Supplemental Nutrition Assistance Program and Food Insecurity among Families with Children

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Abstract

The roles of Supplemental Nutrition Assistance Program (SNAP) and parental resources in household food insecurity are investigated with a endogenous ordered probability model. Data for husband-wife families with children from the 2010 and 2011 Current Population Survey are used. SNAP participation is found to reduce the probability of household food insecurity among adults by 8.8%, increases the probability of being low food security among children by 6.1%, and increases the probability of being very low food security among children by 2.7%. Parental resource and socio-demographic variables also play important roles in determining SNAP participation and household food insecurity.

Key words: Household food insecurity, SNAP participation, husband-wife households with children, ordered probability model

Introduction

Household food security is an important public policy issue worldwide. Even in a developed country like the United States (U.S.), some low income families still experience food insecurity (FI) due to lack of financial or other resources. In 2011, 14.9% of households in the U.S. were food insecure at least some time during the year, including 5.7 percent with very low food security (VLFS) (Coleman-Jensen et al. 2012; USDA-ERS 2012).

To enhance food security of low-income households, the U.S. Department of Agriculture (USDA) implements the Supplemental Nutrition Assistance Program (SNAP), formerly the Food Stamp Program (FSP), to provide food assistance via benefit payments to households meeting eligibility criteria. Other food assistance programs such as the Special Supplemental Nutrition Program for Women, Infants and Children (WIC), National School Lunch Program, and informal food assistance programs are also designed to combat food insecurity and hunger. In 2011, SNAP provides benefits to 44.7 million people in the U.S. at a total program expenditure of over $75 billion. Despite strong support from the government, the rate of households reporting food insecurity has continued to rise. For instance, the percentage of food insecure households increased largely (3.5%) from 2007 to 2008 (Nord, Andrews and Carlson 2009) and slightly (0.4%) from 2010 to 2011 (Coleman-Jensen et al. 2012).

This mounting evidence of food insecurity despite the government effort casts doubt on effectiveness of SNAP and calls for additional investigation of the relationship between SNAP participation and FI. A better understanding of this relationship is important for policy makers to deliberate effective food assistance policies. Since last decade, many studies have investigated the relation between SNAP participation and FI, with mixed findings on the effects of SNAP on FI. Some studies find SNAP participants more likely to be food insecure (e.g. Jensen 2002; Ribar

and Hamrick 2003; Wilde and Nord 2005). Others find no significant relation between SNAP participation and FI (e.g. Gundersen and Oliveira 2001; Huffman and Jensen 2008). More recent studies find that SNAP ameliorates FI to some extent (e.g. Borjas 2004; Bartfeld and Dunifon 2006; DePolt, Moffitt and Ribar 2009; Nord and Golla 2009; Yen et al. 2008; Mykerezi and Mills 2010).

Among studies reporting positive or statistically insignificant relation between SNAP and FI, Jensen (2002) estimates an ordered probability model of household FI and finds FSP participation and FI dependent. Wilde and Nord (2005) use a two-year panel sample from the Current Population Survey (CPS) and find food security status more commonly deteriorated for households who entered FSP during 2001-2002. Gunderson and Oliveira (2001) estimate a simultaneous probit model using data from the 1991–1992 Survey of Income and Program Participation (SIPP), and find FSP has no effect on food insufficiency. Huffman and Jensen (2008) develop a structural simultaneous equation model to estimate the effects of FSP and labor force participation on FI. Result suggests FI increases the probability of household participation in FSP whereas the effect of FSP on FI is not significant.

Positive or insignificant effect of SNAP on household FI is generally believed to be the result of household's self -selection into SNAP that is likely not properly accounted for (Nord and Golla 2009). Inconsistency among previous results calls for a more thorough investigation of the role of SNAP participation in FI. Recent analyses on the subject feature more careful attention to the selection issue of SNAP participation (e.g. Yen et al. 2008; DePolt, Moffitt and Ribar 2009; Mykerezi and Mills 2010; Ratcliffe and McKernan 2010) and find that SNAP participation generally ameliorates FI (e.g. Wilde 2007).

Using data from the 1996–1997 National Food Stamp Program Survey, Yen et al. (2008)

estimate a recursive system, a restricted form of the simultaneous equation system in which SNAP participation is allowed to affect FI but not vice versa, and find that FSP participation lowers FI score by 0.4 among food insecure households. Mykerezi and Mills (2010) estimate a similar model with the 1999 Panel Study of Income Dynamics (PSID), to investigate estimate the effect of losing food stamp benefits. FSP participation is found to lower the severity of FI as in Yen et al. (2008) but in greater magnitudes. DePolt, Moffitt, and Ribar (2009) use longitude data from low-income families with children living in Boston, Chicago, and San Antonio to evaluate the effect of FSP on food hardships. A quasi-fixed-effects procedure is used to control for unobservable household characteristics and a strong negative association between FSP and food hardship is found. Ratcliffe and McKernan (2010) estimate a dummy endogenous variable model with the 1996-2004 SIPP, using instrumental variables of state SNAP policies to control for selection bias. Results suggest participation in SNAP reduces the probability of FI by 31.2% and the probability of very low food security by 20.2%.

Most recent findings of negative association between SNAP and FI were based on the instrumental variable approach to address endogenous SNAP participation, and we identify three shortcomings in these studies. First is use of old data (Mykerezi and Mills 2010; Ratcliffe and McKernan 2010; Yen et al. 2008). Second, except Ratcliffe and McKernan (2010), most studies address household FI in general and do not include low and very low food security among children (Nord 2009). Without such food insecure levels among children in measuring household FI, the effects of SNAP cannot be fully exploited. A third, most important, shortcoming which motivates this study, is the lack of enough attention to the different categories of household FI. Most previous studies either concentrate on just two FI categories (food secure and food insecure households) or use the continuous FI scores without differentiating FI severity categories. The

impact of SNAP participation on each FI categories may differ greatly and dividing FI into different categories will reduce statistical bias and better explore the effects of SNAP.

Parental resources have been found to play a key role in child abuse and neglect in the economics literature (Paxson and Waldfogel 1999), and these factors may well affect other aspects of children's welfare such as FI. No previous study has investigated the effects of parental resources on SNAP participation and FI among households with children. This study fills this empirical gap, by exploring the relationship between SNAP participation and FI, and how parental resources affect SNAP participation decision and FI, among households with children.

Data

Data come from the 2010–2011 Current Population Survey-Food Security Supplement (CPS-FSS). The CPS-FSS data are the basis of USDA's series of annual reports on food security of U.S. households and are collected in the December CPS. The primary purpose of this study is to investigate the effects of SNAP participation on FI among husband-wife families with children (HW-C). The sample is thus limited to SNAP eligible HW-C households. The income criterion is used to determine SNAP eligibility—by restricting households to those with annual income below 130% of Federal Poverty Level (FPL). After removing missing values for important variables, the final sample consists of 1826 SNAP eligible households. Table 1 presents sample statistics of all variables.

Measuring Food Insecurity and SNAP Participation

Household food insecurity is measured by the 18 questions in CPS-FSS, 8 of which

concern children's FI during 12 months prior to the survey. Based on the numbers of affirmative responses to the 18 questions and to the 8 children-specific items, household FI is categorized into four mutually exclusive categories (Nord et al., 2010): food secure (FS, with < 3 affirmative responses); and three categories among those with ≥ 3 affirmative responses: FI among adults only (FIA, with < 2 children-specific responses), low food security among children (LFSC, with 2–4 children-specific responses), and very low food security among children (VLFSC, with ≥ 5 children-specific responses). The above are coded into four categories, with FI scores of 0,1,2, and 3, respectively. The endogenous variable is household SNAP participation—a binary indicator of whether anyone in the household received SNAP in the past 12 months. Table 2 presents the distribution and two-way frequencies of FI categories by SNAP participation status.

Identification Variables

In the SNAP equation, four state SNAP policy variables are used uniquely, and in order to better evaluate the effects of SNAP policies on participation decision, we use the policies one year ahead of the FSS data collection time.[1] A one year lag in SNAP policy variables is reasonable because household decisions of SNAP participation are normally made way before SNAP benefits are received. The first variable is the proportion of SNAP units with earnings (Short 1), and the second variable without earnings (Short 2), both with a short, 1–6 month recertification period. Yen et al. (2008) use a binary indicator of recertification period shorter than six months to identify FSP equation as frequent recertification of FSP eligibility may discourage participation. The third variable is a dummy indicator of simplified reporting option for households with earnings (Report simplified), which may encourage households to

[1] The SNAP policy in June 2009 and 2010 of each state are used with the FSS data in December 2010 and 2011 respectively.

participate in SNAP due to easier administrative process. The fourth variable is the broad-based categorical eligibility (BBCE) for SNAP. BBCE eliminates the asset tests for most households, thus simplifying the process and reducing potential eligibility determination errors. Mabli and Ferrerosa (2010) find that state offering BBCE have a 6.2 percent higher per capital participant count than states without this policy.

Parental Resource and Other Explanatory Variables

Besides SNAP effects, our second focus is on the role of parental resource variables in SNAP participation and FI among HW-C households. Parental resources have been found to play a key role in child abuse and neglect in the economics literature (Paxson and Waldfogel 1999), and we posit that these variables can affect other aspects of children's welfare such as FI. Household head's educational status, race, husband (wife)'s ages, employment status, and working hours belong to this category. In the HW-C sample, about 70% of the household heads graduated from high school or above, including 18% with a bachelor's degree or above. About 82% of the household heads are white. Age of husband (wife) averages to 36.33 (33.48), and working hours of husband (wife) to 27.38 (12.07) hours per week. About 73% of the household have husbands employed and 39% have wives employed.

Other explanatory variables are household annual income, financial status for food, household size, number of children, and locations of residence.[2] Average household income is $20,500 per year, and mean household size is 4.89. Each HW-C household has 2.48 children on average, and about 76% of households live in Metropolitan Statistical Areas. About 34% of the sample live in the South, 12% Northeast, 34% West, and 20% Midwest.

[2] Household income in the CPS data is categorical which ranges from 1–16. The household income used in this study is the mean number of dollars corresponds to each category. Since the HW-C samples are restricted to SNAP eligible households, the highest income category will not be reached.

Methods and Procedure

The mutual causality between FI and SNAP is difficult to be determined simultaneously. One the one hand, SNAP participation can affect FI status, on the other hand, eligible households with FI status may be more likely to participate in SNAP. To avoid the difficulties of mutual causality and model identification in FI we implement a recursive equation system to address the ordinal FI (y_1) and endogenous SNAP (y_2).[3] The model is characterized by two equations for the corresponding latent variables y_1^* and y_2^*:

$$y_1^* = \gamma_1 y_2^* + x'\alpha_1 + z'\alpha_2 + u_1 \tag{6}$$

$$y_2^* = x'\beta_1 + w'\beta_2 + u_2 \tag{7}$$

where x, z and w are vectors of exogenous variables with conformable parameter vectors α_1, β_1, α_2 and β_2; γ_1 is a scalar parameter, and the error terms are assumed to be distributed as bivariate standard normal with correlation ρ. Denote $h = [x', z', w']'$. Then, the reduced forms are

$$y_1^* = h'\delta_1 + v_1 \tag{8}$$

$$y_2^* = h'\delta_2 + v_2 \tag{9}$$

where $\delta_1 = [(\alpha_1 + \gamma_1\beta_1)', \alpha_2', \gamma_1\beta_2']'$, $\delta_2 = [\beta_1', 0, \beta_2']'$, $v_1 = u_1 + \gamma_1 u_2$, and $v_2 = u_2$. The composite error vector $v = [v_1, v_2]'$ is distributed as bivariate normal with zero means, variance ω_1^2 and unitary variance and correlation τ:

$$\begin{bmatrix} v_1 \\ v_2 \end{bmatrix} \sim \mathcal{N}\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \omega_1^2 & \tau\omega_1 \\ \tau\omega_1 & 1 \end{bmatrix} \right) \tag{10}$$

such that $\omega_1^2 = 1 + \gamma_1^2 + 2\rho\gamma_1$, $\tau = (\gamma_1 + \rho) / (1 + \gamma_1^2 + 2\rho\gamma_1)^{1/2}$.

[3] The recursive system model is first developed by Yen et al. (2008) to address the endogenous Food Stamp participation and censored food insecurity outcome.

Based on the reduced forms, Equations (8) and (9), the model with ordinal outcome y_1 and binary outcome y_2 is characterized as

$$y_1 = k \quad \text{if} \quad \xi_{k-1} < y_1^* < \xi_k^{(s)}, \;\; k = 0 \ldots K \tag{11}$$

$$\begin{aligned} y_2 &= 1 \quad \text{if} \quad y_2^* > 0 \\ &= 0 \quad \text{if} \quad y_2^* \le 0 \end{aligned} \tag{12}$$

where ξ's are threshold parameters such that $\xi_0 = -\infty$, $\xi_1 = 0$, $\xi_K = \infty$, and $\xi_2 \ldots \xi_{K-1}$ are estimable.

Maddala (1983) suggests a two-step estimation procedure for a similar model. Two-step estimates are statistically inefficient and for proper statistical inference standard errors need to be corrected which is cumbersome. We develop a more efficient ML procedure. The sample likelihood function is similar to that of a bivariate ordered probit model after solving the reduced forms (Greene and Hensher 2010, pp. 219–220). Denote the cumulative distribution function (cdf) of the bivariate standard normal as Φ_2. Then, the likelihood contribution for a sample observation is the joint probability of each FI category and SNAP participation, which can also be used for calculation of average marginal effects and treatment effects:

$$\begin{aligned} \Pr(y_1 = k, y_2 = j) = \;& \Phi_2\left(\frac{\xi_k - h'\delta_1}{\omega_1}, (-1)^{j+1} h'\delta_2; (-1)^j \tau\right) \\ & - \Phi_2\left(\frac{\xi_{k-1} - h'\delta_1}{\omega_1}, (-1)^{j+1} h'\delta_2; (-1)^j \tau\right), \;\; j = 0,1 \end{aligned} \tag{13}$$

The sample likelihood function is product of the likelihood contributions over the sample.

To facilitate interpretation beyond the ML estimates, average marginal effects of continuous (discrete) explanatory variables can be calculated by differentiating (differencing) various marginal and conditional probabilities implied by the joint probability in Equation (13).

Using these probabilities, the treatment effects of SNAP participation on FI categories conditional on food insecurity $(y_{1i} > 0)$ are

$$TE_k = \Pr(y_{1i} = k \,|\, y_{2i} = 1, y_{1i} > 0) - \Pr(y_{1i} = k \,|\, y_{2i} = 0, y_{1i} > 0) \quad (14)$$
$$= \frac{\Pr(y_{1i} = k, y_{2i} = 1)}{\Pr(y_{2i} = 1) - \Pr(y_{1i} = 0, y_{2i} = 0)} - \frac{\Pr(y_{1i} = k, y_{2i} = 0)}{\Pr(y_{2i} = 0) - \Pr(y_{1i} = 0, y_{2i} = 0)}, \; k = 1, 2, 3$$

For statistical inference, standard errors of the marginal and treatment effects can be derived by the delta method (Papke and Wooldridge 2005).

Results and Discussion

ML Estimates of Endogenous Ordered Probability Model

Table 3 presents ML estimates for the ordered probability model. All threshold parameter estimates are positive and significant at the 1% level (of significance), suggesting that the ordered probability specification is successful in delineating the FI categories. The error correlation (ρ) estimate is positive (0.656) and significant at the 1% level, suggesting that unobserved characteristics affect SNAP and FI in the same direction.

The endogenous SNAP has a significant and negative coefficient (–0.464) in the FI equation at the 5% level, suggesting that participation in SNAP ameliorates FI. Of the 27 explanatory variables in the SNAP equation, 14 are significant at the 10% level, including the two identification variables (BBCE and Report simplified). As to parental resources, husband and wife's ages and working hours are significant in the SNAP equation. Of the 23 explanatory variables in the FI outcome equation, 11 are significant at the 10% level. Husband and wife's working hours, household income, number of children, and household size are significant at 5% level or lower. To further exploit effects of SNAP participation on FI and effects of explanatory variables on SNAP participation and FI, treatment effects and marginal effects are discussed

below.

Treatment Effects of SNAP Participation on FI

To quantify effects of SNAP participation on FI among households who are food insecure (FI > 0), average treatment effects (ATEs) are calculated conditional on food insecurity. Yen et al. (2008) and Mykerezi and Mills (2010) estimate the ATEs of SNAP on continuous FI scores of households with older data, and both of their results suggest SNAP participation decreases the mean FI scores of food insecure households; neither address the effect of SNAP participation on FI of children separately from adults. Without differentiating between adults' FI and children's FI, the actual effect of SNAP cannot be fully explored, and the ATEs will be misleading for LFSC and VLFSC households since the average effect of SNAP on FI in all food insecure households may be dominated by the comparatively larger number of FIA samples and larger magnitude of SNAP effects on FIA households. With mutually exclusive classification of FI for adults and children, we are able to calculate the ATEs for adults and children separately. The results, presented in Table 4, suggest that SNAP participation decreases the probability of FIA, but increases the probabilities of LFSC and VLFSC. According to these ATE estimates, for a randomly selected HW-C household, a SNAP-participating household has an 8.8% lower probability of FIA than non-participating households, while a SNAP participating household has 6.1% and 2.7% higher probabilities of LFSC and VLFSC than non-participating households. Although SNAP participation increases the probabilities of being LFSC and VLFSC, the positive effects are small in magnitudes.

Marginal Effects on the Probability of SNAP Participation

Determinants of SNAP participation are presented in Table 5. Household income shows a negative association with SNAP participation, with a $10,000 increase in income decreasing the marginal (unconditional) probability of SANP participation by 8.84%. The two state policy variables have positive signs as expected, with the state policies of BBCE and Report simplified increasing the marginal probability of SNAP participation by 5.26% and 7.26%, respectively.

As to parental resources, husband and wife's ages and working hours are negatively associated with SNAP participation. A 10-year increase in husband's (wife's) age is associated with a 4.66% (6.92%) decrease in the marginal probability of SNAP participation, and a 10-hour increase in husband's (wife's) weekly working hours is associated with a 3.85% (3.50%) decrease in the marginal probability. Compared with households with husband (wife) not in labor force, household with unemployed husband (wife) is 15.84% (8.89%) more likely to participate in SNAP. College educated households have a 9.58% lower probability of participating in SNAP compared with high-school educated households.[4]

Household size and number of children play positive roles in SNAP participation, with one additional member increasing the probability of SNAP participation by 4.33% unconditionally. Compared with non-metropolitan residents, households residing in a metropolitan area are 8.39% less likely to participate in SNAP. Considering financial status, households reporting more money is needed for future food consumption are 9.91% more likely to participate in SNAP. Hispanic households are 9.99% less likely to participate in SNAP than non-Hispanic households.[5]

[4] Education status of household is drawn from the respondent's education status. "College educated" status includes with a bachelor's degree or above.
[5] Race of household is drawn from the respondent's race.

Marginal Effects on Joint Probability of SNAP and FI

Marginal effects on the joint probabilities of SNAP participation and FI categories are presented in Table 6. Household income is one of the key determinants. Among households not participating in SNAP, a $10,000 increase in income is associated with 7.18%, 1.09%, and 0.54% increases in the "joint probabilities" of being FS, FIA and LFSC (and non-participation); while among SNAP participants the effects are opposite, with that same income increase decreasing the "joint probabilities" of being FS, FIA, LFSC and VLFSC (and SNAP participation) by 3.82%, 2.12%, 2.35%, and 0.55%.[6] Household size affects the joint probabilities of SNAP non-participants negatively but participants positively. One additional member in the non-participating household decreases the joint probabilities of (non-participation and) FS, FIA and LFSC by 2.99%, 0.75% and 0.53%; it increases the joint probabilities of FS, FIA and LFSC by 2.38%, 0.94%, and 0.86% among SNAP participants.

Residing in a metropolitan area increases the joint probabilities of being FS by 5.92% and FIA by 1.40% among non-participants; it decreases the joint probabilities of being FS, FIA and LFSC by 4.45%, 1.84% and 1.76% among participants. For households not participating (participating) in SNAP, the reporting that more money is needed to buy food increases the joint probability of being FIA, LFSC and VLFSC by 4.37%, 8.45% and 1.67% (4.91%, 13.35% and 4.24%). In terms of state policy variables, among non-participants, BBCE and Report simplified are negatively associated with the joint probabilities of being FIA, LFSC and VLFSC, but among participants, BBCE and Report simplified are all positively correlated with joint probabilities of being FS and FIA.

Parental resource variables play key roles. Husband and wife's ages have opposite effects

[6] By "joint probability" we mean the probability of a SNAP participation/non-participation status and one of the FI categories, and not that of two mutually exclusive FI categories.

on the joint probabilities of FI between SNAP non-participants and participants. A 10-year increase in husband's (wife's) age increases the joint probabilities of being FIA, LFSC, and VLFSC by1.21%, 1.07%, and 0.16% (1.65%, 1.41%, and 0.21%) among non-participants; it decreases the probabilities of being FS and FIA by 3.51% and 0.81% (4.87% and 1.28%) among participants.

Effects of working hours also differ notably between non-participants and participants. A 10-hour increase in husband's (wife's) working hours per week increases the joint probabilities of being FS by 3.34% (2.93%) among non-participants; and it decreases the joint probabilities of being FIA, LFSC and VLFSC by 0.97%, 1.14% and 0.28% (0.86%, 0.98% and 0.23%).

Compared to households with a husband not in the labor force, for SNAP non-participants (participants), households with husband unemployed have 11.11%, 2.67% and 1.84% lower (8.40%, 3.48% and 3.31% higher) joint probabilities of being FS, FIA and LFSC. Considering wife's employment status, wife unemployment decreases the joint probability of being FS by 7.31% among SNAP non-participants; it increases the probabilities of being FIA and LFSC by 2.22% and 2.63% among participants.

Education has more influence on the joint probability of SNAP participants than non-participants. Among SNAP participants, a college educated household has 2.71%, 3.47% and 0.88% lower joint probabilities of being FIA, LFSC and VLFSC. Finally, among SNAP non-participants (participants), a Hispanic household has 6.29%, 1.97%, and 1.52% (5.99%, 2.06% and 1.68%) higher (lower) joint probabilities of being FIA, LFSC and VLFS than a black household.

Concluding Remarks

This paper investigates the effects of parental resources and other socio-demographic variable on SNAP participation and FI, and the relationship between SNAP and FI, among HW-C households, using data from the most recent CPS-FSS. FI is used as ordinal outcome variable to measure the severity of food insecure among both adults and children. An endogenous ordered probability model is developed to address ordinal nature of FI categories and endogenous SNAP participation, and estimated by maximum-likelihood.

Our primary finding is that, among food insecure households, participation in SNAP reduces the probability of FIA, but increases probabilities of LFSC and VLFSC slightly. Our result is consistent with previous findings that SNAP participation ameliorates FI among FIA households (Mykerezi and Mills 2010; Yen et al. 2008). Contradictory results of SNAP participation are found among LFSC and VLFSC households. This positive association between SNAP participation and being LFSC or VLFSC, while small in magnitudes, is reasonable when taking into account the possibility that households with severe food insecurity are more likely to participate in SNAP.

This study is the first to evaluate the implication of SNAP participation and FI across parental resource variables and FI categories among HW-C households. Findings can inform policy makers concerned about household food security issues. By calculating marginal effects of explanatory variables for SNAP non-participants and participants, we find that parental resource and socio-demographic variables affect SNAP non-participants and participants differently. For SNAP nonparticipants, husband's (wife's) age and working hours are all positively correlated with each FI category and for SNAP participants, these parental variables are negatively correlated with each FI category. Our findings also suggest that state policy of

BBCE and Report simplified can encourage SNAP participation and thus lower the probabilities of being FIA, LFSC and VLFSC conditional on SNAP participation.

While this paper represents one of the first attempts to investigate the role of SNAP participation in ordinal FI of adults and children, future studies might consider the use of panel data and investigation of FI and other food assistance programs, such as WIC and informal food assistance programs. Further, SNAP and parental resource factors are likely to be important for diet quality and nutrition, and interesting insights may emerge with a similar study for this field.

References

Bartfeld, J., and Dunifon, R. 2006. State-level Predictors of Food Insecurity among Households with Children. *Journal of Policy Analysis and Management* 25(4): 921–942.

Borjas, G.J. 2004. Food Insecurity and Public Assistance. *Journal of Public Economics* 88(7–8): 1421–1443.

Coleman-Jensen, A., Nord, M., Andrews, M., and Carlson, S. 2012. *Household Food Security in the United States in 2011*. Economic Research Report No. 141. Economic Research Service, September, Washington, DC.

DePolt, R.A., Moffitt, R.A., and Ribar, D.C. 2009. Food stamps, Temporary Assistance for Needy Families and Food Hardships in Three American Cities. *Pacific Economic Review* 14(4): 445–473.

Greene, W.H., and Hensher, D. A. 2010. *Modeling Ordered Choices: A Primer*. Cambridge, UK: Cambridge University Press.

Gregory, C., Ploeg, M.V., Andrews, M., and Coleman-Jensen, A. 2013. *Supplemental Nutrition Assistance Program (SNAP) Participation Leads to Modest Changes in Diet Quality*. Economic Research Report No. 147. Economic Research Service, April, Washington, DC.

Gundersen, G., and Oliveira, V. 2001. The Food Stamp Program and Food Insufficiency. *American Journal of Agricultural Economics* 83(4): 875–887.

Huffman, S.K., and Jensen, H.H. 2008. Food Assistance Programs and Outcomes in the Context of Welfare Reform. *Social Science Quarterly* 89(1): 96–115.

Jensen, H.H. 2002. Food Insecurity and the Food Stamp Program. *American Journal of Agricultural Economics* 84(5): 1215–1228.

Kreider, B., Pepper, J., Gundersen, C., and Jolliffe, D. 2012. Identifying the Effects of SNAP (Food Stamps) on Child Health Outcomes When Participation is Endogenous and Misreported. *Journal of the American Statistical Association* 107(499): 958–975.

Mabli, J., and Ferrerosa, C. 2010. *Supplemental Nutrition Assistance Program Caseload Trends and Changes in Measures of Unemployment, Labor Underutilization, and Program Policy from 2002 to 2008*. Final Report to the Food and Nutrition Service, U.S. Department of Agriculture. Mathematica Policy Research Inc. March, Princeton, NJ.

Maddala, G. 1983. *Limited-Dependent and Qualitative Variables in Econometrics*. Cambridge University Press, Cambridge, UK.

Mykerezi, E., and Mills, B. 2010. The Impact of Food Stamp Program Participation on Household Food Insecurity. *American Journal of Agricultural Economics* 92(5): 1379–1391.

Nord, M. 2009. *Food Insecurity in Households with Children: Prevalence, Severity, and Household Characteristics.* Economic Research Service, September, Washington, DC. <http://www.ers.usda.gov/Publications/EIB56/EIB56.pdf > (accessed 10.07.13).

Nord, M., and Golla, A.M. 2009. *Does SNAP Decrease Food Insecurity? Untangling the Self–Selection Effect*. Economic Research Report No. 85. Economic Research Service, October, Washington, DC.

Nord, M., Andrews, M., and Carlson, S. 2009. *Household Food Security in the United States in 2008*. Economic Research Report No. 83. Economic Research Service, November, Washington, DC.

Nord, M., Coleman-Jensen, A., Andrews, M., and Carlson, S. 2010. *Household Food Security in the United States in 2009*. Economic Research Report No. 108. Economic Research Service, November, Washington, DC.

Papke, L.E., Wooldrige, J.M. 2005. A computational Trick for Delta-Method Standard Errors. *Economics Letters* 86(3): 413–417.

Ratcliffe, C., and McKernan, S.M. 2010. *How Much Does SNAP Reduce Food Insecurity?* The Urban Institute, March, Washington, DC.

Ribar, D.C., and Hamrick, K.S. 2003. *Dynamics of Poverty and Food Sufficiency.* Food and Nutrition Research Report No. 36. Economic Research Service, Washington, DC.

U.S. Department of Agriculture, Economic Research Service (USDA-ERS). 2012. Food Security in the United States. < http://www.ers.usda.gov/Briefing/FoodSecurity/ > (accessed 10.07.13).

Wilde, P., and Nord, M. 2005. The Effect of Food Stamps on Food Security: A Panel Data Approach. *Review of Agricultural Economics* 27(3): 425–432.

Wilde, P.E. 2007. Measuring the Effect of Food Stamps on Food Insecurity and Hunger: Research and Policy Considerations. *The Journal of Nutrition* 137(2): 307–310.

Yen, S.T., Andrews, M., Chen, Z., and Eastwood, D. 2008. Food Stamp Program Participation and Food Insecurity: An Instrumental Variable Approach. *American Journal of Agricultural Economics* 90(1): 117–132.

Table 1

Definitions and sample statistics of variables

Variable	Definitions	Mean	SD
FI	Household food insecurity category (0–3)	0.59	0.84
SNAP	Any member in household received SNAP in past 12 months	0.46	0.50
Age (H)	Age of husband	36.33	8.40
Age (W)	Age of wife	33.48	7.19
Work hours (H)	Husband's working hours per week	27.38	20.58
Work hours (W)	Wife's working hours per week	12.07	17.65
Income	Household income in $10,000 per year	2.05	0.97
HH size	Number of persons living in household	4.89	1.57
Children	Number of children < 18 years of age	2.48	1.28
Short 1	Proportion of SNAP units in state with 1-6 months recertification period, and with earnings	0.50	0.44
Short 2	Proportion of SNAP units in state with 1-6 months recertification period, and without earnings	0.40	0.33
Binary explanatory variables (yes = 1, no = 0)			
Year 2011	Data collected in year 2011	0.56	
< High school	Reference person has < high school education	0.30	
High school	Reference person is high school graduate (reference)	0.36	
Some college	Reference person attended college (no degree)	0.17	
College	Reference person has college education or higher	0.18	
Employed (H)	Husband is employed	0.73	
Unemployed (H)	Husband is unemployed	0.15	
Not in labor force (H)	Husband is not in labor force (reference)	0.12	
Employed (W)	Wife is employed	0.39	
Unemployed (W)	Wife is unemployed	0.09	
Not in labor force (W)	Wife is not in labor force (reference)	0.52	
Hispanic	Reference person is Hispanic	0.39	
White	Reference person is white	0.82	
Black	Reference person is black (reference)	0.09	
Other race	Reference person is of other race	0.09	
MSA	Reference person resides in Metropolitan Statistical Area	0.76	
South	Reference person resides in South	0.34	
Northeast	Reference person resides in Northwest	0.12	
West	Reference person resides in West (reference)	0.34	
Midwest	Reference person resides in Midwest	0.20	
BBCE	State uses BBCE categorical eligibility for SNAP	0.63	
Report simplified	For households with earnings, the state uses simplified reporting option for SNAP participants to report changes	0.85	

More money	Need to spend more money to buy enough food to meet needs than you do now	0.31	
Sample size			1826

Table 2

Frequency distribution of SNAP participation and FI categories

SNAP	Household food insecurity (FI)				
Participation	FS	FIA	LFSC	VLFSC	Total
Participants	419	219	168	27	833
Nonparticipants	710	137	130	16	993
Total	1129	356	298	43	1826
Ratio of participants	37%	62%	56%	63%	46%

Table 3

ML estimates of endogenous probability model

Variable	SNAP Participation	Food Insecurity
Latent variable		
SNAP		–0.464 (0.206)**
Other explanatory variables		
BBCE	0.157 (0.066)**	
Short 1	0.032 (0.271)	
Short 2	–0.190 (0.366)	
Report simplified	0.218 (0.105)**	
More money	0.293 (0.070)***	0.915 (0.111)***
Year 2011	0.068 (0.067)	0.138 (0.059)**
Age / 10 (H)	–0.139 (0.063)**	–0.034 (0.064)
Age / 10 (W)	–0.207 (0.075)***	–0.067 (0.082)
< High school	–0.075 (0.085)	0.037 (0.082)
Some college	–0.114 (0.096)	–0.104 (0.093)
College	–0.290 (0.094)***	–0.320 (0.092)***
Employed (H)	0.147 (0.141)	0.134 (0.134)
Unemployed (H)	0.461 (0.128)***	0.277 (0.140)**
Employed (W)	0.099 (0.131)	0.199 (0.116)*
Unemployed (W)	0.262 (0.117)**	0.213 (0.110)*
Work hours / 10 (H)	–0.115 (0.026)***	–0.098 (0.029)***
Work hours / 10 (W)	–0.105 (0.037)***	–0.084 (0.035)**
Income	–0.264 (0.036)***	–0.202 (0.052)***
HH size	0.130 (0.035)***	0.075 (0.038)**
Children	0.058 (0.040)	0.048 (0.036)
Hispanic	–0.298 (0.079)***	–0.145 (0.093)
White	–0.007 (0.126)	–0.032 (0.115)
Other race	0.109 (0.159)	0.118 (0.142)
MSA	–0.248 (0.080)***	–0.150 (0.087)*
South	0.124 (0.089)	0.099 (0.080)
Northeast	0.102 (0.121)	0.092 (0.116)
Midwest	0.067 (0.101)	–0.059 (0.100)
Constant	1.016 (0.264)***	–0.049 (0.431)
ξ_1		0.529 (0.107)***
ξ_2		1.484 (0.292)***
ρ		0.656 (0.169)***
Log likelihood	–2702.9822	
Sample size		1826

Note: Asymptotic standard errors in parentheses. *** 1%, ** 5%, * 10%.

Table 4

Average treatment effects of SNAP on probabilities of food insecurity (conditional on FI > 0)

Food insecure category	ATE
Food insecurity among adults (FIA, FI = 1)	–0.088 (0.014)***
Low food security among children (LFSC, FI = 2)	0.061 (0.010)***
Very low food security among children (VLFSC, FI = 3)	0.027 (0.005)***

Note: Asymptotic standard errors in parentheses. *** 1%, ** 5%, * 10%.

Table 5

Average marginal effects of explanatory variables on the probability of SNAP participation

Variable	Unconditional probability of SNAP participation
Continuous explanatory variables	
Age / 10 (H)	–4.66 (2.10)**
Age / 10 (W)	–6.92 (2.49)***
Work hours/10 (H)	–3.85 (0.86)***
Work hours/10 (W)	–3.50 (1.23)***
Income	–8.84 (1.16)***
HH size	4.33 (1.17)***
Children	1.95 (1.34)
Binary explanatory variables	
Short 1	1.06 (9.07)
Short 2	–6.36 (12.25)
Year 2011	2.26 (2.24)
< High school	–2.51 (2.82)
Some college	–3.80 (3.16)
College	–9.58 (3.04)***
Employed (H)	4.82 (4.52)
Unemployed (H)	15.84 (4.41)***
Employed (W)	3.29 (4.33)
Unemployed (W)	8.89 (3.97)**
Hispanic	–9.99 (2.61)***
White	–0.25 (4.21)
Other race	3.68 (5.36)
MSA	–8.39 (2.71)***
South	4.15 (2.98)
Northeast	3.42 (4.07)
Midwest	2.24 (3.41)
More money	9.91 (2.36)***
BBCE	5.26 (2.18)**
Report simplified	7.26 (3.45)**

Note: All effects on probabilities are multiplied by 100. Asymptotic standard errors in parentheses.

*** 1%, ** 5%, * 10%.

Table 6

Marginal effects of explanatory variables on joint probability of SNAP and FI

	SNAP non-participation and				SNAP participation and			
Variable	FS	FIA	LFSC	VLFSC	FS	FIA	LFSC	VLFSC
Continuous explanatory variables								
Age / 10 (H)	2.22 (1.67)	1.21 (0.52)**	1.07 (0.52)**	0.16 (0.09)*	–3.51 (1.45)**	–0.81 (0.48)*	–0.37 (0.63)	0.04 (0.20)
Age / 10 (W)	3.65 (2.05)*	1.65 (0.63)***	1.41 (0.64)**	0.21 (0.12)*	–4.87 (1.73)***	–1.28 (0.58)**	–0.75 (0.78)	–0.02 (0.25)
Work hours/10 (H)	3.34 (0.73)***	0.39 (0.24)	0.13 (0.25)	–0.01 (0.04)	–1.46 (0.65)**	–0.97 (0.21)***	–1.14 (0.30)***	–0.28 (0.10)***
Work hours/10 (W)	2.93 (0.97)***	0.40 (0.33)	0.17 (0.33)	0.00 (0.06)	–1.44 (0.90)	–0.86 (0.28)***	–0.98 (0.38)**	–0.23 (0.13)*
Income	7.18 (0.97)***	1.09 (0.31)***	0.54 (0.31)*	0.03 (0.06)	–3.82 (0.84)***	–2.12 (0.29)***	–2.35 (0.40)***	–0.55 (0.14)***
HH size	–2.99 (0.93)***	–0.75 (0.32)**	–0.53 (0.32)*	–0.06 (0.06)	2.38 (0.86)***	0.94 (0.27)***	0.86 (0.36)**	0.16 (0.12)
Children	–1.66 (1.04)	–0.21 (0.38)	–0.08 (0.38)	0.00 (0.07)	0.76 (1.03)	0.48 (0.30)	0.56 (0.41)	0.14 (0.13)
Short 1	–0.33 (2.87)	–0.34 (2.95)	–0.33 (2.81)	–0.05 (0.46)	0.96 (8.21)	0.15 (1.30)	–0.01 (0.13)	–0.04 (0.37)
Short 2	2.01 (4.15)	2.07 (3.97)	1.97 (3.79)	0.32 (0.62)	–5.76 (11.04)	–0.91 (1.79)	0.05 (0.67)	0.26 (0.54)
Binary explanatory variables								
Year 2011	–3.71 (1.82)**	0.49 (0.59)	0.79 (0.60)	0.17 (0.11)	–0.79 (1.63)	0.91 (0.51)*	1.62 (0.70)**	0.52 (0.23)**
< High school	–0.07 (2.29)	1.16 (0.73)	1.21 (0.76)	0.21 (0.14)	–3.01 (1.92)	–0.22 (0.66)	0.45 (0.89)	0.27 (0.29)
Some college	3.49 (2.76)	0.30 (0.82)	0.04 (0.84)	–0.02 (0.15)	–1.34 (2.18)	–0.98 (0.75)	–1.19 (1.01)	–0.30 (0.31)
College	10.22 (2.70)***	0.13 (0.88)	–0.60 (0.85)	–0.17 (0.14)	–2.52 (2.24)	–2.71 (0.71)***	–3.47 (0.89)***	–0.88 (0.27)***
Employed (H)	–4.43 (3.91)	–0.38 (1.27)	–0.04 (1.31)	0.03 (0.23)	1.67 (3.34)	1.24 (1.05)	1.52 (1.49)	0.39 (0.49)
Unemployed (H)	–11.11 (3.40)***	–2.67 (1.01)***	–1.84 (0.95)*	–0.22 (0.17)	8.40 (3.32)**	3.48 (1.09)***	3.31 (1.60)**	0.65 (0.53)
Employed (W)	–5.32 (3.43)	0.66 (1.13)	1.12 (1.18)	0.25 (0.22)	–1.19 (3.10)	1.28 (0.98)	2.39 (1.40)*	0.81 (0.51)
Unemployed (W)	–7.31 (3.05)**	–1.07 (0.98)	–0.49 (1.00)	–0.01 (0.18)	3.38 (2.97)	2.22 (0.94)**	2.63 (1.42)*	0.66 (0.49)
Hispanic	6.29 (2.18)***	1.97 (0.70)***	1.52 (0.71)**	0.20 (0.13)	–5.99 (1.81)***	–2.06 (0.62)***	–1.68 (0.83)**	–0.25 (0.27)
White	0.76 (3.56)	–0.20 (0.97)	–0.27 (1.00)	–0.05 (0.18)	0.43 (2.69)	–0.17 (1.01)	–0.38 (1.38)	–0.13 (0.43)
Other race	–3.69 (4.30)	–0.18 (1.25)	0.13 (1.28)	0.06 (0.24)	0.80 (3.55)	1.03 (1.27)	1.43 (1.78)	0.41 (0.59)
MSA	5.92 (2.11)***	1.40 (0.69)**	0.96 (0.68)	0.11 (0.12)	–4.45 (2.05)**	–1.84 (0.63)***	–1.76 (0.89)**	–0.34 (0.29)
South	–3.45 (2.25)	–0.48 (0.80)	–0.22 (0.81)	–0.01 (0.14)	1.69 (2.24)	1.02 (0.66)	1.16 (0.90)	0.28 (0.29)
Northeast	–3.06 (3.35)	–0.31 (0.99)	–0.07 (1.02)	0.02 (0.18)	1.14 (2.80)	0.89 (0.97)	1.10 (1.39)	0.29 (0.45)
Midwest	0.49 (2.71)	–1.24 (0.92)	–1.27 (0.87)	–0.21 (0.14)	3.30 (2.66)	0.03 (0.77)	–0.75 (1.03)	–0.34 (0.32)
More money	–24.40 (1.78)***	4.37 (0.72)***	8.45 (0.85)***	1.67 (0.32)***	–12.59 (1.47)***	4.91 (0.70)***	13.35 (1.17)***	4.24 (0.69)***
BBCE	–1.59 (1.46)	–1.72 (0.65)***	–1.67 (0.67)**	–0.28 (0.13)**	4.71 (1.70)***	0.78 (0.45)*	–0.01 (0.54)	–0.21 (0.19)
Report simplified	–1.94 (2.04)	–2.44 (1.10)**	–2.45 (1.20)**	–0.42 (0.24)*	6.30 (2.61)**	1.17 (0.71)*	0.08 (0.75)	–0.29 (0.28)

Note: All effects on probabilities are multiplied by 100. Asymptotic standard errors in parentheses. *** 1%, ** 5%, * 10%.