of Florida (see Gunderson et al. 2016). We link each respondent household to a measure of the cost of purchasing the TFP from local stores, using the median TFP price from stores within 3.4 miles. (3.4 miles is the average distance FoodAPS respondents report traveling to shop for food.)

In particular, we match each respondent household to weekly store-level "basket prices" according to the household's census block group and week of interview. These basket prices are computed from Information Resources, Inc. (IRI) scanner data on UPC-level sales at the Regional Market Area (RMA) level, and are meant to reflect the cost of the TFP.[12] The data set contains two TFP-cost variables, *basket_price* and *low_basket_price*. The first takes the median price-per-pound for each TFP category, multiplies that price by the quantity (in pounds) prescribed for the TFP, and sums across TFP categories. The latter makes the same calculation, but computes the median price-per-pound only among items in the lowest decile of prices for that TFP category; we employ this measure throughout our analysis.

Figure 3 displays a histogram of the basket prices (median of *low_basket_price* within a 3.4-

[10] That is, SNAP benefits are set such that SNAP households with no net income (after a set of deductions to gross income) receive benefits in a dollar amount equal to the full TFP price. Other households receive the TFP amount minus 30 percent of their net income because the program assumes that households can contribute 30 percent of that income to the purchase of food.

[11] See https://www.cnpp.usda.gov/sites/default/files/CostofFoodNov2016.pdf (Accessed 1/28/17).

[12] Note, however, that the prices are calculated using all items in a food category from a store, including high-price items and thus may not be representative of the purchases made by low-income SNAP households.

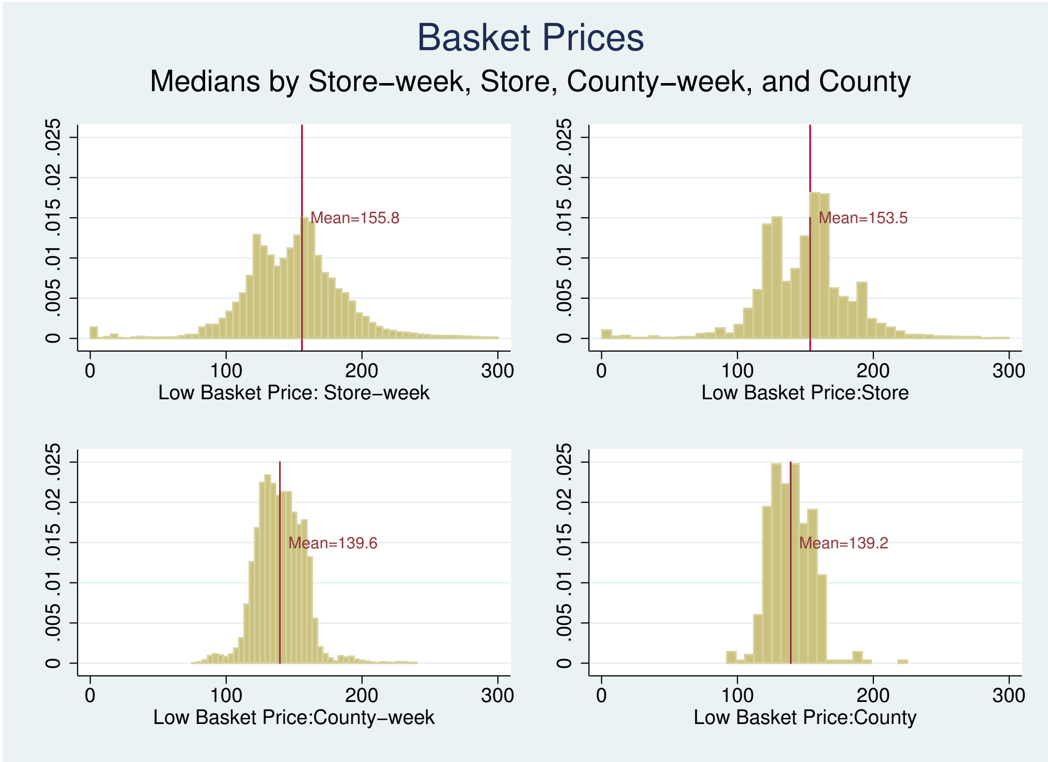

Figure 3: Median Low Basket Prices NOTE: REPLACE WITH INDIVIDUAL NOT STORE AVERAGE

mile radius of the household) faced by households in our FoodAPS sample.[13] For comparison, the statutory figure for this time period was $144.

2.3 Controls for Local Non-Food, Non-Housing Prices

To control for the fact that areas with high food prices may also be characterized by high prices of other items, we include as controls a set of regional Consumer Price Indices (CPIs) for non-food, non-housing categories (apparel, commodities, education, medical, recreation, services, transportation and other goods and services). These are available for 26 metro areas; for the remaining areas, the CPI is calculated within each of the four census regions and for four county population sizes

[13]We are unfortunately unable to show a map or geographic distribution of these prices, as the FoodAPS data only contain the prices from the primary sampling units and neighboring counties and thus we are unable to disclose this information.

(<50,000, 50,000-1.5 million, >1.5 million).

3 Empirical Methods

We estimate the causal impact of variation in the real value of SNAP benefits on measures of nutrition for children and adults in SNAP-recipient households. Throughout, our regressions take the following form:

$$y_{ihr} = \alpha + \beta \ln(\frac{SNAPMAX_h}{TFP_{hr}}) + X_{ihr}\theta + Z_{hr}\gamma + \lambda_r + \epsilon_{irt} \quad (1)$$

where y_{ihr} is the nutrition outcome of individual i in household h who resides in region r. The key independent variable is the natural log of the ratio of the maximum SNAP benefit (which depends on household size) to the TFP price (adjusted for household size) all individuals in a household face. The vector X_{ihr} contains a set of controls for the individual's age, race, sex, and tobacco use, while $Z_h r$ contains household characteristics such as the household's size, urban/rural residence, location in a metropolitan area, household income, days since SNAP receipt, WIC eligibility, whether the household reports having trouble with bills or has faced a recent large expenditure, as well as a set of regional CPIs in non-food, non-housing consumption categories.[14] Some models also include a full set of state fixed effects, λ_r. All regressions are weighted to account for complex sampling design.[15]

The variation of interest in this model is variation in the price of the Thrifty Food Plan across geographic areas. As we showed earlier in Figure 3, there is substantial variation across geographic areas in the purchasing power of SNAP benefits. Looking at the distribution of costs faced by households at the median store within 3.4 miles, the bottom 10th percentile household sees a ratio of benefits to costs of 0.94, while the 90th percentile household sees a ratio of 1.23.[16] We can control for state level variation with fixed effects, but with only cross sectional data, we are still concerned about omitted variable bias.

[14] We are in the process of adding HUD Fair Market Rent data as an additional control.
[15] See FoodAPS Users' Guide at https://www.ers.usda.gov/media/8804/0_foodaps-user-guide-puf.pdf.
[16] Note that since the statutory TFP is constructed using a national average, some areas are, by definition, likely to have SNAP benefits that more than cover the cost of the TFP.

Throughout the paper, we test the robustness of our results to omitted variables bias using the method outlined in Oster (2016). The key insight is that the degree of omitted variables bias from selection on unobservables can be estimated based on the stability of coefficient estimates and changes in R^2 when additional (observable) controls are added to the model. The Oster (2016) approach (which improves upon the method in Altonji, Elder, and Taber (2005)) provides a bias-adjusted estimate of the key coefficient of interest, β^*, under the assumption that selection on unobservables is proportional to selection on observables. The approach also yields an estimate (denoted δ) of the degree of selection on unobservables (relative to selection on observables) that would be necessary to drive the regression estimates to zero. β^* is approximated as below:

$$\beta^* \approx \tilde{\beta} - \delta(\mathring{\beta} - \tilde{\beta})\frac{R_{max} - \tilde{R}}{\tilde{R} - \mathring{R}}$$

$\mathring{\beta}$ and $\mathring{R}$ are the coefficient and R^2 from regressions of outcome with the independent variable of interest only, and no controls. $\tilde{\beta}$ and $\tilde{R}$ are the coefficient and R^2 from regressions of outcome with the independent variable of interest as well as observable controls. R_{max} is the hypothetical R^2 obtained from the regression with the independent variable of interest, observable controls, and unobservable controls. Since this is of course unobservable, one must make assumptions. Altonji, Elder, and Taber (2005) implicitly assume $R_{max} = 1$, which is often unlikely to be the case due to measurement error or idiosyncratic variation. Bellows & Miguel (2009) and Nunn & Wantchekon (2011) assume that unobservables would increase R^2 by the same amount as observables: $R_{max} = \tilde{R} + (\tilde{R} - \mathring{R})$. However, Oster compares evidence from randomized trials to observational studies and shows that $1.3 \times \tilde{R}$ performs well in tests, so we use this for R_{max} throughout.

We report both β^* and δ in the tables of results that follow. We report results of regressions of nutrition on SNAP purchasing power with no controls, and with observable controls to help readers understand the change in coefficients as observable controls are added.

4 Results

4.1 SNAP Purchasing Power and Children's Nutrition

We begin by analyzing the effects of SNAP purchasing power on nutritional outcomes for SNAP recipient children ages 2 through 17. Our primary measure of nutrition is the HEI score for the total diet; these results are displayed in Table 2. The first column includes only the independent variable of interest, the second ads a set of individual/household controls, and the third column adds state fixed effects. In the fourth column, we include controls for participation in the National School Lunch and School Breakfast programs. The results in Table 2 demonstrate a significant, positive relationship between SNAP purchasing power and a child's HEI score. A 10 percent increase in SNAP purchasing power, for example, is found to raise the HEI score by 1.3 to 1.4 points (relative to a baseline mean HEI score of 47.9 for this sample). On the other hand, we find no evidence of a significant association between participation in the School Lunch and School Breakfast programs and children's HEI scores. For regressions on SNAP samples, we control for days since last SNAP receipt, which is not significant by itself, nor in specifications interacting outcome with days since receipt.

In the bottom rows of the table, we evaluate the robustness of our estimates to omitted variables bias using a procedure described in Oster (2016). This method provides a bias-adjusted estimate of the coefficient on (log) SNAP purchasing power by taking into account both coefficient stability and R^2 movements when additional controls are added. We follow Oster (2016) in assuming that the R^2 from a hypothetical regression of the outcome on treatment and both observed and unobserved controls would be no more than 30% higher than the R^2 from the regression that includes observed controls. The results of this exercise indicate that under the assumption that selection on remaining unobservables is equal to selection on observables, a bias-adjusted estimate of the treatment effect is *larger* than the estimates we present. The bias-adjusted estimates suggest a 10 percent increase in SNAP purchasing power would generate increases in children's HEI scores of approximately 2 to 3 points (a 4 to 6 percent improvement relative to the sample mean). The δ parameter yielded by the Oster (2016) procedure indicates the degree of selection on unobservables that would be necessary to drive our coefficient estimates to zero. That these center around -1.0 suggests selection on unobservables would need to be of similar size to selection on observables but operate in the *opposite* direction for this to be the case. In short, the Oster (2016) approach provides a reassuring check on the robustness of these findings to uncontrolled omitted variables bias.

In Table 3, we examine the child's HEI-vegetable and HEI-fruit scores (where these are each out of 5 possible points) as well as the percentage of the child's calories coming from added sugar, solid fats, and alcohol, and a measure of added sugar in the diet (in grams). While the estimated coefficients for the latter three outcomes are of the expected signs, consistent with a beneficial impact of SNAP purchasing power on nutrition, only the result for HEI-vegetable scores is statistically different from zero. This estimate indicates that a 10 percent increase in SNAP purchasing power would raise HEI-vegetable scores by 5.9% relative to the mean HEI-vegetable score (2.41) for the sample of SNAP children.

Broadly, we interpret these results as suggesting that children in households facing higher food prices (and thus, lower SNAP purchasing power) may have slightly worse nutrition, at least as measured by their total HEI scores and their HEI score for vegetables. However, the estimates in Table 3 are sufficiently imprecise that we are unable to shed much additional light on the dietary mechanisms whereby SNAP purchasing power improves total HEI scores; we find no statistically significant evidence of a reduction in moderation components (dietary elements that guidelines would recommend decreasing), like sugars and solid fats.

4.2 SNAP Purchasing Power and Nutrition of SNAP Adults

Table 4 presents similar evidence on the extent to which variation in SNAP purchasing power affects nutrition, but for the sample of adults in SNAP households. The regression specifications include the same set of controls as in Table 4, but we add the amount of alcohol (in grams) in the individual's diet as an additional outcome. The results generally indicate beneficial, but statistically insignificant, impacts of increased SNAP purchasing power on adult nutritional outcomes. The signs of the coefficient estimates for the HEI-total and HEI-vegetables scores are positive, while those for the percentage of calories from sugar, fat, and alcohol and grams of alcohol acquired are negative. Nonetheless, given the imprecision of the estimates, we are unable to rule out zero, or even opposite-signed, effects.

Adult rates of obesity and overweight may also respond to variation in SNAP purchasing power. We explore this question in Table 5 and document a strong positive relationship between SNAP purchasing power and incidence of obesity and overweight in the adult SNAP population. A 10 percent increase in SNAP purchasing power, for example, is associated with a 3 to 4 percentage point increase in the likelihood a SNAP adult is obese (or an increase of 7.4 to 10 percent relative to a mean obesity rate of 39 percent among the sample of SNAP adults). The association between SNAP purchasing power and the likelihood a recipient adult is overweight is also positive, though meaningfully smaller and only marginally significant (p-value approximately 0.10 in column 5). Here a 10 percent increase in SNAP purchasing power is predicted to lead to an approximately 1.5 percent increase in the likelihood of being overweight.

4.3 Robustness Check: Placebo Samples of Higher-Income Children and Adults

A natural check of our finding of a positive impact of SNAP purchasing power on children's nutrition and adult obesity/overweight is to estimate our models for nutrition outcomes on "placebo" samples of those in higher-income households, who should not be directly affected by SNAP purchasing power (i.e., who are not impacted by SNAP benefits and whose diet and nutrition should not be as vulnerable to higher area food prices). In Table 6 we present regression results analogous to those in Tables 2 and 3, but for the sample of children living in households with incomes above 300 percent of the federal poverty line.[17] Interestingly, we estimate a strongly significant and negative relationship between SNAP purchasing power for and total HEI scores for this sample. While this result warrants further investigation, we note that it takes the opposite sign of the estimated relationship between SNAP purchasing power and HEI-total scores for the SNAP sample. Estimated coefficients for all other outcomes are all statistically insignificant.

We test for effects of SNAP purchasing power on nutrition and incidence of obesity and overweight for adults in higher-income households (again, those with incomes above 300 percent of the federal poverty line) in Table 7. Here we estimate only two significant relationships, indicating that higher SNAP purchasing power is associated with lower HEI-vegetable scores and a greater

[17] As before, this sample is limited to children ages 2 through 17.

likelihood of higher-income adults being overweight. The remaining coefficients are all small in magnitude, of the opposite sign from those in Tables 4 and 5, and statistically insignificant.

5 Conclusions

In this paper we provide the first direct evidence on how variation in (real) SNAP benefit generosity affects nutrition among SNAP children and adults. Because legislated SNAP benefits are fixed across the 48 states, neighborhood-level information on local food prices provides a source of quasi-experimental variation to identify the impact of higher SNAP benefits on the nutritional content of SNAP recipients' diets.

We find that SNAP children in areas with higher food prices have diets that are less nutritious overall, as indicated by lower Healthy Eating Index (HEI) scores. A ten percent decrease in SNAP purchasing power, for example, is found to lower HEI-total scores by about 3 percent. Our findings also indicate a reduction in the HEI subscore for vegetable intake for children in higher-price areas. While the estimated coefficients are generally of the expected sign, suggesting a protective effect of SNAP, we find no significant impact of SNAP purchasing power on HEI-fruit scores, percentage of calories from added sugars and solid fats, or grams of added sugar in the diet. Our findings suggest that SNAP generosity can be a key policy lever that can encourage healthy eating in children. This is in line with other evidence on supporting habit formation which suggests SNAP generosity could also encourage healthier eating at school (Loewenstein, George; Price, and Volpp, 2016). Lastly, Carr and Packham (2017) find that SNAP disbursement significantly lowers shoplifting patterns of teens. This suggests SNAP generosity could have other benefits by lowering criminality arrests, which have been shown to have permanent negative consequences for human capital and earnings (Aizer and Doyle 2015).

As for SNAP adults, recipients in higher food price areas demonstrate *reduced* incidence of obesity. We find that a ten percent decrease in SNAP purchasing power is associated with a 7.4 percent reduction in the likelihood of obesity. Our measures of other adult nutritional outcomes do not appear to respond to variation in (real) SNAP generosity, although again, most estimates are of the expected sign, consistent with a protective role for SNAP. One interpretation of our results, taken together, is that SNAP participants with higher (real) benefits have diets with healthier food but also higher quantities of (obesity-inducing) food.[18]

Whether SNAP benefits, as currently legislated, help support healthy diets among program participants is an important question for policy makers, particularly as cuts to the program are considered. Our findings shed light on modest beneficial impacts of SNAP on nutrition but also speak to the question of whether current SNAP benefits are adequate to meet the nutritional needs of program participants. In related work, we find that given local food prices, legislated SNAP benefits (plus 30 percent of income) are insufficient for 20 to 25 percent of SNAP households to afford the Thrifty Food Plan (TFP) at the median-cost store in their area (Christensen and Bronchetti 2017), and that lower SNAP purchasing power is associated with higher rates of food insecurity (Bronchetti, Christensen, and Hoynes, 2017). Here we demonstrate that SNAP participants' average HEI scores are substantially lower than those of children and adults in higher-income, non-SNAP households, and that raising SNAP benefits would likely result in improved total HEI scores and vegetable intake, at least for SNAP children. At the same time, however, our findings suggest that doing so might also increase obesity rates among SNAP adults. Thus, without an ability to target an increase in benefits within the household, the policy implications of our results are less clear.

[18]We will investigate this further. Since the HEI is on a per-calorie basis, and added sugars do not appear to be affected, we will investigate total calories.

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Table 1: Mean Characteristics of SNAP and Non-SNAP Samples

	SNAP Children Ages 2-17	Non-SNAP Children Ages 2-17	SNAP Adults	Non-SNAP Adults
HEI-Total Score (0-100)	47.9	52.2	48.0	54.9
HEI-Vegetable (0-5)	2.41	2.79	2.57	3.23
HEI-Fruit (0-5)	2.08	2.40	1.85	2.43
% Calories from Sugar, Fat, Alcohol	33.9	33.09	33.5	30.9
Added Sugars (grams)	771.5	673.0	557.6	453.0
Alcohol (grams)			29.6	96.7
Obese	0.31	0.21	0.39	0.26
Overweight	0.46	0.35	0.69	0.61
TFP (median-cost store in 3.4 mi)	$145	$147	$146	$148
Days since last SNAP benefit	16.0		14.9	
WIC Eligible	0.96	0.95	0.76	0.57
Household Size	4.86	4.56	3.78	2.91
Household Max Age	42.1	43.6	49.7	52.4
Household Min Age	5.83	7.22	19.3	31.3
Household Income/FPL	117	365	153	455
Household Has Earnings	0.71	0.97	0.67	0.84
Household College Educated	0.16	0.48	0.16	0.52
Household Has Car	0.74	0.98	0.73	0.94
Travel Time to Primary Store (min)	9.22	8.06	10.20	8.60
Trouble Paying Bills	0.35	0.11	0.30	0.07
Large Expenditure	0.15	0.14	0.17	0.10
High Food Security	0.32	0.63	0.33	0.74
Marginal Food Security	0.27	0.22	0.23	0.15
Low Food Security	0.26	0.11	0.24	0.07
Very Low Food Security	0.16	0.04	0.20	0.04
Rural	0.14	0.23	0.15	0.20
Metropolitan Area	0.93	0.94	0.94	0.94
Northeast	0.11	0.16	0.13	0.16
Midwest	0.35	0.26	0.29	0.27
South	0.33	0.31	0.37	0.33
West	0.21	0.26	0.21	0.24

Notes: Means are weighted to account for complex sampling design. See FoodAPS Users' Guide: https://www.ers.usda.gov/media/8804/0_foodaps-user-guide-puf.pdf.

Table 2: SNAP Purchasing Power and Children's HEI Total Scores
(Sample: SNAP Children Ages 2-17)

	(1)	(2)	(3)	(4)
ln(SNAPmax/TFP)	-4.045	14.09***	15.09**	18.73
	(5.662)	(5.123)	(6.226)	(11.25)
School Breakfast			0.676	
			(1.853)	
School Lunch			-4.710	
			(4.414)	
Controls?	No	Yes	Yes	Yes
State FE?	No	No	No	Yes
N	1,225	1,225	824	1,225
R^2	0.001	0.169	0.223	0.219
Effect of 10% increase in SNAP PP	-0.385	1.343	1.438	1.785
As a % of Mean	-0.8%	2.8%	3.0%	3.7%
β^* (Oster 2016; $R_{max} = 1.3\tilde{R}$)		23.37	25.77	28.96
δ (Oster 2016; $R^2_{max} = 1.3\tilde{R}$)		-0.933	-1.034	-1.019

Notes: Controls added in column (2) include individual-level controls for age (and its square), race/ethnicity, and gender; household-level controls for household size, income, car ownership, rural and nonmetro residence, WIC categorical eligibility, WIC participation, trouble paying bills, recent large expenditures, days since last SNAP benefit was received, college education, and whether anyone in the household uses tobacco; and HUD Fair Market Rents and a set of Consumer Price Indices (CPIs) in non-food, non-housing consumption categories.

Table 3: SNAP Purchasing Power and Children's Nutrition Outcomes
(Sample: SNAP Children Ages 2-17)

	(1) HEI- Vegetable	(2) HEI- Fruit	(3) % Calories From Sugar, Fat, Alcohol	(4) Added Sugar
ln(SNAPmax/TFP)	1.497**	1.139	-8.049	-189.9
	(0.696)	(0.867)	(6.393)	(368.3)
School Breakfast	-0.187	0.224	1.288	77.59
	(0.297)	(0.237)	(1.376)	(87.97)
School Lunch	-0.660	1.116***	3.332	-688.4**
	(0.528)	(0.211)	(2.800)	(272.9)
Controls?	Yes	Yes	Yes	Yes
N	903	903	903	903
R^2	0.156	0.145	0.131	0.230
Effect of 10% ↑ in SNAP PP	0.143	0.109	-0.550	-111.8
As a % of Mean	5.9%	5.2%	-2.3%	-14.5%
β^* (Oster 2016; $R_{max} = 1.3\tilde{R}$)	2.477	2.324	-14.68	-359.1
δ (Oster 2016; $R_{max} = 1.3\tilde{R}$)	-1.365	-0.874	-1.160	-1.540

Table 4: SNAP Purchasing Power and Adults' Nutrition Outcomes
(Sample: SNAP Adults)

	(1) HEI- Total	(2) HEI- Veg.	(3) HEI- Fruit	(4) % Calories from Sugar, Fat, Alc.	(5) Added Sugars (grams)	(6) Alcohol (grams)
ln(SNAPmax/TFP)	6.851	0.836	-0.076	-6.050	293.4	-11.42
	(5.886)	(0.568)	(0.688)	(4.604)	(246.4)	(39.03)
Controls?	Yes	Yes	Yes	Yes	Yes	Yes
N	2,145	2,311	2,311	2,311	2,311	2,311
R^2	0.120	0.053	0.139	0.091	0.212	0.049
Effect of 10% ↑ in SNAP PP	0.653	0.080	0.054	-0.577	27.96	-1.088
As a % of Mean	1.4%	3.1%	2.9%	-1.7%	5.0%	-3.7%
β^* (Oster 2016; $R_{max} = 1.3\tilde{R}$)	14.68	1.529	1.431	-10.81	351.3	-2.331
δ (Oster 2016; $R_{max} = 1.3\tilde{R}$)	-0.681	-0.756	-0.664	-0.993	-9.567	1.226

Table 5: SNAP Purchasing Power and Adult Incidence of Obesity and Overweight
(Sample: SNAP Adults)

	Obese			Overweight		
	(1)	(2)	(3)	(4)	(5)	(6)
ln(SNAPmax/TFP)	0.368***	0.304***	0.419*	0.085	0.108	0.138
	(0.127)	(0.0867)	(0.192)	(0.0642)	0.064)	(0.190)
Controls?	No	Yes	Yes	No	Yes	Yes
State FE?	No	No	Yes	No	No	Yes
N	2,350	2,289	2,289	2,350	2,289	2,289
R^2	0.008	0.080	0.108	0.000	0.070	0.095
Effect of 10% ↑ in SNAP PP	0.035	0.029	0.040	0.008	0.010	0.026
As a % of Mean	9.0%	7.4%	10.3%	1.2%	1.5%	1.9%
β^* (Oster 2016; $R_{max} = 1.3\tilde{R}$)		0.339	0.501		-1.438	-0.130
δ (Oster 2016; $R_{max} = 1.3\tilde{R}$)		-47.89	-7.025		-0.070	0.606

Table 6: Robustness Check: SNAP Purchasing Power and Children's Nutrition Outcomes
(Placebo Sample: Children Ages 2-17 with Household Income > 300% FPL)

	(1) HEI-Total	(2) HEI-Veg.	(3) HEI-Fruit	(4) % Calories from Sugar, Fat, Alcohol	(5) Added Sugars (grams)
ln(SNAPmax/TFP)	-36.74***	-1.022	-1.293	10.20	198.3
	(13.06)	(1.060)	(1.131)	(7.508)	(196.3)
Controls?	Yes	Yes	Yes	Yes	Yes
N	225	225	225	225	225
R^2	0.284	0.336	0.250	0.221	0.433
Effect of 10% ↑ in SNAP PP	-3.502	3.205	2.556	0.972	18.90
As a % of Mean	-6.7%	12.0%	10.3%	2.9%	2.4%
β^* (Oster 2016; $R_{max} = 1.3\tilde{R}$)	-45.66	1.500	1.166	10.99	218.9
δ (Oster 2016; $R_{max} = 1.3\tilde{R}$)	-1.943	-1.598	-0.555	-37.07	-19.79

Table 7: Robustness Check: SNAP Purchasing Power and Adults' Nutrition Outcomes
(Placebo Sample: Adults with Household Income > 300% FPL)

	(1) HEI-Total	(2) HEI-Veg.	(3) HEI-Fruit	(4) % Calories from Sugar, Fat, Alc.	(5) Added Sugars (grams)	(6) Alcohol (grams)	(7) Obese	(8) Over-weight
ln(SNAPmax/TFP)	-3.711	-0.860*	-0.412	1.921	199.5	32.06	0.006	0.205**
	(4.118)	(0.462)	(0.606)	(3.389)	(141.1)	(69.24)	(0.0734)	(0.0964)
Controls?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,938	2,103	2,103	2,103	2,103	2,103	2,080	2,080
R^2	0.196	0.060	0.114	0.082	0.016	0.088	0.072	0.128
Effect of 10% ↑ in SNAP PP	-0.354	-0.082	-0.039	0.183	19.01	3.055	0.001	0.020
As a % of Mean	-0.7%	-3.2%	-2.1%	0.5%	3.4%	10.3%	0.19%	2.8%