The Effect of SNAP Benefits for Food Insecurity

Abstract

This paper investigates the effect of Supplemental Nutrition Assistance Program (SNAP) benefits for food insecurity. The American Recovery and Reinvestment Act (ARRA) temporarily increased SNAP benefits. We use that increase as a natural experiment to identify the causal effect of endogenous SNAP benefits. We estimate models of food insecurity with linear two-stage least squares and non-linear instrumental variable (IV) probit. Results suggest that a per person SNAP dollar decreases food insecurity by 0.4% to 0.9%. However, effects are nonlinear. The probability of food insecurity is highest, and marginal effects are largest, when benefit amounts are small. (JEL: I18, Q18 D12, H51)

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I. INTRODUCTION

The Supplemental Nutrition Assistance Program (SNAP, formerly food stamps) is this nation's largest food assistance program and helps qualifying households purchase food. Its goal is "to alleviate … hunger and malnutrition … by increasing food purchasing power for all eligible households who apply for participation (P.L. 88-525)." Recently, the program has come under congressional scrutiny as expenditures have grown. Meanwhile, researchers continue to investigate program efficacy. This paper investigates the effectiveness of SNAP benefits for achieving the program's goal of alleviating hunger and informs policymakers of likely consequences of proposed program changes.

SNAP participation and expenditures have risen since the recession that began in December 2007 (figure 1). SNAP participation expanded as household incomes fell and unemployment rates grew as part of that recession (Ziliak, 2013). The American Reinvestment and Recovery Act (ARRA), which took effect in April 2009, temporarily increased the maximum household benefit likely increasing program participation (Nord and Prell, 2011).

Expanding program participation and increasing program costs gained the attention of policymakers. Some policymakers voiced a desire, and proposed legislation, that would reduce the size of the program significantly to reduce federal spending. A 2015 Congressional Budget Office (CBO) report evaluated the effect of several proposed modifications on incomes of eligible and participating households. The report considered the consequences from reducing benefits, increasing the rate at which benefits decline with net income, and reducing the income limits for eligibility (CBO, 2015).

Negotiations for the Agriculture Act of 2014 (hereafter Farm Bill) stalled prior to the Act's passage as House of Representatives and Senate versions of the Farm Bill differed on levels of SNAP funding, further highlighting congressional focus on SNAP benefits (Grovum, 2013;

Wilde, 2014). After the Farm Bills passage, lawmakers continued to suggest program modifications, including a consideration to alter the program by turning funding into block grants to states (CBO, 2015).

Previous research has examined the effect of SNAP participation on food security. Food security is the term used in government surveys to measure the adequacy of a household's food resources and it proxies for hunger risk. Households at risk of inadequate food resources are deemed food insecure. Previous research suggests that program modifications that decrease program participation would have adverse food security effects (see for example, Myzkerezi and Mills, 2010; Yen et al., 2008; Nord and Golla, 2009; Ratcliffe, McKernan, and Zhang, 2011).

Relatively little research has examined the effectiveness of program *benefits* and whether program effectiveness varies with benefit amount. SNAP provides households with a maximum benefit amount that depends on the number of household members. That maximum benefit is then reduced by $0.30 for every dollar of household net income (P.L. 88-525). Data from the 2014 Current Population Survey-Food Security Supplement (CPS-FSS) show that monthly benefit amounts were as low as $0.50 per person, and that 8.5 % of households received less than $20 per person per month. In contrast, the largest per person monthly benefit was $189 in 2014. It is unclear whether, for example, a $20 monthly benefit has an effect on household food security.

Further highlighting the importance of SNAP benefit research, the National Academies of Sciences recently completed a review of the adequacy of the SNAP benefit amount (Caswell and Yaktine, 2013). That study concluded, "[T]he most recent research suggests that it [the prevalence of food insecurity among SNAP households] would be even higher absent SNAP benefits," and calls for more research "estimating the impact of SNAP benefits" on food security and other health outcomes. This paper provides such important evidence-based economic analysis. We estimate the marginal impact of a per-person SNAP dollar on food security and simulate the effects of various SNAP program modification proposals on food security.

We estimate marginal impacts using instrumental variables (IV), where a natural experiment, the temporary ARRA increase in benefits, serves as an instrument for endogenous benefits.[1] The ARRA was passed as a response to an unforeseen economic crisis caused by disruptions in the financial system. The ARRA-induced SNAP benefit increases were applied uniformly across eligible US households. And, the benefit increase was temporary and was initiated after national food insecurity levels had already increased. The decrease in benefits was unforeseen and occurred after subsequent and separate legislative action in 2013, even though food insecurity levels remained elevated. Thus the timing of the changes, increase and decrease, are exogenous to local economic conditions and to changes in unobserved household characteristics. The timing also suggests that changes were a function of political considerations rather than considerations about food insecurity levels, bolstering that argument that ARRA benefit changes were exogenous to individual household food insecurity.

We find that the probability of being food insecure is highest when SNAP benefit amounts are low, even though incomes for these SNAP households are relatively high: the probability of being food insecure is about 50% at the lowest benefit amounts, but falls to less than 5% at the highest benefit amounts. We estimate that that a per-person benefit dollar reduces food insecurity by about 0.4% to 0.9%. But, the marginal effect of a per person SNAP benefit dollar is not constant over benefit amounts; the marginal effect is largest, when SNAP amounts are small, and marginal effects diminish as benefit amounts increase.

[1] Gregory, Rabbit, and Ribar (2013) suggest 'natural experiments' may be a promising avenue to examine SNAP efficacy.

The implications for policy are that any benefit reduction would adversely affect food security at all benefit levels. However, the largest effects will be felt by households that receive the lowest benefit levels. Program efficacy could be improved by lowering the rate at which benefits are reduced with net income, rather than increasing the rate as is currently being considered. As federal budgets tighten, it is important to know how best to direct changes in food assistance spending. This research informs those policy decisions and clarifies whether current benefit levels, especially low benefit levels, are achieving the program goal of alleviating food insecurity.

II. SNAP AND POLICY

SNAP eligibility is determined by a household's income and resources, while the household benefit is determined by household size, income, and deductions for certain expenses. Eligibility guidelines require gross monthly income to be equal or less than 130 percent of the poverty level, and net income after allowable expense deductions must be at or below the poverty line.[2] Resource guidelines require households to have assets equal to $2,250 or less, while households with elderly or disabled members may have assets equal to $3,250.[3] And, some persons are typically ineligible for food stamps regardless of income and resources, including undocumented immigrants, persons on strike, and some legal immigrants in the US for less than five years. In addition, childless unemployed adults are typically limited to three months of benefits.

Gross household income is reduced by deductions for living expenses, including a standard deduction, and deductions for medical, dependent care, child support, and shelter

[2] Some households are "categorically" eligible for SNAP, apart from normal income and assets tests, if they qualify for some other assistance programs.

[3] Some assets are not counted for purposes of determining eligibility. For example, home and lot are not counted. And, states differ on the policies toward vehicles and some states completely exclude the value of a vehicle form countable assets.

expenses, to arrive at net income. Maximum household benefits increase at a decreasing rate with household-size. Households with zero net-income receive the maximum benefit for that household size, and benefits are reduced from the maximum by 30 cents for each dollar of net-income.

The American Recovery and Reinvestment Act of 2009 (ARRA) was signed into law in February of 2009 in response to severe weakness in the US economy that originated from disruptions in global financial markets. The ARRA was intended to stimulate the economy by expanding government spending, and reducing taxes, by an estimated $787 billion between 2009 and 2019. Spending provisions in the ARRA included increased funding to states and localities, increased infrastructure spending, extended unemployment benefits, and additional aid to low-income households.

Aid to low-income households included changes in federal food assistance programs. The ARRA expanded SNAP eligibility to jobless households with no children, and increased the maximum SNAP benefit by about 13.6 percent. SNAP benefit increases were intended to be temporary. The benefit increase was set to expire when the regular rate of benefit inflation overtook it, but legislation in 2010 instead terminated the increase in November 2013 (Dean and Rosenbaum, 2013).[4]

The ARRA also provided additional funds to states for other food assistance programs; the ARRA allotted $500 million to the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) with $400 million devoted to an anticipated increase in demand for services. The ARRA provided $150 million for local agencies to support food banks, soup

[4] The ARRA 13.6 percent increase in benefits in 2009 did not further increase with inflation. Increases were originally set to gradually expire as inflation overtook them. When the ARRA increase was eliminated in 2013, inflation had eroded about 7 percent of the spending power of the increase. So, the final decrease in benefits levels amounted to about 6 percent.

kitchens, and food pantries. The Act also provided funds to the National School Lunch Program (NSLP) and food distribution programs on Indian Reservations. But the funds, $100 million to the NSLP and $5 million to Indian Reservations, were designated for purchase of equipment and facility upgrades and are unlikely to have an impact of food security.

Even though National Bureau of Economic Research (NBER) sets June 2009 as the end of that recession, SNAP participation and spending remained high in the post-recession years compared to levels in prior years. These facts led to congressional debates over the appropriate ways to fund the program. For example, negotiations over the 2014 Farm Bill stalled as bills in the US House of Representatives and Senate differed on levels of SNAP funding (Grovum, 2013; Wilde, 2014). The final version of the Farm Bill that passed into law in 2014 reduced SNAP spending by $8 billion over 10 years, with reductions coming in addition to the 2013 reductions (Wilde, 2014).

The Farm Bill benefit reduction was concentrated in a small number of households. Some states provide SNAP households with energy assistance. Previously, these households were able to take an energy related deduction when determining net income for SNAP benefits. The Farm Bill eliminated this energy assistance deduction, and the Congressional Budget Office (CBO) estimated this change would decrease SNAP spending by $8 billion over 10 years (Wilde, 2014).

The Farm Bill reduction amounted to about a 1% reduction in program costs. Subsequent Congressional proposals sought further ways to modify the program and reduce program expenditures (CBO, 2015). The Congressional Budget Office considered the effect of several program modifications on household incomes. These modifications include reducing benefit levels, increasing the rate at which benefits decline with net income, and reducing the income limits for eligibility (CBO, 2015).

III. SNAP AND FOOD INSECURITY

The ARRA changes in SNAP may have affected food insecurity through two avenues. SNAP participation is likely to have increased because of expanded eligibility standards. But, SNAP participation might also increase because of expanded food benefits. Prior to the Act some households may have chosen not to participate, even though they were eligible, because the benefit from participating did not exceed the perceived, perhaps psychic cost, of participating in SNAP. After the Act, the enhanced benefits likely changed the cost-benefit calculation for some households leading them to participate (Nord and Prell, 2011).

Previous research investigating SNAP's ability to improve food security show mixed results. Jensen (2002) notes that there is likely a positive correlation between a household's SNAP-participation decision and their food-insecurity status. Using full-information maximum likelihood, she jointly estimates limited-dependent variable equations and finds that "expected SNAP benefits" reduce the probability of food insecurity; the CPS-FSS, did not capture actual SNAP benefits in the 2000 survey. Gunderson and Oliveira (2001) estimate two equations for SNAP participation and food security using simultaneous probit, but are unable to identify a statistically significant link between the two. Wilde and Nord (2005) exploit the longitudinal nature of the CPS-FSS to control for unobserved household heterogeneity. But, again they are unable to identify a statistically significant causal relationship between SNAP and food insecurity.

More recent research uses instrumental variables to identify SNAP participation effects. Food insecurity status and SNAP participation are separate limited dependent-variable equations. Heterogeneity in participation rules across states exogenously shifts the participation equation allowing the identification of the participation effect in the food insecurity equation (Yen, et al. 2008; Ratcliffe, McKernan, and Zhang, 2011). Another approach uses state-level errors in payments as instruments for benefits (Myzkerezi and Mills, 2010). These studies find a negative relationship between SNAP participation and food insecurity, and they are also among the most convincing research establishing the effectiveness of SNAP participation. These studies also highlight the effectiveness of instrumental variable estimation to disentangle the simultaneous determination of food insecurity and SNAP participation.[5]

Mabli et al. (2013) use a nationally representative sample of SNAP households collected by Mathematica Policy Research to analyze the effectiveness of SNAP. Mabli et al. measures food insecurity among participating households from initial entry into the program and after 6 months in the program. The authors find that the proportion of food insecure households falls after a duration of time on SNAP.

Nord and Golla (2009) follow a similar approach and analyze SNAP households before and after entry into the program, also finding that food insecurity declines after a household participates in SNAP for a duration of time. Gregory, Rabbit, and Ribar (2013) review the SNAP and food security literature and conduct analysis using data from the CPS-FSS for 2009-2011. They find weak evidence that SNAP participation reduces food insecurity, but they find stronger evidence that SNAP reduces food insecurity when examining SNAP benefits.

Most previous studies view SNAP's efficacy as dichotomous and homogeneous among participants receiving varying benefits. A relatively small number of previous studies estimate a causal relationship, and overall results in previous studies are mixed. In contrast, we recognize that households' benefits are heterogeneous, as benefits are reduced thirty cents for each dollar of a household's net income, and therefore program effectiveness may be correspondingly heterogeneous. We use a regulatory increase in benefits from ARRA as an instrument to identify

[5] Other studies that find that food stamps (or SNAP) reduce food insecurity include, DePolt et al. (2008), Nord and Golla (2009), and Borjas (2004).

the causal effect of benefits. We find strong evidence that SNAP reduces food insecurity, but that effects vary with benefit level.

IV. CONCEPTUAL MODEL

As in previous research (Yen, et al., 2008, Ratcliffe, McKernan, and Zhang, 2011, Mykerezi and Mills, 2010) we model food insecurity as a function of SNAP. However, in contrast to these studies we do not model SNAP as a binary participation variable, but as the number of monthly SNAP dollars received by a household divided by the number of household members, i.e., per person SNAP dollars (SNAP$),[6]

(1) $$FI = f(\boldsymbol{X}, SNAP\$; \boldsymbol{\beta}) + \varepsilon,$$

where $\boldsymbol{X}$ is a vector of variables determining food insecurity (***FI***), including household characteristics, $\boldsymbol{\beta}$ is a vector of parameters to estimate, and ε is an error term capturing unobserved factors affecting $\boldsymbol{FI}$. Assuming a linear function, equation (1) could be estimated with ordinary least squares (OLS). However, coefficient estimates of $\boldsymbol{\beta}$ would be biased and inconsistent because ***SNAP$*** is simultaneously determined with FI and is thus an endogenous variable in (1). That is,

(2) $$SNAP\$ = f(\boldsymbol{Z}, FI; \boldsymbol{\delta}) + u,$$

where $\boldsymbol{Z}$ is a vector of variables determining SNAP benefits, $\boldsymbol{\delta}$ is a vector of parameters to estimate, and u is an error term capturing unobserved factors affecting ***SNAP$. Z*** and ***X*** may overlap, but if there is at least one variable in ***Z*** that is not in ***X*** then equation (1) is identified, and $\boldsymbol{\beta}$ can be consistently estimated by instrumental variable methods. The variable(s) in ***Z***, but excluded from ***X***, are the instrumental variable(s).[7]

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[6] Gregory, Rabbit, and Ribar (2013) also analyze SNAP benefits, but use a different data set and different instruments than we use in our model. They do not examine effectiveness at different benefit levels.

[7] Other variables in ***X*** and ***Z*** include household income, age, whether the household includes a married couple, home ownership, education level, minority status, household size, children in household, employment status, gender, state dummy variables, and annual dummy variables.

In order for a variable to be a valid instrument, it should be correlated with the endogenous variable SNAP$. But it must be otherwise uncorrelated with the dependent variable, FI, in equation (1). This means that the instrumental variable cannot be a determinant of FI, except through its effect on SNAP$. And, there cannot be any unobservable factors in ε that are correlated with the instrument.

The ARRA increased SNAP maximum benefits in April of 2009. However, in November of 2013 benefits were reduced to their previous levels, except for normal inflation increases. So, average SNAP benefits increased during the time the ARRA provisions were in effect. Thus, we define a variable, ***ARRA***, that takes a value of 1 for the years in the data for which ARRA was in effect. ***ARRA*** takes a value of zero for all other years.

The ARRA also relaxed the restriction that childless households could not receive benefits. We include a childless dummy variable in ***X*** and ***Z*** because childless households may be less likely to be food insecure and because they are sometimes restricted from receiving SNAP benefits. But, we include an interaction of the childless dummy and the ARRA dummy in ***Z*** (***ChildlessxARRA***), reflecting the change in policy while ARRA was in effect.

As a robustness check, we use an alternative instrument instead of the ***ARRA*** dummy. The ARRA increased benefits, but did away with annual cost of living increases. Once normal cost of living increases overtook the initial 13.6 percent increases, cost of living increases would resume. Thus, the purchasing power of the ARRA increase erodes with food price inflation; we include a variable, ***CPIfoodxARRA,*** that captures this effect. We adjust ***SNAP$*** for inflation using the consumer price index for food (***CPIfood***). Outside of the ARRA years, nominal SNAP benefits were increased for food price inflation and there is no relationship between real ***SNAP$*** and ***CPIfood,*** all else constant; nominal dollars in the numerator increase at the same rate as ***CPIfood*** in the denominator. However, during the years that ARRA was in effect, real ***SNAP$*** decreased with ***CPIfood***; nominal benefits in the numerator were constant, while ***CPIfood*** in the denominator increased.

Because ***ARRA***, ***ChildlessxARRA***, and ***CPIfoodxARRA*** are correlated with ***SNAP$*** they should be included in ***Z***. However, to be a legitimate instrument they should not be included in ***X.*** FI is likely a function of macroeconomic conditions and ***ARRA*** is arguably a function of macroeconomic conditions. We include annual dummy variables in ***X*** and ***Z*** to control for these unobservable factors.[8] So, including the ***ARRA*** dummy variable in ***X*** would be redundant, unless the specific timing of the policy change was correlated with FI, after controlling for the unobservable factors with annual dummy variables. This seems unlikely because the ARRA benefit increase did not take effect until 2009 and was discontinued in 2013. National measures of FI were nearly constant at about 11% from 2005 to 2007. But, FI increased to 14.6% in 2008, a year before ARRA SNAP benefit changes, and remained near that level until at least 2014; FI was 14% in 2014. So the timing of the ARRA benefit change seems determined by political considerations and not household food insecurity levels. We conduct falsification tests and Sargan tests of over-identifying restrictions to support our contention that ***ARRA***, ***ChildlessxARRA*** and ***CPIfoodxARRA*** are exogenous and properly excluded from ***X***.

V. DATA

We use household observations from the CPS-FSS from 2005 through 2014. The CPS surveys about 56,000 households monthly. Households in the CPS are interviewed each month for four consecutive months, then ignored for eight months, then interviewed for the same four months the following year. The FSS of the CPS is conducted in December of each year.

[8]We also experimented with variables meant to capture macroeconomic conditions. Our empirical conclusions were unchanged when we included state unemployment levels and state gross domestic product in ***X*** and ***Z*** instead of annual dummy variables.

The survey asks a number of detailed questions that are combined into a single overall measure of household food security called the household's food security scale. The scale is a continuous variable that measures the severity of a household's food insecurity and hunger. The scale provides a more thorough way of capturing the complex factors inherent when measuring food security. It is useful to summarize the continuous scale into discrete measures of food security for research purposes. In the CPS-FSS households are categorized as food secure, moderately food secure, low food secure, and very-low food secure. In this study, food secure households are those categorized as either food secure or moderately food secure in the CPS-FSS data. Thus, ***FI*** is a binary variable that takes a value of one if a household is food insecure, and zero otherwise.

The CPS-FSS includes a number of household characteristics including households' incomes and food purchases. A key question is the amount of SNAP dollars received in the most recent month in which a household participated in SNAP; the survey also captures the number of persons in a household. SNAP dollars divided by household size is the dependent variable in equation 2 (***SNAP$***). ***SNAP$*** is deflated to constant 2009 dollars by the consumer price index for food.[9]

The annual number of households in the data varies from year to year, with a minimum of 53,410 households in 2013, to a maximum of 54,556 households in 2005. Aggregating over all 10 years, there are 538,138 households in the data. We limit our investigation to households that are below 130% of the poverty level, assuring that the included households are likely SNAP eligible. After this restriction, the data include a total of 99,884 households. Missing and unreported values for some variables reduce the number of household observations to 80,521.

[9] We deflate to 2009 so that one of our instruments, ***CPIfoodxARRA***, takes a value of 1 in 2009 easing interpretation of our first-stage coefficients.

The CPS is a multi-stage stratified sample, and not a random sample of U.S. households. Failing to account for this complex survey design will produce understated standard errors using standard econometric software. Furthermore, failure to appropriately weight data to account for non-random sampling can produce incorrect coefficient estimates (Holt, Smith, and Winter 1980). We follow the procedure suggested by the Center for Economic and Policy Research to correctly estimate standard errors and coefficient estimates when using data from the Current Population Survey (CEPR, 2015). Few previous studies of the effect of SNAP participation on food insecurity expressly state whether they use sampling weights in their analysis, and fewer still detail their method for controlling for stratified sampling design.[10] In contrast, our research explicitly details the methods used and results are generalizable to the SNAP eligible U.S. population.

VI. ESTIMATION METHODS AND RESULTS

We investigate two methods to consistently estimate the parameters in equation 1. In the first method, we estimate equation (1) as a linear probability model (LPM) and begin by presenting results from a naïve regression without considering the endogeneity of ***SNAP$***. Next, we estimate equation (1) using two-stage least squares, where equation (2) serves as the fist-stage reduced form for endogenous ***SNAP$***. As a linear model, the LPM estimates a constant marginal effect for SNAP benefits.

In the second method, we assume (ε, u) has a mean-zero bivariate normal distribution and estimate equation (1) with a probit model taking account of the endogeneity of ***SNAP$***. This is the so-called Instrumental Variable-Probit estimator (IV-probit) and can be estimated using

[10]We confirmed our weighting method by reproducing the national percent of food insecure households as reported by the Economic Research Service for each year, 2005-2014. We were able to exactly replicate ERS' food insecurity estimates.

maximum likelihood (ML). The benefit of the probit estimator is that it is nonlinear, and so estimates of marginal effects are also nonlinear.

As mentioned, all estimates use appropriate sample weights and adjust standard errors for stratified sampling design. Table 1 lists all variables included in the regressions, and table 2 presents summary statistics for all variables.

Naïve Model Results

We begin by running naïve regressions of SNAP benefits (and other controls) on food insecurity, without controlling for the endogeneity of benefits. Table 3 shows the results from two samples, using linear regression and probit. The first sample includes households that are below 130% of the poverty level, and thus are likely SNAP eligible. The second sample recognizes that the ARRA increased funding for WIC and food pantries and so ARRA may affect food insecurity other than through SNAP. The second sample is from households below 130% of the poverty, but that did not participate in WIC or visit a food pantry in the 30 days prior to the survey.

As expected, the coefficient on SNAP benefits is positive and statistically significant in all cases in table 3. These regressions point to the difficulty identifying the effect of SNAP benefits on food insecurity without controlling for the endogeneity of benefits. In these naive regressions, it appears increases in benefits are associated with increases in food insecurity in contrast to predictions from economic theory. Such an empirical finding provides unreliable and inappropriate policy guidance.

Two-Stage Least Squares Linear Probability Model (LPM): First Stage Results

We next conduct LPM estimation using two-stage least squares and ***ARRA, ChildlessxARRA,*** and ***CPIfoodxARRA*** as instruments for SNAP benefits. Table 4 shows the results from the first-stage regression with ***SNAP$*** as the dependent variable.

It appears ARRA is a relevant instrument in that there is a strong partial correlation between ARRA and per-capita SNAP benefits in the first-stage regressions. Results indicate the ARRA increased per-capita SNAP benefits about: $7.01 in the first sample, $6.44 in the second sample, conditioned on the other explanatory variables.

The interaction term, ***ChildlessxARRA***, is a much weaker instrument in both samples as its individual coefficient is not statistically significant. However, the coefficients for ***ARRA*** and ***ChildlessxARRA*** are jointly significant at the 1 percent level (F(2,119)=15.10, p-value=0.000) when using the larger sample, and with similar results when using the smaller sample).

The final two columns in table 4 show results from using ***CPIfoodxARRA*** as an instrument instead of ***ARRA***. We deflate income and ***SNAP$*** per capita to constant 2009 dollars using the food CPI. So, ***CPIfoodxARRA*** takes a value of zero prior to 2009, takes a value of 1 in 2009 and increases thereafter with the pace of food inflation, until taking a value of 0 in 2014 after ARRA ended and benefits were reduced. As in the first two columns of table 4, ***CPIfoodxARRA*** is strongly correlated with ***SNAP$*** per capita, while ***ChildlessxARRA*** is weakly correlated. However, their coefficients are jointly significant (F(2, 119)=15.06, p-value=0.000 when using the large sample).

Two-Stage Least Squares Linear Probability Model (LPM): Second Stage Results

Table 5 shows the second stage results for the LPM specification. Once the endogeneity of ***SNAP$*** per person is controlled using instrumental variables, the coefficient on ***SNAP$*** is negative and statistically significant. Interpreting the coefficients, shows that a one dollar increase in SNAP benefits per person causes a decrease in the probability of food insecurity ranging from 0.7% to 0.9%.

Interestingly, the results for the sample restricted to non-WIC/non-food pantry households are slightly larger than those for the unrestricted sample. It does not appear that ARRA funding expansions to WIC and food pantries are contaminating our SNAP estimates. If the ***ARRA*** instrument is capturing the effect of expansions in those programs, then the effect of ***SNAP$*** would be overstated; the error term in equation 2 would be correlated with ***ARRA***. If this were true, eliminating the households that benefited from expansions in those programs should reduce the magnitude of the ***SNAP$*** per capita coefficient in equation 1. Because they are instead larger suggests our estimates are not overstated. We conclude that the difference in estimates between samples is due to sampling variability.

The negative coefficient confirms earlier studies that found that SNAP participation decreased the probability of household food insecurity. However, the LPM does not allow us to examine whether effects vary with benefit level. Below, we report marginal effects from a non-linear probit estimator that vary with SNAP benefits.

<u>Instrument Exogeneity: A Sargan Test</u>

We are somewhat concerned that ***ARRA*** does not capture an exogenous increase in ***SNAP$***. Because we have two potential instruments, either ***ARRA*** and ***ChildlessxARRA*** or ***CPIfoodxARRA*** and ***ChildlessxARRA***, we can test the validity of the instruments using a Sargan overidentification (exogeneity) test. The results for this test are reported in the bottom portion of table 5. In all cases, we cannot reject the null hypothesis of exogenous instruments.

<u>Instrument Exogeneity: A Falsification Test</u>

Our hypothesis is that the ARRA affected food insecurity only because it increased SNAP benefits or increased SNAP eligibility, and therefore ***ARRA***, ***ChildlessxARRA, and CPIfoodxARRA*** are properly excluded from equation 1. The data provide a useful falsification test. So far, the results suggest that an increase in SNAP benefits decreases the probability of household food insecurity. If food insecurity decreases only because of ARRA regulatory changes to SNAP, then food insecurity at households that did not receive SNAP benefits should be unaffected during the years the ARRA was in effect (all else constant). We test whether food insecurity for non-SNAP households changed during the years in which the ARRA's regulatory changes were in effect by creating a sample of households below 130 percent of the poverty level that did not participate in SNAP. We then regress ***FI*** on all other included independent variables and the excluded instruments. We then predict food insecurity for each year, 2005-2014. When we calculate predicted food insecurity, all variables are held constant at their means, except for the annual dummy variables and the instruments. We then average predicted food insecurity for the ARRA years, and for the non-ARRA years.[11]

The difference in the average food security between the ARRA years compared to the non ARRA years is reported in table 6. The average change is about 0.8 percent and is not statistically significant, regardless of the modeling method and choice of instruments. There was not a statistically significant change in the probability of food insecurity at households that did not receive SNAP benefits during the years ARRA was in effect. We consider this strong evidence that the instruments are not capturing the effect of unobserved determinants of food insecurity, except for the intended effect of regulatory changes.

<u>IV-Probit Results</u>

There is debate about the merits of the various methods used to estimate binary dependent variable models. Angrist and Pishke (2009) voice the argument that linear regression models do well at estimating marginal effects of independent variables and since most studies are primarily interested in marginal effects, linear models are sufficient. In this argument, non-linear models are unnecessarily complex, and their consistency is dependent on choosing the correct nonlinear

[11] This method is essentially equivalent to regressing FI on the instruments and all other control variables, except for the annual dummy variables. When we estimate this regression equation, the coefficients on the instruments are not statistically significantly different from zero, individually or jointly.

model, which is not testable since the correct (i.e., population) model is unknown. On the other hand, some researchers contend that nonlinear models should not be so easily dismissed. As an example, the linear probability model is biased and likely inconsistent unless the predicted values from the true linear model are within the unit interval (Horrace and Oaxaca, 2006).

Our approach is to estimate a linear model followed by a nonlinear probit model, and compare the results. We use the probit estimator because it is readily adapted to address endogeneity of independent variables. Table 7 shows the average marginal effects from the second-stage IV-probit estimation. These average marginal effects are slightly smaller than those from the LPM. But, again the results suggest that SNAP benefits cause a decrease in the probability of food insecurity. The coefficients in this specification range from -0.4% to -0.5%.

Some prior research suggests that SNAP participation reduces the probability of food insecurity by about 16 percent. For example, Ratcliffe, McKernan and Zhang find a reduction in food insecurity from SNAP participation of 16.2 percent, and Mykerezi and Mills report a 14.1 to 16.8 percent reduction. If we (somewhat arbitrarily) assume SNAP results in a 16 percent reduction in the probability of food insecurity, then we can calculate the implied marginal effect of a SNAP dollar. In 2014, the average per person SNAP benefit was about $120 and the average marginal effect of a per-person SNAP dollar is -16/120 = -0.133 percent.

This implied marginal effect from earlier studies, -.133, is smaller in absolute value than the average marginal effect in table 7. However, our results suggest that marginal effects are nonlinear. Figures 2 and 3 show estimated marginal effects (and 95% confidence intervals) from the IV-probit model, when effects are evaluated at different amounts of per capita SNAP benefits. The average marginal effect at $120 in figure 2 is -0.30% and -0.25% in figure 3, still larger, but more consistent with the implied effect from prior studies.[12] Both figures 2 and 3 show that the marginal effect of a per person SNAP dollar is largest when benefits amounts are low, and that marginal effects grow smaller as benefit amounts increase.

Figures 4 and 5 show the predicted probabilities (and 95 percent confidence intervals) of being food insecure at different benefit amounts using the IV-probit estimates. We estimated the probability of food insecurity for each household in the sample given each household's characteristics. That is, we do not evaluate probabilities at variable averages, but instead evaluate each household's probability given that household's characteristics and then average probabilities for households that have different levels of SNAP benefits. So each probability in figures 1 and 2 is the average probability for households with each level of SNAP benefit.

We calculated probabilities, then took averages because we want to know the estimated probability of food insecurity, conditioned on each household's actual characteristics. We did not want to impose an income level on a household then calculate the probability of food insecurity. Instead, we wanted to know, given a household's income, SNAP benefit, and other characteristics, what is the probability that household is food insecure.

Figures 4 and 5 suggest a relationship between the probability of food insecurity, household income, and SNAP benefits. As per person benefits increase, the probability of food insecurity decreases. However, the figures show that there is a large probability of food insecurity

[12]We argue our approach is better able to accurately estimate the marginal effect of SNAP benefits. First, we explicitly estimate SNAP benefit marginal effects, rather than "backing-out" a rough estimate from a probit estimate of SNAP participation. Second, because prior studies estimate SNAP participation using a probit model the marginal effects in those studies are also nonlinear. It is easy to show that the marginal effect of SNAP participation on food insecurity in those studies is affected when evaluated at different values of the control variables. For example, the effect of SNAP participation for a disabled, female headed, black household, with a less than high school education living in a Metro area in 2003, using the mean values of all continuous variables is about -22 percent when using coefficients from Ratcliffe, McKernan, and Zhang. The implied marginal effect of a SNAP benefit dollar in that case is -0.2 percent.

for households that receive less than about $100 dollars in benefits per person per month. This is true even though household incomes are higher for those households.

VII. DISCUSSION

The results presented in figures 2-5 point to several factors reflecting the efficacy of SNAP. For example, figures 4 and 5 suggest that it would require a per person benefit of nearly 200 2009 dollars to reduce the probability of food insecurity to near zero (or 221 in 2015 dollars). While it is true that the maximum benefit has been $200 for a single-person household in some years, the maximum per person maximum in multiple member households is almost always less than $200. For example, in 2016 the maximum monthly benefit for a three person household was 463 2009 dollars, or $154 per household member.[13] As mentioned earlier, per person maximums decrease with household size, so larger households qualify for even smaller per person maximums. The implication is that even if eligible households were exogenously assigned to receive SNAP benefits, the current benefit maximums are not adequate to reduce the probability of food insecurity to zero.[14]

Our results also support the finding in Caswell and Yaktine (2013) that the SNAP benefit reduction rate is too large. Caswell and Yaktine note that the 0.30 benefit reduction rate is based on the assumption that a "household spends 30 percent of its income on food" which is outdated since households today spend only about 13 percent of their income on food (Caswell and Yaktine, 2013, pp 179). Figures 4 and 5 show that the probability of food insecurity is highest when SNAP benefits are low. Households receive lower benefits primarily because their benefit is reduced by $0.30 for each dollar of net income (our model controls for household size, another

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[13] The maximum benefit for a three person household was $511 in 2015. We discounted this value to 2009 dollars using the consumer price index for all urban consumers.
[14] Current maximum benefits seem even less adequate once we recognize that benefits are truly endogenous; 26 percent of households are observed to be food insecure although they receive nearly $200 in per person benefits.

important determinant of per person benefits).[15] Figures 2 and 3 show that the marginal effect of a SNAP dollar is largest when per person benefit amounts are low. If larger net incomes offset the effect of lower SNAP benefits, we would expect a lower probability of food insecurity at low benefits, and an approximately constant marginal effect across all benefit amounts.

Finally, our results suggest that changes in benefit levels are likely to have the largest impacts for households that receive relatively small per person benefit amounts. For example, the recent ARRA increase in benefits most likely had the largest effect on households that received less than $100 a month in benefits. Likewise, the subsequent November 2013 decrease in SNAP benefits is likely to have its largest food security impact on those low-benefit households. On the other hand, the ARRA increase in benefits, and the 2013 decrease, is likely to have had a relatively small marginal impact on the food security of households that received larger benefit amounts.

VIII. CONCLUSION

Policy makers are debating altering the Supplemental Nutrition Assistance Program as program participation and expenditures remain elevated even though the US is several years removed from the 2008-2009 recession. At the same time, research questions remain over the program's effectiveness at achieving its goals of alleviating hunger and malnutrition. This paper evaluates whether SNAP benefits are effective at reducing food insecurity, and whether benefit effectiveness varies with benefit amounts. Our results point to several considerations when contemplating future program changes.

[15]Household size is relatively constant across all per person SNAP benefit amounts. However, there is a slight quadratic relationship as benefits increase. The average household has 2.55 members at $10 per month, increases to 3.73 members at $80 of benefits, and then declines to 1.11 members at $200.

We find that SNAP benefits decrease the probability of household food insecurity. This finding supports earlier studies that find that SNAP participation reduces the probability of food insecurity. Thus, the program is effective at achieving its goal of alleviating hunger, as food insecurity is a proxy for hunger risk.

However, we find that program effectiveness varies with benefit level. Interpreting our findings is complicated because they rely on assuming SNAP benefits are exogenous, even though benefits are, in reality, endogenous. Assuming benefits are exogenous, we find that the probability of food insecurity is nearly 45 percent when per person benefits are less than $20. We also find that it would require nearly $200 ($221 in 2015 dollars) per month in per person benefits to reduce the probability of food insecurity to near zero. We believe this finding sheds light on the question of benefit adequacy. Current regulations do not allow for a household to receive $200 ($221) in per person benefits; the 2016 maximum benefit for a single person household is $194, and per person maximums decline with household size. It is even less likely that current benefits are adequate to drive food insecurity to zero because benefits are actually endogenous and households are more likely to apply for and receive benefits when they are least food secure.

SNAP regulations reduce SNAP benefits by $0.30 for each dollar of net income under the assumption that households spend 30 percent of income on food. In 2013, USDA-Food and Nutrition Service (USDA-FNS) sponsored a study by the National Academies of Science to examine the adequacy of SNAP allotments; the study report specifically recommended that, "USDA-FNS should evaluate whether there is a need to adjust downward the current benefit reduction rate" (Caswell and Yaktine, 2013). The results of our research suggest the current benefit reduction rate is too severe if the program's goal is to alleviate food insecurity. We find that the probability of food insecurity is highest when SNAP benefits are lowest. Because the primary cause of low per person benefits is the net income reduction, it follows that the net income reduction is a driver of increased food insecurity at low benefit levels. We also find that the marginal effect of a per person SNAP dollar is largest, when benefits are low, suggesting that a change in the benefit reduction rate, or any change that increased benefits, would improve the food insecurity status of low benefit households.

We hope this paper will contribute to the ongoing policy debates. SNAP is effective at reducing food insecurity. Any benefit changes will have food insecurity consequences. Our paper informs on the likely consequences of changes, and our hope is that it can be used to direct policy to efficiently achieve the program's goals.

Table 1.
Variable Names

Variable Name	Definition
Food Insecure	A binary variable for whether the household was food insecure in the last 12 months.
SNAP$ per Capita	Food stamp dollars received in the most recent month, divided by the number of persons in the household .
House Income	A continuous measure of income. The mid-point of upper and lower values of the categorical income values in the CPS-FSS. In 10,000s of dollars, delated to constant 2009 by the consumer price index for all urban consumers.
Age	The age of the person answering the survey in the CPS-FSS
Age Squared	Age x age
Married	Binary variable. Household is a married couple=1.
Own Home	Binary variable. Household owns their home =1.
HS Graduate	Binary variable. Person answering the survey graduated high-school=1. Not a high school graduate is the base.
College Graduate	Binary variable Person answering the survey graduated college=1. Not a high school graduate is the base.
Minority	Binary variable Person answering the survey identified themselves as non-Caucasian=1.
Unemployed	Binary variable. Person answering survey unemployed=1.
Childless	Binary variable. No children in the household=1.
HH Size	Number of persons in the household.
Male	Binary variable. Person answering survey is male (male=1).
ARRA	Binary variable = 1 after March 2009 and before December 2013.
CPI_food	Consumer Price Index for food, 2009 =100.

Table 2.
Variable Summary Statistics

Variable Name	Mean	Std. Dev.
Food Insecurity	0.339	0.006
Income	1.363	0.015
HH Age	48.294	0.670
HH Age Squared	2692.27	69.64
Married	0.286	0.008
Own Home	0.385	0.035
High School	0.605	0.012
College	0.095	0.011
Minority	0.272	0.022
HH Size	2.638	0.051
Childless	0.652	0.010
Unemployed	0.090	0.005
2005=1	0.075	0.002
2006=1	0.069	0.002
2007=1	0.074	0.002
2008=1	0.086	0.001
2009=1	0.096	0.001
2010=1	0.124	0.001
2011=1	0.122	0.002
2012=1	0.121	0.001
2013=1	0.118	0.003
2014=1	0.114	0.004
SNAP$	30.048	1.031
ARRA=1	0.580	0.004
ChildlessxARRA	0.382	0.005
CPIfoodxARRA	0.610	0.005

Table 3.
Naïve Regressions. Dependent Variable=Food Insecurity

	OLS		Probit	
	HH < 130 Poverty Level	HH < 130 Poverty, No WIC, No Food Pantry	HH < 130 Poverty Level	HH < 130 Poverty, No WIC, No Food Pantry
SNAP$ per person	0.001***	0.001***	0.004***	0.004***
	(0.0001)	(0.0001)	(0.0001)	(0.0002)
HH Income	-0.0412	0.0083	-0.0579	0.0991
	(34.425)	(35.890)	(98.561)	(115.126)
Age	0.021***	0.015***	0.069***	0.056***
	(0.001)	(0.001)	(0.003)	(0.003)
Age squared	-0.000***	-0.000***	-0.001***	-0.001***
	8.030E-06	7.190E-06	2.940E-05	3.030E-05
Married	-0.049***	-0.054***	-0.145***	-0.182***
	(0.003)	(0.004)	(0.011)	(0.016)
Own Home	-0.070***	-0.050***	-0.211***	-0.170***
	(0.005)	(0.005)	(0.014)	(0.017)
HS Grad	-0.039***	-0.037***	-0.123***	-0.131***
	(0.006)	(0.005)	(0.017)	(0.016)
College Grad	-0.139***	-0.114***	-0.453***	-0.421***
	(0.006)	(0.006)	(0.023)	(0.024)
Minority	0.017***	0.023***	0.055***	0.077***
	(0.006)	(0.007)	(0.017)	(0.023)
HH Size	0.012***	0.004*	0.032***	0.012
	(0.002)	(0.002)	(0.005)	(0.008)
Childless	-0.015**	-0.029**	-0.027	-0.067*
	(0.008)	(0.011)	(0.023)	(0.034)
Unemployed	0.095***	0.096***	0.258***	0.275***
	(0.011)	(0.010)	(0.030)	(0.027)
Male	-0.023***	-0.016***	-0.071***	-0.055***
	(0.006)	(0.005)	(0.018)	(0.018)
Constant	-0.047*	0.049	-1.686***	-1.485***
	(0.027)	(0.035)	(0.089)	(0.125)
R-squared	0.106	0.089		
Number of Obs	80,521	61,497	80,521	61,497
Annual Dummies	Yes	Yes	Yes	Yes
State Dummies	Yes	Yes	Yes	Yes

Notes: Linearized standard errors in parentheses. ** p<.05, *** p<.01

Table 4.
First-Stage Regressions. Dep. Var. = ***SNAP$*** per person

	HH < 130 Poverty Level	HH < 130 Poverty, No WIC, No Food Pantry	HH < 130 Poverty Level	HH < 130 Poverty, No WIC, No Food Pantry
HH Income	-112***	-91.3***	-112.00***	-91.3***
	(9.756)	(8.695)	(9.756)	(8.695)
Age	1.525***	1.459***	1.525***	1.459***
	(0.118)	(0.103)	(0.118)	(0.103)
Age squared	-0.016***	-0.015***	-0.016***	-0.015***
	(0.001)	(0.001)	-1.000E-03	-1.000E-03
Married	-9.448***	-8.436***	-9.448***	-8.436***
	(0.835)	(0.656)	(0.835)	(0.656)
Own Home	-12.726***	-11.472***	-12.726***	-11.472***
	(0.848)	(0.902)	(0.848)	(0.902)
HS Grad	-5.415***	-4.794***	-5.415***	-4.794***
	(0.626)	(0.628)	(0.626)	(0.628)
College Grad	-18.741***	-15.325***	-18.741***	-15.325***
	(1.040)	(0.868)	(1.040)	(0.868)
Minority	5.724***	6.116***	5.724***	6.116***
	(1.229)	(1.265)	(1.229)	(1.265)
HH Size	0.232	0.352	0.232	0.352
	(0.386)	(0.373)	(0.386)	(0.373)
Childless	-18.266***	-16.005***	-18.268***	-16.008***
	(0.697)	(0.859)	(0.697)	(0.859)
Unemployed	13.127***	10.220***	13.127***	10.220***
	(0.938)	(1.049)	(0.938)	(1.049)
Male	-8.178***	-6.582***	-8.178***	-6.582***
	(0.519)	(0.610)	(0.519)	(0.610)
ARRA	7.008***	6.437***		
	(1.506)	(1.749)		
CPIfoodxAARRA			6.469***	5.942***
			(1.393)	(1.618)
ChildlessxARRA	-0.849	-0.911	-0.845	-0.907
	(0.95)	(0.90)	(0.946)	(0.904)
Constant	38.051***	26.229***	38.057***	26.235***
	-2.878	-2.267	-2.878	-2.267
R-squared	0.157	0.129	0.157	0.129
Number of Obs	80,521	61,497	80,521	61,497
Annual Dummies	Yes	Yes	Yes	Yes
State Dummies	Yes	Yes	Yes	Yes

Notes: Linearized standard errors in parentheses. ** p<.05, *** p<.01

Table 5.

Two-Stage Least Squares Second Stage: Dependent Variable = Food Insecurity

	HH < 130 Poverty Level	HH < 130 Poverty, No WIC, No Food Pantry	HH < 130 Poverty Level	HH < 130 Poverty, No WIC, No Food Pantry
SNAP$ per person	-0.0067***	-0.009***	-0.007***	-0.009***
	(0.002)	(0.002)	(0.002)	(0.002)
HH Income	-0.964***	-0.970***	-0.965***	-0.971***
	(0.242)	(0.250)	(0.243)	(0.250)
Age	0.033***	0.031***	0.033***	0.031***
	(0.003)	(0.003)	(0.003)	(0.003)
Age squared	-0.0003***	-0.0003***	-0.000***	-0.000***
	3.5E-05	3.4E-05	3.5E-05	3.4E-05
Married	-0.126***	-0.144***	-0.127***	-0.144***
	(0.018)	(0.018)	(0.018)	(0.018)
Own Home	-0.175***	-0.173***	-0.175***	-0.173***
	(0.025)	(0.025)	(0.025)	(0.025)
HS Grad	-0.082***	-0.087***	-0.082***	-0.087***
	(0.012)	(0.015)	(0.012)	(0.015)
College Grad	-0.291***	-0.277***	-0.291***	-0.277***
	(0.043)	(0.034)	(0.043)	(0.034)
Minority	0.064***	0.088***	0.064***	0.088***
	(0.021)	(0.023)	(0.021)	(0.023)
HH Size	0.014***	0.008	0.014***	0.008
	(0.004)	(0.006)	(0.004)	(0.006)
Childless	-0.168***	-0.205***	-0.168***	-0.205***
	(0.038)	(0.036)	(0.038)	(0.036)
HH Head Unemployed	0.204***	0.205***	0.204***	0.205***
	(0.026)	(0.024)	(0.026)	(0.024)
Male	-0.090***	-0.086***	-0.090***	-0.086***
	(0.018)	(0.014)	(0.018)	(0.014)
Constant	0.296***	0.368***	0.296***	0.368***
	(0.093)	(0.060)	(0.093)	(0.060)
Instruments	*ARRA, ChildlessxARRA*	*ARRA, ChildlessxARRA*	*CPI_FxARRA, ChildlessxARRA*	*CPI_FxARRA, ChildlessxARRA*
Sargan Test of Overidentifying Restrictions	0.313	0.344	0.306	0.334
Sargan p-value	0.576	0.557	0.580	0.564
Number of Obs	80,521	61,497	80,521	61,497
Annual Dummies	Yes	Yes	Yes	Yes
State Dummies	Yes	Yes	Yes	Yes

Notes: Linearized standard errors in parentheses. ** p<.05, *** p<.01

Table 6.

Falsification Test, Average Change in Food Insecurity for Eligible, Non-SNAP Households

	OLS	Probit	OLS	Probit
Average Change in Food Insecurity Probability, ARRA years - NonARRA Years	-0.0084	-0.0088	-0.0084	-0.0088
	(0.0048)	(0.0047)	(0.0048)	(0.0047)
Instruments	***ARRA, ChildlessxARRA***	***ARRA, ChildlessxARRA***	***CPI_FxARRA, ChildlessxARRA***	***CPI_FxARRA, ChildlessxARRA***

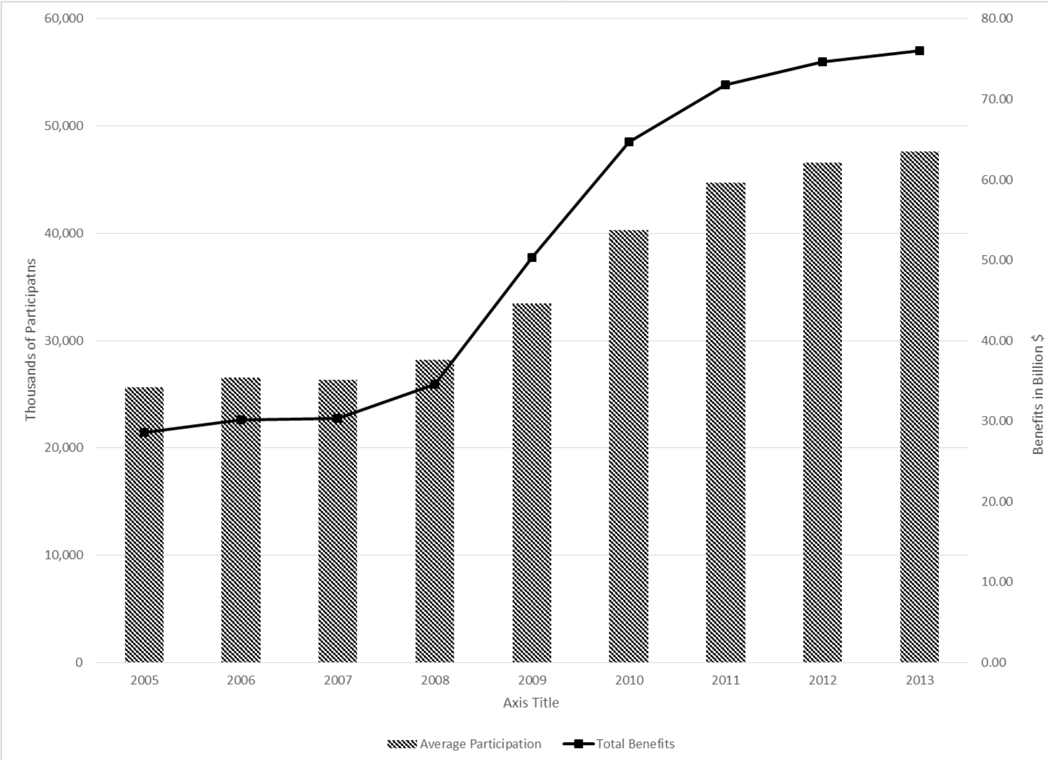
Linearized standard errors in parentheses.

Table 7.
IV-Probit Marginal Effects: Dependent Variable = Food Insecurity

	HH < 130 Poverty Level	HH < 130 Poverty, No WIC, No Food Pantry	HH < 130 Poverty Level	HH < 130 Poverty, No WIC, No Food Pantry
SNAP$ per person	-0.004***	-0.005***	-0.004***	-0.005***
	(0.001)	(0.001)	(0.0010)	(0.0010)
HH Income	-0.586***	-0.533***	-0.5867***	-0.533***
	(0.075)	(0.087)	(0.0754)	(0.0866)
Age	0.022***	0.019***	0.022***	0.019***
	(0.002)	(0.001)	(0.0020)	(0.0010)
Age squared	-0.000***	-0.000***	-0.000***	-0.000***
	0.0E+00	0.0E+00	(0.000)	(0.0000)
Married	-0.078***	-0.082***	-0.078***	-0.082***
	(0.004)	(0.004)	(0.0040)	(0.0040)
Own Home	-0.110***	-0.100***	-0.110***	-0.100***
	(0.004)	(0.005)	(0.0040)	(0.0050)
HS Grad	-0.053***	-0.052***	-0.053***	-0.052***
	(0.005)	(0.005)	(0.0050)	(0.0050)
College Grad	-0.179***	-0.157***	-0.179***	-0.157***
	(0.006)	(0.006)	(0.0060)	(0.0060)
Minority	0.041***	0.051***	0.041***	0.051***
	(0.009)	(0.011)	(0.0090)	(0.0110)
HH Size	0.008***	0.004	0.008***	0.004
	(0.003)	(0.003)	(0.0030)	(0.0030)
Childless	-0.102***	-0.112***	-0.102***	-0.112***
	(0.008)	(0.007)	(0.0080)	(0.0070)
HH Head Unemployed	0.124***	0.113***	0.124***	0.113***
	(0.008)	(0.008)	(0.0080)	(0.0080)
Male	-0.056***	-0.049***	-0.056***	-0.049***
	(0.004)	(0.003)	(0.0040)	(0.0030)
Instruments	*ARRA, ChildlessxARRA*	*ARRA, ChildlessxARRA*	*CPI_FxARRA, ChildlessxARRA*	*CPI_FxARRA, ChildlessxARRA*
Number of Obs	80,521	61,497	80,521	61,497
Annual Dummies	Yes	Yes	Yes	Yes
State Dummies	Yes	Yes	Yes	Yes

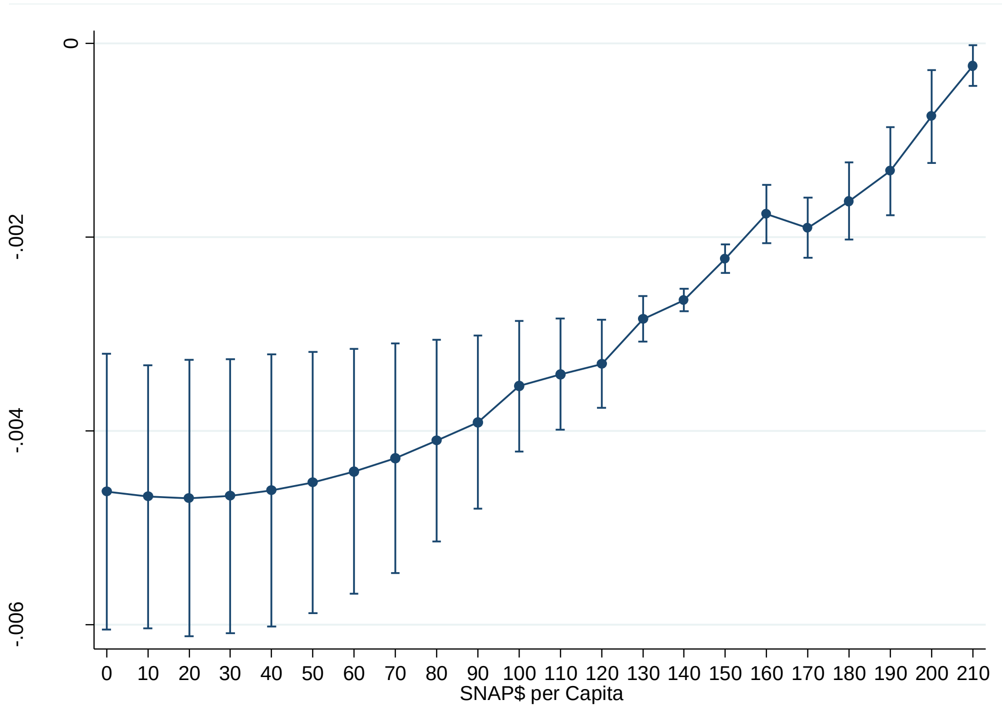
Notes: Standard errors in parentheses derived using the delta method. ** p<.05, *** p<.01

Figure 1.
SNAP Participation and Expenditures



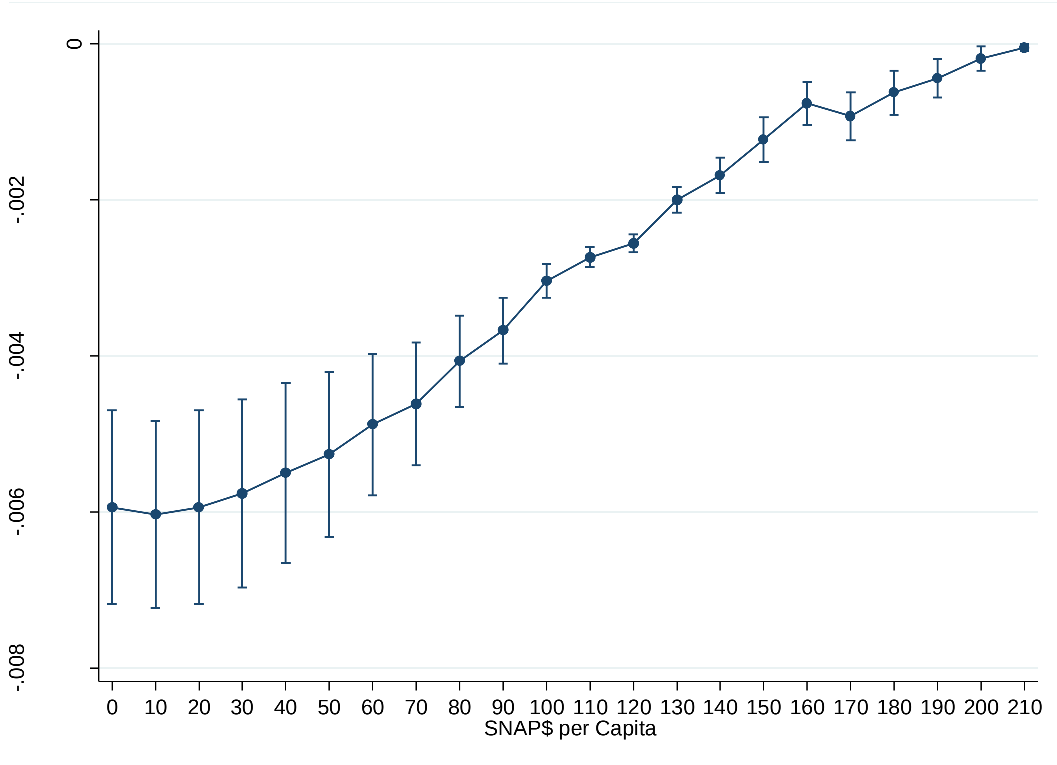
Source: Food and Nutrition Service Administrative Data

Figure 2.
Nonlinear SNAP$ Per Person Marginal Effects, Households < 130% Poverty



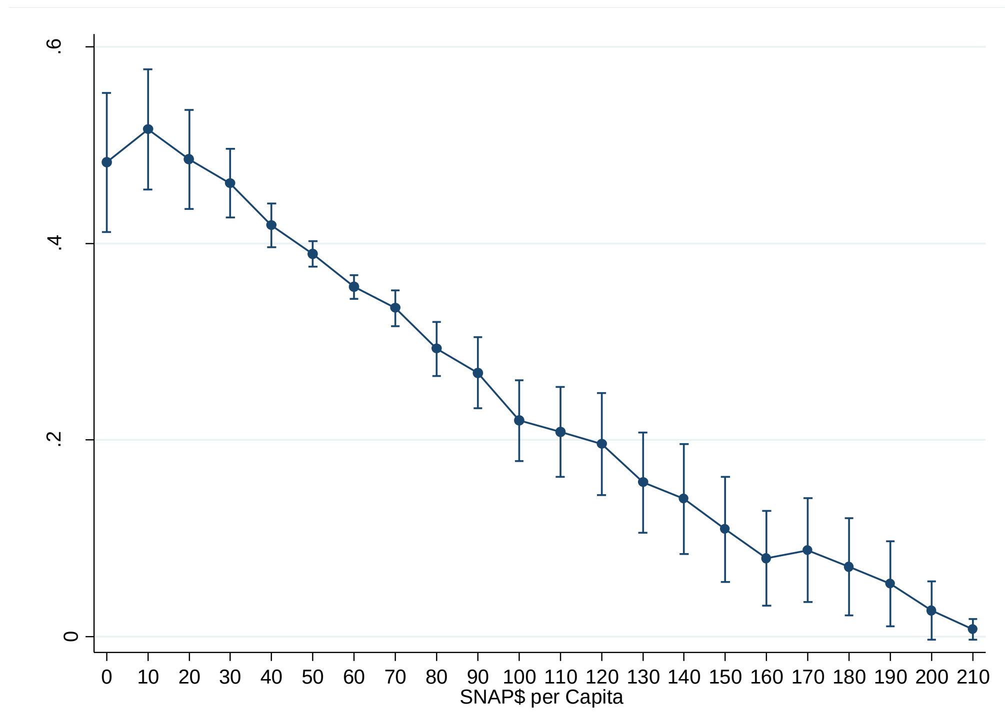
Note: Vertical lines represent 95% confidence interval.

Figure 3.
Nonlinear SNAP$ Per Person Marginal Effects, Households < 130% Poverty, NonWIC, No Food Pantry



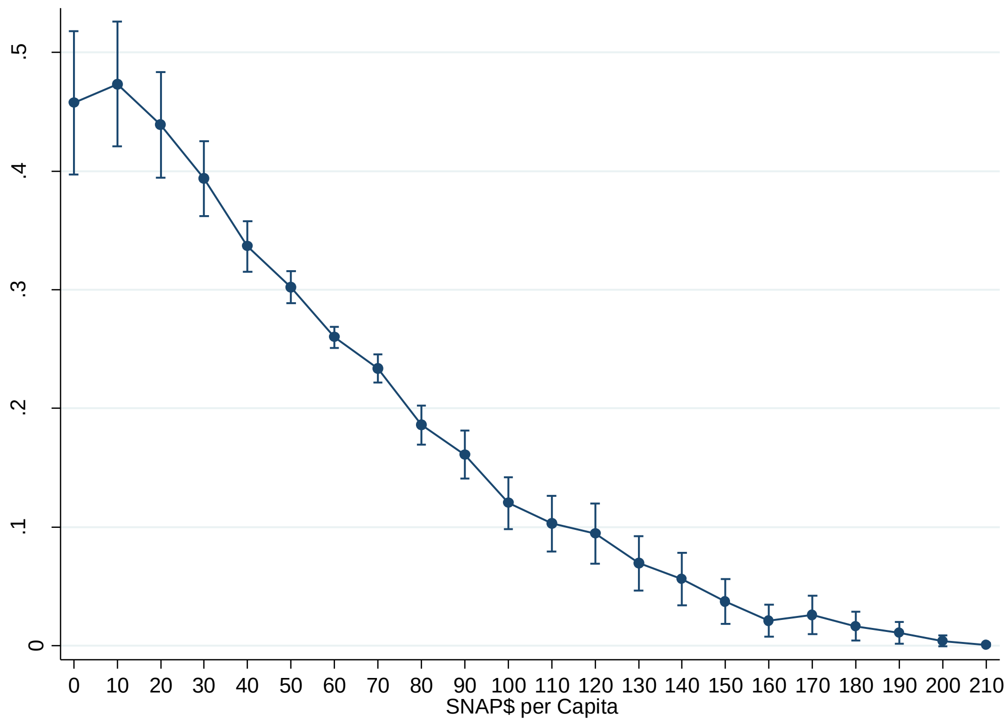
Note: Vertical lines represent 95% confidence interval.

Figure 4.
Predicted Probability of Food Insecurity, Households <130% Poverty



Note: Vertical lines represent 95% confidence interval.

Figure 5.
Predicted Probability of Food Insecurity, Households <130% Poverty, NonWIC, No Food Panty



Note: Vertical Lines represent 95% confidence interval.

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