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**Food Stamp Program and Food Insecurity Dynamics: Using
Intra-Annual Measurements**

**Yiran Li, Virginia Tech
Bradford F. Mills, Virginia Tech
Elton Mykerezi, University of Minnesota**

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1 Introduction

Many U.S. households do not have the access to enough food for an active, healthy life for all household members. In 2010 14.5 percent (17.3 million) of U.S. households were food insecure (USDA), in that they had “limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain availability to acquire acceptable foods in socially acceptable ways” (Anderson, 1990; Nord et al.,2002). Food insecurity also differs in severity: in 2010 9.1 percent (10.9 million) of U.S. households had low food security, while 5.4 percent (6.4 million) of U.S. households had very low food security (USDA 2010).

In response to food insecurity and other nutritional concerns in low-income households, the U.S. Department of Agriculture implements sixteen Food Assistance and Nutrition Programs as a food safety net to provide low-income families and children with access to healthy diets. The United States Supplemental Nutrition Assistance Program (SNAP), historically and commonly known as the Food Stamp Program (FSP), is a federal-assistance program designed to provide food assistance via benefit payments to low-income households¹. FSP is the largest component of the USDA’s nutrition program. During fiscal year 2011, an average of 44.7 million persons per month participated in the program. That is, on average 14 percent of Americans participated in FSP each month during fiscal 2011. Federal spending for the program in fiscal year 2011 was \$75.3 billion, comprising 73% of all Federal food and nutrition spending (USDA 2011). FSP is designed to be one of the main components of the social safety net for the food insecure population. With so much of the nation’s food assistance resources devoted to FSP, it is important to document the effectiveness of FSP in providing the basic protection to food insecure populations.

In order to understand food security impact, close attention needs to be paid to the nature of food security status and FSP participation. As will be discussed, most studies

¹Since the data used in this paper is pre-SNAP, we use Food Stamp Program as a generic reference to the program.

have examined and measured both food security and FSP participation on a yearly basis, but a household, especially a working household, may move in and out of food security and the FSP within a year due to reasons such as employment and income volatility. This dynamic pattern of monthly food security and FSP participation will be masked by an analysis with annual measures and potentially lead to incorrect inference about the severity of food insecurity and the effectiveness of FSP in addressing food insecurity. Therefore, because both food security and FSP participation are dynamic rather than static variables, there is a need to consider and incorporate the dynamics of food security and FSP participation and the interaction between the two when the relationship between food security and FSP participation is investigated.

2 Literature Review

A major goal of the FSP is to reduce food insecurity. But the link between FSP and measures of household food security has been surprisingly difficult to establish empirically. In fact, most studies find either no significant relationship between FSP use and food insecurity (FI) or, in some cases, a paradoxical positive correlation. Identifying the effect of FSP participation on the severity of FI with non-experimental data has proven particularly difficult, as households with higher severity of food insecurity are often more likely to participate in the FSP. Attempts to control for heterogeneity that influences both FSP use and FI in cross-section data condition on a variety of household attributes via linear regression and non-parametric estimators (e.g. Gibson-Davis and Foster, 2006), two-stage estimators that rely on instruments (Gundersen and Oliveira, 2001; Kabbani and Yazbeck Kmeid, 2004, Jensen, 2002), and structural simultaneous equations models (Huffman and Jensen, 2006).

Others have used panel data to control for potential unobserved heterogeneity that affects both FSP participation and FI. Ribar and Hamrick (2003), for instance, use longitudinal data

on transitions to and from food insufficiency and do not find that FSP participation reduces food insufficiency. Similarly, Wilde and Nord (2005) use longitudinal data to estimate the impact of FSP participation on food insecurity with a household-fixed effects model and find no significant negative impact of FSP use on FI. Several studies find some evidence that FSP might lower FI, but none is decisive. Borjas (2004), in a natural experiment, finds that FI increased when immigrant populations became ineligible for social assistance during the welfare reform era, and concludes that the availability of public assistance reduces food insecurity. The finding is, however, not specific to the FSP and is based on a unique subset of the general population, immigrants. Yen et al. (2008) and DePolt et al. (2008) also find reductions in FI associated with FSP use, but the studies use smaller data sets that are not nationally representative. Yen et al. (2008) find a small effect using data from the 1996-97 National Food Stamp Program Survey, a survey of roughly 2,200 FSP participants and income-eligible nonparticipants. In their dataset, in stark contrast with nearly all datasets that record FSP and FI, FI was actually higher among non participants than participants. Bartfeld and Dunifon (2006) find that households in states with higher participation in FSP are less likely to be food insecure, after controlling for other household assets and conditions, but the effect is very small.

Mykerezi and Mills (2010) employ two different strategies to measure FSP impacts on FI with the Panel Survey of Income Dynamics. First, instrumental variable models are employed and reveal a negative impact of FSP participation on FI in the US as a whole. Second, a variable that records instances when the government interrupted participants' food stamps is exploited to estimate the impact of loss of benefits on food insecurity relative to otherwise similar FSP participants who do not lose benefits. Loss appears to increase food insecurity by about 20 percent, which is roughly the same magnitude by which FSP participation decreases food insecurity in the IV approach.

In sum, over a decade of research on the links between food assistance and food insecurity

has produced only marginal evidence of a program effect. One potential reason for the weaker than expected link between FSP receipt and increased household food security is that a relatively aggregate annual timeframe of FI and FSP participation has been employed in analyses to date. Specifically, almost all prior analyses of the FSP-food security link have used annual measures of FSP participation and food security. However the relationship between FSP use and food security may evolve within the far shorter timeframe that is often associated with the duration of exposure to negative economic shocks like employment loss and family member illness.

The transient intra-annual nature of household economic well-being is explicitly recognized in new federal program guidelines, with FSP recertification required every six months and state options to impose shorter recertification periods (USDA, 2010). The intra-annual dynamics of food insecurity have received virtually no attention until recently. An Economic Research Service report (Nord and Golla, 2009), however, notes that by virtue of how food insecurity is measured, a household could be classified as food insecure for the year based solely on food hardships that occurred in one or two months of the year. Specifically, measures of (adult) food insecurity are derived from a 10 item survey of household conditions. Questions elicit information on whether food ran out and the households didn't have money for more at some point during the year, if they had to alter the kinds of foods purchased or the quantity of food purchased, if they cut meal sizes, skipped meals, lost weight, or if they were hungry for one or more days at a time and couldn't afford food. Typically, answering one question in the affirmative will classify a household as marginally food secure (as opposed to fully food secure), and answering 3 items in the affirmative will classify households as food insecure. The food hardships that may have led to an affirmative answer to the first three items on the survey could, in fact, have all occurred in one or two months.

Some food hardships early in the year may cause both an affirmative response to the first few items of the FI Core Module and the household to apply for food assistance. Par-

ticipation in food assistance may then prevent the same conditions from occurring over the rest of the year or from getting worse. Data with annual reference cannot distinguish food security immediately before and after FSP participation. Nord and Golla (2009) hypothesize that it is precisely this inability to observe intra-annual dynamics that may be responsible for the lower-than-expected empirical links between FSP and FI. Their study employs two features of the Current Populations Survey’s Food Security Supplement; questions about if households participate in FSP each month (starting in 2001) and a 30 day follow up to the FI Core Module that tracks food conditions over two 30-day periods in two different years for households that participated in the survey in two panel periods. The authors take advantage of the fact that the 30-day reports of food insecurity are always conducted in mid-December, but the timing of food stamp spells relative to the month of December varies. The study finds significant deterioration in food security prior to FSP spells and an improvement after (of about 30 percent). Our investigation follows a similar logic, but does so with data that records monthly FSP participation of households in every month over a nine year period and has monthly FI status in every other year within the same 9 year period. We thus are able to take full advantage of substantial within-household variation in food stamp spells, and compare household FI immediately before and after FSP participation.

3 Data and Methods

We use the Panel Data of Income Dynamics (PSID) to study the dynamics of food security in response to FSP participation. The PSID began in 1968 and is a longitudinal survey of nationally representative individuals and families. The 1999, 2001, and 2003 waves of the PSID provide detailed month-to-month variations in both food stamps and food insecurity in the previous calendar year and are therefore chosen as the data source for this paper.²

²1999, 2001, and 2003 are the most recent three waves that include the ERS-USDA Household Food Security Module and the resulting food security measure used in the paper.

Specifically, each household reporting FSP receipt for the previous calendar year was asked to report whether or not they received FSP benefits each month. Similarly, each household with children that answered at least three of the Food Security Core Module items in the affirmative way were asked to report whether they “had difficulty getting enough food” in each month of the reference year.

The major variables of interest are monthly food security and monthly FSP participation. Monthly FSP participation is readily available in the dataset for years 1998, 2000, and 2002. Annual food security is determined based on the USDA Food Security Module included in the survey. The Module has 10 questions for households without children and 18 questions for households with children. Following USDA definitions, households are classified as food secure if they answered none, or only one or two of the questions affirmatively. Households are classified as food insecure if they answer three or more of the questions affirmatively (ERS/USDA 2007). Food insecure households with children that answered three or more above items affirmatively are further asked if they encountered any difficulty in getting food in each month. A household that is determined as food insecure on annual scale is food insecure in a particular month if it encounters difficulty in getting food in that month and is food secure otherwise. The monthly food security status can be determined as above for all households in 2002, but in 1998 and 2000 the status can only be determined for households with children. That is, each household that answered three or more questions affirmatively are asked about monthly difficulty in getting food in 2002. However, only households with children that answered three or more questions affirmatively are asked about such difficulties in 1998 and 2000. Thus, only households with children are included for analysis.

Causality between food security and FSP has been extremely difficult to establish due to self-selection bias. Instead of focusing on the sign and direct impact of FSP on food security, this paper investigates how food security evolves before and after a household enters FSP. Specifically, a household’s interaction with FSP is divided into pre-FSP and in-FSP periods.

The pre-FSP period is disaggregated into 1, 2, 3 months before entering FSP and a 4-12 months aggregate pre-FSP period³. Similarly the in-FSP period is disaggregated into 1, 2, 3 months in FSP and a long-term participating period of 4-14 months in FSP⁴. Since the change in food security condition before and after FSP entry is of primary interest, the paper focuses on households that at least have some interactions with FSP in 1998, 2000, and 2002, the years for which monthly food security information is available.

As shown in Table 1, the PSID includes 3,393 households with children in 1998, 3,484 households with children in 2000, and 3,545 households with children in 2002. Sample food insecurity rates are 13.03%, 11.31% and 10.94% respectively in 1998, 2000, and 2002. It is worth noting that food insecure rates are significantly higher for households that have at least some interactions with FSP in those years. Among those with exposure to FSP, 35.63% households were food insecure in 1998, 33.95% households were food insecure in 2000, and 28.83% households were food insecure in 2002. The simple descriptive statistics support self-selection bias among FSP participants in terms of lower pre-existing food security among households participating in FSP.

Table 2 shows how food security rates change along the timeline for households that have some interactions with FSP in 1998, 2000, and 2002. As indicated in the table, food insecurity increases in the months prior to participation, with food insecurity rate going up from 3.9% in 4-12 months non-immediate pre-FSP period to 14.9% in the month immediately prior to participation. The rate of food insecurity then declines once the household participates in

³The non-immediate pre-FSP period (4-12 months before FSP entry) and long-term participating period (4-14 months in the FSP) are aggregated to maintain adequate observations, as the number of observations decreases significantly when the period before and after entering FSP grows longer.

⁴The slight difference in the length of pre-FSP and in-FSP periods is due to data limitation. All three waves were carried out in February or later months of 1999, 2001, and 2003. Therefore, FSP participation is observed for all households only for January of the current year. This affects the identification of pre-FSP months in 1998, 2000, and 2002, and consequently the farthest temporal distance from FSP entry is only 12 months before FSP entry. The in-FSP period is free of this data limitation and the only requirement is to have a change of FSP status (e.g. from 1 month in FSP to 2 months in FSP). The longest participation period of 14 months in FSP happens when a household is 3 months in FSP in January and 4 (and more) months in FSP for the rest of the year.

FSP, dropping to 11.8% in the first month in FSP and to 5.6% in the second month. The food insecurity rate bounces back up by 2% in the third month. In the long-term participating period, the food insecurity rate actually reaches its second highest point along the timeline, 9.9%, only slightly lower than 1 month before participation. This high rate may be due to the fact that households that are chronically food insecure are likely to also be long-term FSP participants, rather than the impact of FSP on food security. A fixed effect model will control for this potential adverse selection.

The fixed effect model in a panel data framework is estimated with monthly observations of food insecurity, FSP participation, and unemployment to examine how food insecurity status varies in the months before and after a household enters FSP. The model is specified as:

$$\begin{aligned}
 FI_{it} = & \eta_1 FSPP3_{it} + \eta_2 FSPP2_{it} + \eta_3 FSPP1_{it} + \eta_4 FSP1_{it} + \eta_5 FSP2_{it} \\
 & + \eta_6 FSP3_{it} + \eta_7 FSP4_{it} + \theta UNEM_{it} + \kappa OLF_{it} + M_{it}\omega + \mu_i + \varepsilon_{it}
 \end{aligned}$$

$FSPP3$, $FSPP2$, and $FSPP1$ represent 3, 2, and one months prior to FSP entry, while $FSP3$, $FSP2$, $FSP1$ represent 3, 2, and 1 months in FSP, and $FSP4$ represent the long-term participation period of 4-14 months in the FSP. The non-immediate pre-FSP period (4-12 months prior) is the baseline period. FI_{it} is a binary variable that equals to 1 if a household is food insecure in a month, and equals to 0 otherwise. Similarly $UNEM_{it}$ is a binary variable that indicates monthly unemployment status and OLF_{it} is a binary variable that indicates monthly out of labor force status. M is a vector of month dummies used to capture seasonal effects. μ_i is the household specific fixed effect. η 's, θ , κ , and ω are coefficients.

The specification effectively compares the FI status of participating households in pre-

FSP and during-FSP months. A fixed effect Linear Probability Model (LPM) is used to estimate the relationships.⁵

4 Results

Table 3 presents results from the fixed effect LPM model that examines how household food insecurity changes before and after FSP entry. The dependent variable and independent variables are binary. The omitted categories for the independent variables are employed household heads, the month of January, and the non-immediate (4-12 months) pre-FSP period.

The first column provides parameter estimates for the sample in which households enter or are about to enter the FSP in 1998, 2000, and 2002. That is, all households in the sample have a change of FSP status. The change in probability of food insecurity along the timeline with respect to FSP participation shows similar pattern to the basic statistics presented in table 2 until the long-term participating period. Compared to the non-immediate pre-FSP period (the baseline), a household is 2.5 percentage points more likely to be food insecure 3 months before FSP entry, and the probability continues to increase as the household gets closer to FSP entry, reaching a peak of 7.2 percentage points more likely the month before a household enters FSP. The probability of the household being food insecure then starts to decrease once the household enters FSP. Numerically, after one month in the program the probability of being food insecure declines to 5.3 percentage points above the baseline and continues to decline to 2.3 percentage points above the baseline when the household is 2 months into the program. Then food insecurity bounces back, to be 2.7 percentage points

⁵Fixed effect probit models do not yield consistent estimates (Baltagi 2008). The conditional fixed effects logit model yields consistent estimates but drops the groups where the dependent variable does not change over time; i.e. households that do not have a change in food security status over time are dropped. Another popular method in literature used to estimate panel datasets with binary dependent variables is the random effect probit model. Using an FE logit and RE probit estimator does not substantially change the estimation results.

more likely compared to the baseline 3 months into the program. Finally when a household enters the long-term participation period (4-14 months), the household is only 2.2 percentage points more likely to be food insecure compared to the baseline. Further, after one month in the program the household is statistically no more likely to be food insecure than they were 4 to 12 months prior to entering the program.

It is worth noting that in table 2 food insecurity rate is significantly higher in the long-term participating period than other times, while results from fixed effect LPM shows that a household is less likely to be food insecure during long-term participating period compared to immediately prior to and after FSP entry. This difference likely arises because household heterogeneity is controlled for in fixed effect model and, therefore, the parameter only captures the difference in food insecurity relative to timing of FSP participation of the same household. Figure 1 provides a graphical illustration of the change in the percentage point probability of food insecurity in the fixed effects LPM model relative to the base period of 4-12 months prior to FSP participation.

Labor market indicator variables also have expected signs. Compared to the baseline case with a working household head, being unemployed increases the probability of a household being food insecure by 8 percentage points, while being out of labor force increases the probability by 10.6 percentage points. As for seasonal effects, the probability of a household being food insecure is numerically higher than the January baseline in February, March, June, July, and December and lower the rest of the year. But only the coefficient for September is statistically significant. The results suggest that there may be some evidence that household food insecurity tends to get worse in winter and in summer, possibly due to financial stresses from heating and air-conditioning expenses faced by households.

Results in columns 2 and 3 of Table 3 are based on the same model, but slightly different samples. Unlike column 1, which only includes households with a change in FSP status in the year, column 2 includes the larger sample of households that experience a change in

FSP status in at least one year out of the three years. Meanwhile, column 3 includes all households in the sample for which FSP status can be identified for each month of 1998, 2000, and 2002, whether they experience a change in status or not. Parameter estimates in columns 2 and 3 are very similar to those of column 1, with the same estimated trends in food insecurity in the pre-FSP and in-FSP periods. (i.e. food insecurity first increases prior to FSP entry and then starts declining once a household enters FSP).

In order to test the robustness of the results to the FSP lead and lag structure we also re-estimate the model with the pre-FSP period disaggregated into 1, 2, 3, 4 months before and non-immediate pre-FSP period (5-12 months before) and the in-FSP period disaggregated into 1, 2, 3, 4 months in FSP and long-term participating period (5-14 months in). The results, table 4, are presented for samples with households that have a change in FSP status in the year, in at least one out of the three years, and all households including those with no change in FSP status. Estimates for the major parameters of interest are similar to those in table 3. For instance, for households with a change of FSP status in the year (column 1), the probability of being food insecure is not statistically different from the non-immediate pre-FSP period (5-12 months) 4 months before FSP entry. Then the household is more likely to be food insecure as it gets closer to FSP entry, with the probability increasing from around 2.6 percentage points above the baseline 3 months before FSP entry to almost 7.4 percentage points above the baseline the month before FSP entry. Once a household enters FSP, the likelihood of being food insecure declines, and then continues to decline numerically with the length of the FSP. Again, when the participation spell is longer than 1 month, the household is not statistically more likely to be food insecure compared to the baseline .

The use of intra-annual measures and incorporation of pre- and in-FSP dynamics are the key to our novel findings of robust impacts of FSP participation on food security. To demonstrate this claim, table 5 presents the same fixed effect LPM regressions of household food insecurity on FSP participation and head employment status using annual measures of

food insecurity and FSP participation instead of monthly measures. The first column is based on the sample of households that had a change in FSP status in the year (in correspondence with column 1 of table 3), column 2 is based on the sample of households that had a change of FSP status at least one of three years (in correspondence with column 2 of table 3), and column 3 is based on the entire sample of households with children in waves 1999, 2001, and 2003 of the PSID. As indicated in the table, the coefficients for FSP participation in the three columns are positive 0.139, 0.044, and 0.016, respectively. However, the magnitude of the estimates are not statistically significant. Thus, with annual data there is no evidence that FSP ameliorates household food insecurity. The result again supports the notion that FSP impacts on food security occur over a time period far shorter than the annual measures commonly used in studies. Monthly food insecurity and FSP participation measures may be crucial in uncovering the true effect of FSP on participants' food security.

5 Conclusions

Instead of focusing on the sign and direct impact of FSP on household food security at a single point in time, this paper uses monthly measures of both household FSP participation and food insecurity to examine how food security evolves before and after a household enters the FSP. Results indicate that household food security starts deteriorating a few months before a household enters FSP. But the program effectively ameliorates FSP participants' worsening food sufficiency conditions. A household's continued participation in the program (at least 2 months) brings food security at least back to the level seen 4 months before FSP entry level. When annual measures are used instead of monthly measures, results from an otherwise similar model suggest that FSP participation does not have any effects on household food security among participating households. Those FSP impacts on food security are primarily manifest within instead of across years. The important role FSP plays

in mitigating household declines in food security needs to be highlighted to policy makers and designers of food assistance programs. Political support for programs that effectively safeguard household well-being in the face of adverse economic shocks is likely to be greater than support that increases general well-being. The results also suggest that a two-tier program to protect household food security may be warranted. In the long-term the program needs to provide support with asset and human capital building, while in the short-term it is important to provide easy access to short-term assistance to mitigate negative economic shocks before they significantly impact economic well-being.

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Table 1. Food Insecurity Rates by Year (%)

Food security rate	1998	2000	2002	1998	2000	2002
	Entire sample			Households with exposure to FSP		
Food secure	86.97	88.69	89.06	64.37	66.05	71.17
Food insecure with low food security	9.84	8.21	7.39	25.42	21.75	18.15
Food insecure with very low food security	3.18	3.1	3.55	10.21	12.2	10.69
Total number of observations	3,393	3,484	3,545	421	377	496

Table 2. FSP Participation and Food Security Status (%)

Month	Food secure	Food insecure	Total number of observations
non-immediate pre-FSP period	96.1	3.9	1,880
3 month before participation	92.4	7.6	316
2 month before participation	89.0	11.0	344
1 month before participation	85.1	14.9	390
1 month in the program	88.2	11.8	365
2 months in the program	94.4	5.6	377
3 months in the program	92.4	7.6	367
long-term participating period	86.0	14.0	1,,695

Table 3. Household Food Insecurity and FSP Participation (Fixed Effect LPM)

Variables	At least a change every year	At least one change in 3 years	Including no changes
Head is unemployed	0.080*** (0.020)	0.040** (0.016)	0.020 (0.013)
Head is out of labor force	0.106*** (0.019)	0.020* (0.012)	0.017* (0.009)
February	0.004 (0.015)	0.005 (0.013)	-0.002 (0.010)
March	0.007 (0.015)	0.001 (0.013)	-0.013 (0.009)
April	-0.012 (0.014)	-0.011 (0.013)	-0.015 (0.009)
May	-0.004 (0.014)	-0.004 (0.013)	-0.017* (0.009)
June	0.006 (0.015)	0.010 (0.014)	-0.006 (0.010)
July	0.003 (0.015)	0.013 (0.014)	0.005 (0.010)
August	-0.006 (0.015)	0.006 (0.014)	-0.005 (0.010)
September	-0.030** (0.015)	-0.023* (0.013)	-0.030*** (0.009)
October	-0.009 (0.017)	0.001 (0.015)	-0.006 (0.010)
November	-0.001 (0.018)	0.025 (0.016)	0.026** (0.011)
December	0.022 (0.019)	0.041*** (0.016)	0.040*** (0.011)
3 month before participation	0.025* (0.013)	0.020 (0.014)	0.020 (0.013)
2 month before participation	0.056*** (0.015)	0.043*** (0.015)	0.040*** (0.015)
1 month before participation	0.072*** (0.017)	0.062*** (0.016)	0.059*** (0.016)
1 month in the program	0.053*** (0.017)	0.046*** (0.017)	0.043*** (0.017)
2 months in the program	0.023 (0.016)	0.016 (0.016)	0.015 (0.016)
3 months in the program	0.027 (0.018)	0.022 (0.018)	0.022 (0.017)
long-term participating period	0.022 (0.015)	0.003 (0.011)	0.001 (0.010)
Average household fixed effects	0.053*** (0.013)	0.090*** (0.012)	0.102*** (0.010)
Number of observations	5724	7800	14664
Number of groups (fixed effects)	431	453	820

Notes: Heteroskedastic robust standard errors are in parentheses. Asterisks indicate levels of significance in two-tailed t-tests. *** indicates p=0.01, ** indicates p=0.05, and * indicates p=0.10.

Table 4. Robustness checks (Extending lead and lag structure)

Variables	At least a change every year	At least one change in 3 years	Including no changes
Head is unemployed	0.067*** (0.020)	0.025 (0.016)	0.020 (0.013)
Head is out of labor force	0.102*** (0.018)	0.028** (0.012)	0.017* (0.009)
February	0.006 (0.015)	0.007 (0.013)	-0.002 (0.010)
March	0.007 (0.015)	0.001 (0.013)	-0.013 (0.009)
April	-0.009 (0.014)	-0.009 (0.013)	-0.015 (0.009)
May	-0.002 (0.014)	-0.002 (0.013)	-0.017* (0.009)
June	0.008 (0.015)	0.012 (0.013)	-0.006 (0.010)
July	0.004 (0.015)	0.015 (0.013)	0.005 (0.010)
August	-0.005 (0.015)	0.008 (0.014)	-0.005 (0.010)
September	-0.030* (0.016)	-0.020 (0.013)	-0.030*** (0.009)
October	-0.010 (0.017)	0.004 (0.015)	-0.006 (0.010)
November	0.001 (0.018)	0.030** (0.015)	0.026** (0.011)
December	0.023 (0.019)	0.043*** (0.016)	0.040*** (0.011)
4 months before participation	0.001 (0.013)	-0.004 (0.013)	-0.003 (0.012)
3 month before participation	0.026* (0.014)	0.018 (0.014)	0.019 (0.014)
2 month before participation	0.056*** (0.016)	0.040** (0.016)	0.039*** (0.015)
1 month before participation	0.074*** (0.017)	0.060*** (0.017)	0.059*** (0.016)
1 month in the program	0.055*** (0.017)	0.045*** (0.017)	0.043** (0.017)
2 months in the program	0.025 (0.017)	0.015 (0.017)	0.014 (0.016)
3 months in the program	0.029 (0.019)	0.020 (0.018)	0.021 (0.018)
4 months in the program	0.019 (0.019)	0.005 (0.018)	0.003 (0.018)
long-term participating period	0.024 (0.017)	0.000 (0.012)	-0.000 (0.011)
Average household fixed effects	0.054*** (0.013)	0.090*** (0.012)	0.103*** (0.011)
Number of observations	5832	7968	14664
Number of groups (fixed effects)	440	462	820

Notes: Heteroskedastic robust standard errors are in parentheses. Asterisks indicate levels of significance in two-tailed t-tests. *** indicates $p=0.01$, ** indicates $p=0.05$, and * indicates $p=0.10$. Extending the lead and lag structure adds the changes of 4 months in FSP to 5 months in SNAP and results in more households that have a change of SNAP status, and therefore, a few more observations in the first columns of table 5 compared with table 4.

Table 5. Household Food Insecurity and FSP Participation (Annual Measures; Fixed effect LPM)

Variables	Households with at least a change every year	Households with at least one change in 3 years	Entire sample
FSP participation	0.139 (0.314)	0.044 (0.152)	0.016 (0.029)
Head is unemployed	-0.007 (0.323)	-0.165 (0.113)	-0.006 (0.022)
Head is out of labor force	-0.028 (0.319)	-0.198** (0.096)	0.047* (0.025)
Average household fixed effects	0.217 (0.264)	0.395*** (0.144)	0.140*** (0.006)
Number of observations	477	650	10,375
Number of groups (fixed effects)	431	453	4,846

Change in probability of food security

