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Re-Examining the SNAP Benefit Cycle Allowing for Heterogeneity

Jeffrey H. Dorfman,* Christian Gregory, Zhongyuan Liu, and Ran Huo

Jeffrey H. Dorfman is a professor, and Zhongyuan Liu and Ran Huo are PhD students in the Department of Agricultural and Applied Economics at The University of Georgia. Christian Gregory is an economist at USDA/Economic Research Service
*Correspondence may be sent to: jdorfman@uga.edu.

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Abstract *A well-known feature of the Supplemental Nutrition Assistance Program (SNAP) is that some recipients spend a disproportionate amount of their monthly benefit early in the month. Using a finite mixture model that optimally separates households into two groups, coupled with the National Household Food Acquisition and Purchase Survey, we re-examine this spending pattern. Results show that a minority of SNAP recipients cause the benefit cycle by spending, on average, two-thirds of their monthly benefit within the first four days. A potential implication of these findings is that more frequent SNAP benefit disbursal or educational programs designed to encourage smoother spending over the month might be of benefit to some SNAP households.*

Key words: SNAP, SNAP benefit cycle, food insecurity, mixture model.

JEL codes: C21, D12, I38.

Both anecdotal evidence and social science research have documented what is known as the Supplemental Nutrition Assistance Program (SNAP) benefit cycle, in which SNAP recipients spend much of their monthly benefit very early in the month. Such behavior is of concern to policy makers because SNAP is the government's main and largest food assistance program (previously and still often known as food stamps), and if recipients spend their benefit early in the month they may experience nutritional deficiencies or food insecurity later in the benefit month. Previous studies have established that, on a purely descriptive level, about 20% of SNAP recipients experience very low food security (Coleman-Jensen et al. 2016). It seems a reasonable hypothesis that if SNAP recipients spend most of their SNAP benefit early in their benefit month, they have a higher probability of being

food insecure late in the benefit month when they may lack the financial resources to purchase sufficient food.

Past research has shown convincingly that SNAP participation improves the well-being of recipients over numerous dimensions, including reductions in food insecurity (Nord and Golla 2009; Gregory, Rabbitt, and Ribar 2015; Gundersen and Ziliak 2015), improvements in health outcomes such as anemia (Kreider et al. 2012) and birth outcomes (Almond, Hoynes, and Schanzenbach 2011), and increases in the quality of participants' diets and nutrition (Gregory et al. 2013; Gundersen 2015). Recognizing the benefit of the SNAP program, understanding the nature and causes of the benefit cycle is important because policies that smooth out the SNAP cycle could further improve both the effectiveness and cost efficiency of the program.

This paper is motivated by the fact that while the existence of the SNAP benefit cycle is well established, there is considerably less research that has examined SNAP spending behavior across the benefit month at the micro level. Until recently, this has been due to lack of data. However, from 2012 to 2013 the U.S. Department of Agriculture conducted the first nationally representative survey on household food purchases and acquisition. The National Household Food Acquisition and Purchase Survey (FoodAPS) oversampled low-income households and asked about both food-at-home (FAH) and food-away-from-home (FAFH) purchase information, inquired about any sources for acquiring free food, and collected demographic and income information including SNAP participation and the amount of any SNAP benefit. The survey also recorded how each purchase was paid for and collected information on households' SNAP receipt date. These data provide the best opportunity to date for examining the SNAP benefit cycle at the household level (a fuller description of this data is below).

In this paper, we re-examine the SNAP benefit cycle using a finite mixture model that allows different groups of SNAP recipients to display distinct patterns of spending across the benefit month. In estimating a finite mixture model, the number of groups is chosen by model selection criteria, and which group each household belongs to is chosen to maximize the likelihood function. Using the empirical estimates, we attempt to identify whether the benefit cycle is caused by the behavior of a sub-group of SNAP recipients and then to identify behaviors correlated with that suboptimal spending. Ideally, successful identification of such behaviors would allow the design of program improvements that could help SNAP better address nutritional outcomes and food insecurity.

We find clear classification of our sample into two groups—designated as patient and impatient groups—that display wildly different spending patterns for their monthly SNAP benefits. The smaller group of impatient households spends two-thirds of their monthly benefit in the first four days, while patient households only spend one-sixth. That the SNAP benefit cycle is confined to a subset of households has implications for designing policy to address the issue.

The rest of the paper is organized as follows. A literature review provides context for the model that is developed in the following section, along with a description of the estimation methodology. The data are described next. This is followed by our empirical results. Finally, implications and conclusions complete the paper.

Conceptual Background

The life-cycle or permanent income hypothesis is a mainstay of textbook economic theory. According to this model, households' expectations of lifetime (permanent) income shape their purchasing and decision-making activity in the present more than their current actual income (Friedman 1957; Hall 1978). If markets for credit, information, and insurance are complete, households can always borrow against future income in order to execute optimal consumption decisions today. A testable prediction that has developed from the empirical literature in this domain is that predictable changes in income—for example, the specific timing of regular paychecks, stipends, or program benefit payments—should have no effect on consumption. Put another way, consumption decisions in the current period will not be related to current income or its timing; choices about consumption in the short- and long-term are perfectly time-consistent.

Behavioral departures from the life-cycle or permanent income hypothesis' rational calculus of utility could be due to market imperfections or other economic causes. In the case of the SNAP benefit cycle, some research has focused on preference heterogeneity—that is, difference in time preferences between SNAP and non-SNAP households.[1] In this context, the behavior of SNAP participants has been found to be consistent with hyperbolic discounting, which describes the situation in which people discount utility in the near future much more heavily than in the not-so-distant future (Laibson, 1997; Smith et al. 2016; Wilde and Ranney 2000). Empirical research has suggested that this could lead to reductions in food purchases and nutritional quality at the end of the benefit month. For example, Shapiro (2005) showed that the SNAP cycle led to decreased caloric intake *as well as* declining dollar value of intake across the benefit month. Differences in the estimates of these decreases implied a shift away from higher- to lower- quality foods over the course of the month. Wilde and Ranney (2000) examined average calorie intake and found decreased intakes in the fourth week of the SNAP distribution month. Todd (2015) found that, before the increase in SNAP benefits associated with the American Recovery and Reinvestment Act of 2009, caloric intake declined by as much as 25% in the fourth week of the SNAP month. Tarasuk, Mclntyre, and Li (2007) showed that low-income women's dietary quality was sensitive to the time since the receipt of income. Finally, Kharmats et al. (2014) found that nutrient quality and energy declined for each day removed from SNAP receipt in a sample of low-income African-Americans in Baltimore.

Other research has shown that this lack of smoothing behavior may be linked to food insecurity. For example, Hamrick and Andrews (2016) used the American Time Use Survey to show that SNAP recipients were more likely to have a day without eating at the end of the SNAP benefit month. Weinstein et al. (2009) found that low-income households were 5.5 times as likely to report food insecurity at the end of the benefit month as at the beginning; additionally, they found that in households with children, food-insecure households were much more likely to have a child with anemia.

Our study contributes to this literature by examining unobserved heterogeneity in responses to SNAP receipt and using administrative data to check the robustness of the results. This allows us to test the hypothesis that the

[1]*While the SNAP benefit cycle is the most common term for this phenomenon, it has also been referred to as "intra-month spending cyclicality" and "SNAP benefit-month spending cyclicality" in the literature; cf., Hastings and Washington (2010) and Mastrobuoni and Weinberg (2009).*

SNAP benefit cycle is caused by a subgroup of SNAP recipients, and to then test for observables correlated with group membership.

Methodology

In order to test our theory that the SNAP benefit cycle might be caused by only a subset of SNAP recipients, we apply a normal finite mixture model to data on spending patterns from the FoodAPS dataset. A mixture model assumes that data are generated by two or more different unobserved processes with each observation being assigned a probability of belonging to each process or group (Dempster, Laird, and Rubin 1977). The model specification of the data-generating process in each group can be different, or even if the model stays constant across groups, the model parameters will differ. During the estimation process, the parameters of each group's model are chosen to maximize the likelihood function, and the number of groups is chosen to optimize a model selection criteria such as the Akaike Information Criterion or AIC.

For this application, we apply a normal finite mixture model, meaning that each group is assumed to follow a normal linear regression model. Our chosen dependent variable is the percentage of each household's monthly SNAP benefit spent in the first four days of the benefit month. This variable is selected because it represents a strong signal of the SNAP benefit cycle. Recipients who spend their SNAP benefit evenly throughout the entire month would spend about 13% in the first four days. In extreme cases of the type of behavior that produces the benefit cycle, some households are observed spending their entire SNAP benefit in the first four days.

By focusing on this measure of very rapid spending, we narrow our examination to the behavior that is most indicative of the spending pattern we are seeking to identify and modify. In these first few days, the spending rates of the two groups are the most different, making classification into groups the most accurate. The later in the benefit month we go, the more similar the spending rates become as the impatient households have little left to spend, while the patient group steadily spends small amounts all month. Thus, we focus on the first few days of the benefit month because that is where the informative behavior is displayed that allows us to accurately classify people into the two groups.

To explain the share of SNAP benefits spent in the first four days of the month, we include a host of factors in different categories: demographic variables, financial management measures, health-related self-ratings, and store-choice/location. These explanatory variables are identical in all group's models. Insight can be gained from the differences in the model parameters or in the distribution of exogenous variable values in different groups. We include the amount of monthly SNAP benefits, indicators for three levels of food security, and an indicator of whether the household has utilized a food pantry in the past month.[2] The demographic variables include standard

[2]*Normally, food insecurity and health status variables are not included as explanatory variables when evaluating outcomes related to the SNAP program as they are known to be endogenous to SNAP participation. However, in this case, we are not trying to predict SNAP participation or a treatment effect on some outcome variable (say, obesity) from SNAP participation. Rather, we are trying to explain differences in behavior among SNAP participation; if food insecurity makes rapid spending of SNAP benefits more likely, we need to know that. Further, if we drop the food insecurity and health status variables from the model, the results are qualitatively the same and quantitatively very similar, with a small increase in the difference in the average value of the dependent variable across the two groups.*

variables such as age, gender, race, household size, employment status, and the number of children and elderly in the household. Health measures include variables for tobacco use, self-assessed health status, self-assessed diet quality, and how frequently the shopper looks at nutritional labels. In the shopping category, we have variables for travel time to the shopper's favored store location, reasons for choosing their usual grocery outlet, and the frequency of grocery list usage.[3] The financial measures include whether the household owns their house or apartment, how regularly they pay their bills on time, a self-assessed measure of the household's financial condition, and an indicator for the presence of more or less than $2,000 in liquid assets.

Given this set of explanatory variables, the share of SNAP benefits expended in the first four days of the benefit cycle (*Ratio*) is represented as a linear model,

$$Ratio_i = \beta_{oj} + DG_i\beta_{1j} + FS_i\beta_{2j} + H_i\beta_{3j} + FN_i\beta_{4j} + SH_i\beta_{5j} + \varepsilon_i \quad (1)$$

where DG is a vector of demographic variables, FS are the food security measures, H is a vector of health-related variables, FN is a vector of financial measures, and SH is a vector of variables about shopping location choices and shopping behavior. The βs are parameters to be estimated, with the first subscript denoting the subset of variables they are associated with, and the second subscript denoting the group the observation belongs to ($j = 1, \ldots, J$), while ε_i is a stochastic term for observation i.

Ratio, the share of SNAP benefits spent in the first four days, cannot be negative and is top-censored at 1. Some households do spend more than their monthly SNAP benefit because benefits do rollover if not spent, so it is possible to spend more than 100% in a month or in the first four days. While spending ratios above 1 are therefore possible, we felt that top-censored was preferred. Although the dependent variable, *Ratio*, is censored on both ends of its range, we are estimating standard linear regression models. There are 45 observations at the lower limit, and 10 observations at the upper limit from a total of 163. While the model results do produce 32 predicted values above 1 and 17 below zero, it is important to note that values greater than one are theoretically possible, and the vast majority of the predicted values outside the imposed range are quite nearby (e.g., 13 out of 17 negative predictions are between 0 and -0.1). Given this, we believe it is defensible to apply linear regression models to this data in spite of its censoring.

The likelihood function for a finite mixture model of normal distributions is given by

$$L(\pi, \beta, \sigma \mid X, y) = \prod_{j=1}^{J} \prod_{i=1}^{n} \pi_{ij} \phi\left[\frac{Ratio_i - X_i\beta_j}{\sigma}\right] \quad (2)$$

where the π_{ij} are the probabilities that observation i belongs to group j, $\phi(\bullet)$ is the pdf of a standard normal distribution, X is the collection of all the

[3]*We include variables here beyond those previously associated with patience/impatience (cf., Aguiar and Hurst 2005; Mastrobuoni and Weinberg 2009) because we are hoping to identify any food shopping-specific traits correlated with impatience so that educational programs could be designed to minimize this behavior.*

explanatory variables, and β_j is the vector of all regression coefficients for group j. To estimate the mixture model for a given number of groups, one maximizes the likelihood function in equation (2) subject to constraints on the π_{ij} to ensure they sum to one for each observation. We use the Expectation Maximization (EM) algorithm to achieve this (Dempster, Laird, and Rubin 1977; Frühwirth-Schnatter 2006). The EM algorithm works in two steps: in the first, E-step, with a set of estimates for π_{ij} in hand, one takes the conditional expectation of the log likelihood $L(y, \pi \mid X, \beta, \sigma)$. Then, given the estimates of β_j and σ from the E-step, find a new set of π_{ij} that maximizes the complete likelihood function in equation (2) conditional on these updated regression parameters (M-step). This loop repeats until convergence to a maximum is achieved. Finally, mixture models are estimated for several different numbers of groups and a model selection criterion such as the AIC is employed to choose the optimal number of groups.

To measure the success at classifying the observations into the two groups, we compute the entropy measure of discrimination suggested by Celeux and Soromenho (1996). Discrimination measures how confidently the model has assigned observations to one of the groups. The entropy measure is computed in two steps,

$$E = \sum_{i=1}^{n}\sum_{j=1}^{J}\pi_{ij}\ln(\pi_{ij}) \tag{3}$$

and

$$ER = 1 - E/[n\ln(J)]. \tag{4}$$

With the scaling in equation (4), the value of ER is bounded between 0 and 1. If $ER = 0$ it means the estimated probabilities of belonging to each model are all $1/J$ (complete uncertainty); when $ER = 1$, all observations can be placed in a group with complete certainty (probability = 1 for that group, 0 for all others). Common practice is that values above 0.8 demonstrate strong confidence in the classification process.

Data

The USDA's National Household Food Acquisition and Purchase Survey (FoodAPS) is the first nationally representative survey to collect comprehensive data about household food purchases and acquisition.[4] The seven-day survey was conducted between April 2012 and January 2013 on a nationally-representative sample of 4,826 households. This survey covers SNAP households, low-income households not participating in SNAP, and higher-income households. SNAP households were oversampled to ensure good statistical variation and coverage of this subsample. Sampling weights are included to transform the data set into a nationally representative sample.

[4]*The FoodAPS household is defined as all persons who live together and share food and who expect to be present at the sampled address during at least part of the data collection week.*

For a one week data collection period, each participating household was asked to record food-at-home (FAH) and food-away-from-home (FAFH) purchase information, and also reported all sources of free food. Respondents also participated in two interviews that aimed to collect detailed household-level and individual-level information. This detailed information includes variables about shopping outlet choice and the reasons for those choices, self-assessed health measures, measures of both household financial condition and financial management, and many other variables on both food acquisition habits and household demographics.

FoodAPS has several advantages for this project. First, FoodAPS collected extensive information on demographic characteristics, labor market activity, program participation, income, and expenditures—both food and nonfood—for each household. This is helpful in determining if characteristics differ across the groups estimated by the mixture model. Additionally, each individual's shopping events are also characterized by the payment type. In particular, we know whether acquisitions are paid for with SNAP benefits, cash, or a combination. Finally, the dataset also lists whether respondents are SNAP recipients and contains an administrative verification of that status (which is important as SNAP status is frequently misreported).

We focus on a subsample: the 1,581 of the 4,826 total households that were administratively verified SNAP recipients during the week of the survey. The initial interview was usually conducted right before the seven-day survey period to screen the eligible households. Using information in the FoodAPS data set, we created a variable "*dayinterval*" to record the number of days between the first day of the seven-day survey period and the last SNAP benefits date. Because each household receives SNAP benefits on the same calendar day as the previous month, *dayinterval* equals 0 on the day that SNAP benefits are received and reaches a maximum of 30 before the benefit cycle repeats.

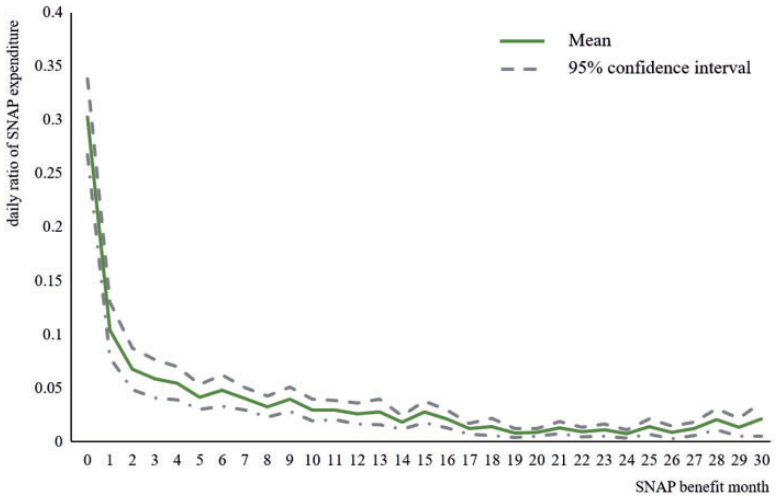
We are interested in the pattern of how households redeem their SNAP benefits throughout the month. Thus, we calculate the daily SNAP expenditure ratio ("daily ratio" for short) as the percentage of daily SNAP expenditure over monthly SNAP benefits, letting the daily ratio equal 0 if there is no shopping event on a survey day. Figure 1 presents the average daily ratio of SNAP expenditure for all SNAP recipients in the dataset throughout the SNAP benefit month. The average daily ratio is 30.27% on the day of benefit receipt (i.e., $dayinterval = 0$), which means that the average household spends about 30% of its SNAP benefits on the SNAP receipt day. The average daily ratio drops to 5.87% on the third day. Throughout the rest of the benefit month, the daily ratio displays a consistent decrease.

As demonstrated by figure 1, a well-known and oft-studied feature of SNAP recipients is that, on average, SNAP participants spend a large percentage of their benefits within the first few days of the benefit month. Figure 1 reaffirms this SNAP benefit cycle. Since we are most interested in the feature at the start of the benefit cycle, we focus on those households for whom days 0–3 are all observed ($dayinterval = 0$, 1, 2, and 3). The ratio of total SNAP expenditures in these days to monthly SNAP benefits is *Ratio*, which is the dependent variable in our mixture model.[5]

Because interview windows are distributed evenly throughout the benefit month, many observations do not include the necessary four days.

[5]*We name the dependent variable* Ratio *to distinguish it from the daily ratio, also discussed above.*

Figure 1 Average ratio of SNAP expenditures to SNAP benefit by day of benefit cycle



We additionally restrict the sample in the following ways: (*a*) we exclude SNAP households with benefits less than $20 per month, and (*b*) the primary household respondents must be adults (age of primary respondent greater than 19). We also drop households missing values for any of our included explanatory variables. These conditions leave us 734 food acquisition events and 163 households.

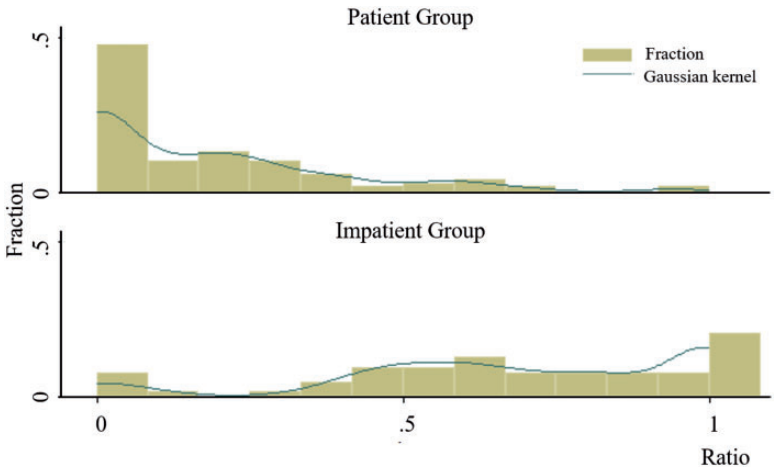
Full details of the explanatory variables and their construction is in appendix tables 1 and 2, including a description of how we built categorical variables from the survey's coded responses. In many cases, we took a variable with, for example, five responses and made it into one or two dummy variables by combining several responses into a single category; this allows us to keep the explanatory variables to a manageable number.

Notable variables beyond a number of standard demographic ones are as follow: the number of dinners eaten together as a family at home; self-assessed health and diet ratings; tobacco usage; use of nutrition labels when shopping; familiarity with My Pyramid and My Plate diet recommendations; reported food security; whether the household used a food pantry or food bank in the previous month; frequency of grocery list usage; travel time to the household's primary food store; usual means of getting to their food store; whether the household owns or rents their residence; how frequently they pay their bills on time; and whether the household had used a payday loan in the previous six months. For a full list of the explanatory variables, see appendix table 1.

Results

The estimation of the mixture model results in the finding of two groups of SNAP recipients, which we denote as the patient and impatient groups. A model selection criterion was not needed as models with more than two groups failed to converge. Out of our 163 households, we find 63 members in the impatient group (39% of the sample) and 100 members in the patient group (61%). Recalling that classification confidence is good if the entropy measure ER exceeds 0.8, we are pleased to report that our model has a value

Figure 2 First four days of SNAP expenditure ratios by group



of *ER*=0.9574, so the classification of these households into patient and impatient groups has a high degree of confidence.

Figure 2 clearly displays the vast difference in average early-benefit cycle spending behavior by members of these two groups. The impatient group spends four times as much of their monthly SNAP benefit in those first few days of the benefit cycle as the households in the patient group. While the patient households spend only slightly more than a proportional share of their monthly benefits on days 0 to 3 of the benefit cycle (a 17.7% spending ratio in 13.3% of the days), the impatient households spend an average of 67.2% of their benefit, over two-thirds of the benefit gone with roughly four weeks left in the benefit month.

The estimated coefficients of the mixture model are shown in table 1, along with measures of their statistical precision. These results show that having a job makes impatient households spend their SNAP benefits faster (expected increase in ratio=0.289) while having more kids at home makes them spend their SNAP benefits more slowly (expected decrease in ratio per kid=0.161); neither of these variables has a significant effect on patient household spending. Impatient people spend their SNAP benefits faster if they use tobacco (0.167) or rate themselves as more unhealthy (base category, but healthier ratings have negative estimated coefficients), again with little similar effect among the patient households. Using a grocery list regularly slows the SNAP spending of impatient households (-0.182). We also see more even spending from impatient households who choose their primary grocery store because of its produce (-0.246), but faster spending by impatient households who choose their primary store for variety or closeness (0.314 and 0.165, respectively). Similarly, impatient households who choose their prime store for prices have higher ratios of early-month spending (0.036); loyalty programs, on the other hand, tend to reduce spending at the beginning of the month (-0.125), perhaps due to discount or coupon programs. Owning their house (0.296) and having some money in the bank (0.225) both led impatient households to spend their SNAP benefit faster, likely because of a greater ability to buy food with cash later in the benefit month. Considering that these are expected changes in the share of monthly

Table 1 Mixture Model Regression Results

	Group1: Impatient				Group2: Patient			
Variable	**Coefficient**	**std.err**	**z-score**	**p-value**	**coefficient**	**std.err**	**z-score**	**p-value**
Constant	1.734	0.055	31.666	0.000	0.004	0.119	0.034	0.973
Family and Personal Characteristics								
Sex	0.169	0.014	−12.209	0.000	0.029	0.029	−0.972	0.331
Age	−0.010	0.000	−22.764	0.000	0.006	0.001	5.082	0.000
Work	0.289	0.013	22.203	0.000	−0.014	0.022	−0.630	0.529
racecat1	−0.232	0.023	−9.999	0.000	−0.056	0.027	−2.090	0.037
racecat2	−0.330	0.023	−14.419	0.000	−0.089	0.034	−2.607	0.009
Highedu	−0.011	0.002	−5.088	0.000	0.003	0.003	1.040	0.298
Hhsize	0.014	0.004	3.492	0.000	−0.004	0.014	−0.308	0.758
Kidsnum	−0.161	0.006	−26.644	0.000	−0.002	0.021	−0.119	0.905
Oldersnum	0.058	0.009	6.743	0.000	−0.070	0.022	−3.160	0.002
Nmealshome	0.002	0.002	0.868	0.385	0.006	0.005	1.246	0.213
Nmealstogether	−0.012	0.001	−16.227	0.000	0.001	0.003	0.548	0.584
Health Lifestyle								
Tobacco	0.167	0.010	16.722	0.000	0.022	0.026	0.822	0.411
healthrate1	−0.583	0.021	−27.54	0.000	0.009	0.049	0.184	0.854
healthrate2	−0.522	0.016	−32.425	0.000	−0.086	0.040	−2.184	0.029
dietrate1	0.016	0.027	0.577	0.564	0.195	0.052	3.733	0.000
dietrate2	0.011	0.014	0.806	0.420	0.066	0.037	1.790	0.073
Nutritionfact	−0.012	0.011	−1.051	0.293	0.015	0.028	0.531	0.595
Nutritionsearch	0.232	0.012	19.984	0.000	−0.052	0.033	−1.581	0.114
Healthycost	−0.003	0.010	−0.284	0.776	−0.108	0.025	−4.316	0.000

Food Security and Assistance								
Snaplastamt	0.001	0.000	17.497	0.000	0.000	0.000	2.863	0.004
adltfscat1	0.150	0.015	9.851	0.000	−0.183	0.037	−4.936	0.000
adltfscat2	−0.052	0.015	−3.398	0.001	−0.111	0.032	−3.450	0.001
adltfscat3	−0.148	0.013	−11.309	0.000	−0.134	0.028	−4.742	0.000
Foodpantry	−0.061	0.017	−3.622	0.000	−0.002	0.037	−0.052	0.958
Food Shopping								
Primstoretraveltime	−0.009	0.001	−12.551	0.000	0.001	0.002	0.582	0.561
Grocerylistfrequency	−0.182	0.008	−21.614	0.000	−0.043	0.027	−1.587	0.113
Primstoreprices	0.036	0.012	2.919	0.004	−0.017	0.022	−0.772	0.440
Primstoreproduce	−0.246	0.016	−15.405	0.000	0.068	0.035	1.932	0.053
Primstoremeat	−0.117	0.019	−6.054	0.000	−0.020	0.038	−0.539	0.590
Primstorequality	0.183	0.015	12.562	0.000	−0.037	0.036	−1.052	0.293
Primstorevariety	0.314	0.013	23.575	0.000	0.010	0.029	0.345	0.730
Primstorespecial	−0.180	0.028	−6.484	0.000	−0.187	0.075	−2.505	0.012
Primstoreclose	0.165	0.013	12.491	0.000	−0.034	0.022	−1.504	0.133
Primstoreloyalty	−0.125	0.021	−6.024	0.000	0.083	0.032	2.642	0.008
shopplace1	−0.267	0.016	−16.261	0.000	−0.048	0.024	−1.964	0.050
shopplace2	0.010	0.019	0.524	0.600	−0.004	0.027	−0.163	0.870
shopplace3	−0.313	0.024	−12.96	0.000	−0.121	0.073	−1.653	0.098
shopplace4	0.361	0.030	11.94	0.000	0.011	0.086	0.128	0.898
shopmeans1	0.244	0.018	13.77	0.000	0.016	0.042	0.378	0.705
shopmeans2	0.334	0.023	14.588	0.000	−0.013	0.044	−0.287	0.774
Financial Situation								
Ownhousing	0.296	0.010	30.884	0.000	−0.005	0.030	−0.164	0.870
Billsontime	0.025	0.012	2.059	0.039	0.023	0.025	0.913	0.361
Finccondition	−0.113	0.012	−9.488	0.000	−0.025	0.034	−0.734	0.463
liqassets2000	0.225	0.026	8.579	0.000	0.099	0.053	1.854	0.064
Observations	63				100			
R2	0.978							

SNAP benefit spent in the first four days of the benefit month, these are quite large effect sizes.

Interestingly, while the mixture model results show both that a number of the explanatory variables do affect the rapidity of SNAP spending and that some explanatory variables have very different marginal effects on SNAP spending for patient versus impatient households, there are few statistically significant differences between patient and impatient households in the average values of these explanatory variables, presented in table 2. Impatient households self-rate their diet slightly worse, use a grocery list somewhat more often, are more likely to choose their primary food store based on price, but less likely to choose it based on variety, closeness, or because it has a loyalty program. Impatient households face a somewhat longer driving distance to their primary store (5.6 versus 3.8 miles) and have fewer SNAP-accepting stores nearby than do the patient households.

More notable are the significant differences we do not find. The patient and impatient households do not differ significantly in working, education, number of kids in the home, eating together as a family, reported food security, or the use of food pantries. Importantly, there is no significant difference in total earnings or amount of SNAP benefit between our two groups. Both groups are equally likely to use their own car as their primary means of getting to the grocery store, and report very similar financial conditions.

To confirm that demographic and socioeconomic differences do not drive the divide between the two groups, we estimated a series of logit models that attempted to predict the group membership of our households from the set of variables included in our regression models. Starting with just the demographic variables, then adding two subsets of financial and health variables, and finally the full set of forty-two variables that includes things as varied as reasons for grocery shopping store choice, how often you pay your bills on time, and how often the family eats meals together, we find very little predictive power and only four statistically significant variables out of forty-two included in the fullest specification. These results are provided in appendix table 3.

The clear message of these empirical results is that the SNAP benefit cycle is caused by a subset of SNAP recipients, but the behavior of those households is not driven by some difference that forces their shopping pattern to vary. While we have demonstrated that spending behavior differs, we cannot track when households actually consume the food they purchase. It is possible that our impatient group is composed of impatient shoppers who then budget their consumption of that food evenly through the month, thus suffering little or no negative effects. However, we cannot find an explanation for why some households would shop in such a pattern. Based on the data on earned income, car ownership, and other variables, the households in the impatient group are not spending all their money at once because it is harder for them to get to the store or because they have less cash income. The simple story seems to be that a share of SNAP households (39%) choose to spend a large share of their SNAP benefits very rapidly as soon as they are received.

Implications

While our patient and impatient groups report roughly equal food security in the early days of the benefit month, food insecurity does rise through

Table 2 Comparing Characteristics across the Groups

Variable	Explanation	Impatient		Patient		P-value	P-value (Lower one-sided)	P-value (Upper one-sided)
		Count	Mean (sd)	Count	Mean (sd)			
Dependent variable								
Ratio	Percentage of SNAP expenditure over total SNAP benefits in the first 3 days	63	0.672 (0.293)	100	0.177 (0.220)	0.000	1.000	0.000
Family and Personal Characteristics								
Sex	Gender: male = 1 and female = 0	63	0.175 (0.383)	100	0.270 (0.446)	0.163	0.919	0.081
Age	Year	63	40.746 (13.262)	100	39.860 (12.792)	0.672	0.664	0.336
Work	Yes = 1	63	0.317 (0.469)	100	0.380 (0.488)	0.420	0.210	0.790
racecat1	White = 1	63	0.730 (0.447)	100	0.660 (0.476)	0.350	0.825	0.175
racecat2	Black = 1	63	0.175 (0.383)	100	0.160 (0.368)	0.809	0.596	0.404
racecat3	Others = 1	63	0.095 (0.296)	100	0.140 (0.349)	0.399	0.200	0.800
Highedu	Higher education between household heads	63	19.635 (2.802)	99	19.323 (3.006)	0.510	0.745	0.255
Hhsize	Household size	63	3.810 (2.162)	100	3.330 (1.815)	0.129	0.935	0.065
Kidsnum	Number of household members (age < 18)	63	1.651 (1.557)	100	1.340 (1.430)	0.194	0.903	0.097

Continued

Table 2 *Continued*

Variable	Explanation	Impatient		Patient		P-value	P-value (Lower one-sided)	P-value (Upper one-sided)
		Count	Mean (sd)	Count	Mean (sd)			
Oldersnum	Number of household members (age > 60)	63	0.238 (0.499)	100	0.240 (0.534)	0.982	0.491	0.509
Nmealshome	Number of times prepared food for dinner at home	62	5.774 (2.658)	100	5.560 (2.634)	0.617	0.692	0.308
Nmealstogether	Number of times family ate dinner together, at home	54	7.296 (5.910)	84	6.262 (4.842)	0.264	0.868	0.132
incamount1	Amount of earnings from work for respondent	49	411.265 (728.073)	76	401.013 (548.451)	0.929	0.536	0.464
Incamounttotal	Total amount of earnings from work for household	52	764.538 (1264.820)	84	757.393 (1123.379)	0.973	0.514	0.486
stregion1	Household comes from Northeast (Yes = 1)	63	0.079 (0.272)	100	0.200 (0.402)	0.038	0.019	0.981
stregion2	Household comes from Midwest (Yes = 1)	63	0.175 (0.383)	100	0.200 (0.402)	0.690	0.345	0.655
stregion3	Household comes from South (Yes = 1)	63	0.444 (0.501)	100	0.440 (0.499)	0.956	0.522	0.478
stregion4	Household comes from West(Yes = 1)	63	0.302 (0.463)	100	0.160 (0.368)	0.032	0.984	0.016
Health Lifestyle								
Tobacco	Yes = 1	63	0.381 (0.490)	100	0.440 (0.499)	0.460	0.230	0.770
healthrate1	Health condition is excellent (Yes = 1)	63	0.206 (0.408)	100	0.210 (0.409)	0.956	0.478	0.522

healthrate2	Health condition is good (Yes = 1)	63	0.730 (0.447)	100	0.680 (0.469)	0.499	0.750	0.250
healthrate3	Health condition is poor (Yes = 1)	63	0.063 (0.246)	100	0.110 (0.314)	0.320	0.160	0.840
dietrate1	Diet condition is excellent (Yes = 1)	63	0.079 (0.272)	100	0.220 (0.416)	0.019	0.009	0.991
dietrate2	Diet condition is good (Yes = 1)	63	0.825 (0.383)	100	0.650 (0.479)	0.015	0.992	0.008
dietrate3	Diet condition is poor (Yes = 1)	63	0.095 (0.296)	100	0.130 (0.338)	0.504	0.252	0.748
Nutritionfact	Always use nutrition facts (Yes = 1)	63	0.254 (0.439)	100	0.200 (0.402)	0.422	0.789	0.211
Nutritionsearch	searched internet for nutrition information (Yes = 1)	63	0.254 (0.439)	100	0.210 (0.409)	0.517	0.741	0.259
Healthycost	It costs too much to eat healthy foods (Yes = 1)	63	0.476 (0.503)	99	0.475 (0.502)	0.986	0.507	0.493
Healthytime	Respondent is too busy to take time to prepare healthy foods (Yes = 1)	63	0.127 (0.336)	100	0.150 (0.359)	0.683	0.342	0.658
Mypyramid	Heard of MyPyramid (Yes = 1)	63	0.508 (0.504)	100	0.530 (0.502)	0.785	0.393	0.607
Mypyramidfollow	Tried to follow MyPyramid plan recommendations (Yes = 1)	24	0.500 (0.511)	32	0.406 (0.499)	0.494	0.753	0.247
Myplate	Heard of MyPlate (Yes = 1)	63	0.175 (0.383)	100	0.190 (0.394)	0.806	0.403	0.597
Myplatefollow	Tried to follow MyPlate guidelines (Yes = 1)	11	0.636 (0.505)	19	0.368 (0.496)	0.167	0.916	0.084
Food Security and Assistance								
Snaplastamt	Reported amount of SNAP benefits last received	63	297.365 (185.581)	100	289.780 (193.071)	0.805	0.598	0.402

Continued

Table 2 *Continued*

Variable	Explanation	Impatient		Patient		P-value	P-value (Lower one-sided)	P-value (Upper one-sided)
		Count	Mean (sd)	Count	Mean (sd)			
adltfscat1	High food security (Yes = 1)	63	0.286 (0.455)	100	0.360 (0.482)	0.330	0.165	0.835
adltfscat2	Marginal food security (Yes = 1)	63	0.270 (0.447)	100	0.210 (0.409)	0.382	0.809	0.191
adltfscat3	Low food security (Yes = 1)	63	0.254 (0.439)	100	0.220 (0.416)	0.620	0.690	0.310
adltfscat4	Very low food security (Yes = 1)	63	0.190 (0.396)	100	0.210 (0.409)	0.764	0.382	0.618
Foodpantry	Household went to a food bank or food pantry in past 30 days for groceries (Yes = 1)	63	0.111 (0.317)	100	0.090 (0.288)	0.661	0.669	0.331
Kidsbrkfstindex	Child's school breakfasts are free or at a reduced price (Yes = 1)	18	1.000 (0.000)	33	1.000 (0.000)	.	.	.
Kidslunchindex	Child's school lunches are free or at a reduced price (Yes = 1)	31	0.935 (0.250)	47	0.936 (0.247)	0.990	0.495	0.505
Food Shopping								
primstoretraveltime	One-way travel time to primary food store, in minutes	63	12.349 (8.106)	100	11.300 (7.887)	0.414	0.793	0.207
grocerylistfrequency	respondent always or very often shops with a grocery list (Yes = 1)	63	0.492 (0.504)	100	0.330 (0.473)	0.039	0.980	0.020
Primstoreprices	Shop at primary store b/c has low prices/good value (Yes = 1)	62	0.774 (0.422)	100	0.590 (0.494)	0.016	0.992	0.008
Primstoreproduce	Shop at primary store b/c has good produce selection (Yes = 1)	62	0.177 (0.385)	100	0.130 (0.338)	0.412	0.794	0.206

Primstoremeat	Shop at primary store b/c has a good meat department (Yes = 1)	62	0.097 (0.298)	100	0.150 (0.359)	0.330	0.165	0.835
Primstorequality	Shop at primary store b/c has good quality food (Yes = 1)	62	0.177 (0.385)	100	0.160 (0.368)	0.774	0.613	0.387
Primstorevariety	Shop at primary store b/c has good variety of general foods (Yes = 1)	62	0.129 (0.338)	100	0.240 (0.429)	0.086	0.043	0.957
Primstorespecial	Shop at primary store b/c has good variety of special foods (Yes = 1)	62	0.048 (0.216)	100	0.050 (0.219)	0.964	0.482	0.518
Primstoreclose	Shop at primary store b/c is close to home (Yes = 1)	62	0.371 (0.487)	100	0.530 (0.502)	0.049	0.025	0.975
Primstoreloyalty	Shop at primary store for loyalty card program (Yes = 1)	62	0.048 (0.216)	100	0.140 (0.349)	0.065	0.033	0.967
shopplace1	Household shopped for food at a convenience store (Yes = 1)	63	0.381 (0.490)	100	0.400 (0.492)	0.810	0.405	0.595
shopplace2	Household shopped for food at a discount or big box store or wholesale club (Yes = 1)	63	0.302 (0.463)	100	0.270 (0.446)	0.665	0.668	0.332
shopplace3	Household shopped for food at a dollar store (Yes = 1)	63	0.095 (0.296)	100	0.040 (0.197)	0.154	0.923	0.077
shopplace4	Household shopped for food at a bakery or meat or fish market or produce store or vegetable stand (Yes = 1)	63	0.048 (0.215)	100	0.040 (0.197)	0.817	0.592	0.408
shopmeans1	Usual means of getting to primary food store: own car (Yes = 1)	63	0.683 (0.469)	100	0.630 (0.485)	0.496	0.752	0.248
shopmeans2	Usual means of getting to primary food store: others' car (Yes = 1)	63	0.206 (0.408)	100	0.220 (0.416)	0.837	0.419	0.581

Continued

Table 2 *Continued*

Variable	Explanation	Impatient		Patient		P-value	P-value (Lower one-sided)	P-value (Upper one-sided)
		Count	Mean (sd)	Count	Mean (sd)			
primstoredist_d	Driving distance, in miles, between residence and primary food store	58	5.551 (5.907)	92	3.786 (5.024)	0.052	0.974	0.026
primstoredist_s	Straight-line distance, in miles, between residence and primary food store	58	4.339 (4.719)	92	2.803 (3.846)	0.031	0.985	0.015
snap1	Number of SNAP-authorized retailers within 0.25 mi	63	0.794 (1.608)	100	1.630 (3.240)	0.059	0.029	0.971
snap2	Number of SNAP-authorized retailers within 0.50 mi	63	3.127 (4.401)	100	5.790 (11.989)	0.093	0.046	0.954
snap3	Number of SNAP-authorized retailers within 1 mi	63	11.238 (17.138)	100	17.030 (30.947)	0.176	0.088	0.912
snap4	Number of SNAP-authorized retailers within 2 mi	63	33.794 (57.319)	100	48.820 (84.768)	0.217	0.109	0.891
snap5	Number of SNAP-authorized retailers within 5 mi	63	153.206 (371.588)	100	232.240 (549.932)	0.317	0.158	0.842
snap6	Number of SNAP-authorized retailers within 10 mi	63	472.286 (1210.802)	100	819.990 (2077.441)	0.230	0.115	0.885
snap7	Number of SNAP-authorized retailers within 15 mi	63	838.365 (1831.448)	100	1305.790 (3116.821)	0.283	0.141	0.859
snap8	Number of SNAP-authorized retailers within 30 mi	63	1810.508 (3046.322)	100	2180.940 (3861.750)	0.520	0.260	0.740
Totalnfexp	Household total non-food expenses	63	1034.760 (2245.196)	100	726.205 (557.492)	0.191	0.905	0.095

Financial Situation								
Ownhousing	Household owns residential unit	63	0.317 (0.469)	100	0.260 (0.441)	0.430	0.785	0.215
Billsontime	Household always or often pays bills on time (Yes = 1)	63	0.683 (0.469)	100	0.710 (0.456)	0.712	0.356	0.644
Finccondition	Household's reported financial condition is comfortable and secure (Yes = 1)	63	0.175 (0.383)	100	0.180 (0.386)	0.931	0.465	0.535
liqassets2000	Household has $2,000 or more in liquid assets (Yes = 1)	63	0.063 (0.246)	100	0.080 (0.273)	0.696	0.348	0.652
paydayloan6mos	Household took out a payday-like loan within last 6 months (Yes = 1)	52	0.135 (0.345)	82	0.122 (0.329)	0.832	0.584	0.416
utilnotpaid6mos	Household could not pay full amount of utility bills within last 6 months (Yes = 1)	52	0.385 (0.491)	82	0.329 (0.473)	0.517	0.742	0.258
Povertyindex	Household average income is above 100% poverty guideline for household of this size (Yes = 1)	63	1.540 (0.502)	100	1.460 (0.501)	0.325	0.838	0.162

the SNAP benefit month. Based on the full sample of SNAP households in FoodAPS, low or very low food security rises from 44% to 48% of SNAP households when the first ten and last ten days of the benefit month are compared, meaning that 4% more SNAP households become food insecure by the end of their benefit month. While respondents are supposed to consider the entire month, that people more frequently recall their current circumstances is not surprising. Thus, it is likely that some impatient households are running low on financial resources with which to purchase food at the end of their benefit month. It is also possible that better budgeting of SNAP benefits could improve this situation. Thus, it could be worth trying to help impatient SNAP households to utilize their SNAP benefit more evenly throughout the month.

The USDA can easily identify impatient households by examining their SNAP spending in the first few days of the benefit month. The few statistically significant differences between patient and impatient households suggest that the behavioral differences are not driven by a difference in circumstances. Nor could as simple a nudge as encouraging the use of grocery lists completely solve the problem, because while our results show that grocery list usage does help, nearly half of the impatient households already regularly use a grocery list. Thus, an educational program might be one effective response; that is, teaching these households some basic budgeting skills and tools, and helping them to understand the potential benefit of a more evenly distributed spending pattern.

Another possible response would be to provide SNAP benefits more frequently, such as twice a month. Such a policy change was raised as a possible remedy to the SNAP benefit cycle by Smith et al. (2016). It should even be possible to target the twice-monthly benefits specifically to those SNAP recipients who need the nudge toward more even spending.

Conclusions

By examining the SNAP benefit cycle at the household level using a finite mixture model, we find that the phenomenon is caused by a minority of SNAP recipients. Within the subsample of households in the FoodAPS dataset examined here, 39% of SNAP recipients are in our impatient group, spending roughly twice the average amount of their monthly SNAP benefits within the first four days of receiving them. The remaining households appear to budget their benefits evenly throughout the month and should not be of concern to policymakers.

A potential implication of these findings is that educational programs might be of benefit to some SNAP households. If the calorie deficits at the end of the SNAP month (Todd 2015) result from households' expenditure patterns, consumer education in food budgeting, use of grocery lists, and other techniques designed to encourage smoother spending over the month could be helpful. Another potential implication is that allowing households to opt into more frequent SNAP disbursal could be of benefit. In either case, our results suggest that the ill-effects of non-smoothed consumption behavior are concentrated in a small subset of households. Policies that encourage households to choose what is best for them, in this context, could have beneficial results.

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Appendix Table 1 Descriptive Statistics of Data

Variable	Explanation	Mean	SD
Dependent variable			
Ratio	SNAP spending in first 4 days ÷ total SNAP benefits in first 4 days	0.368	0.348
Family and Personal Characteristics			
Sex	Gender: male = 1 and female = 0	0.233	0.424
Age	Year	40.202	12.942
Work	Yes = 1	0.356	0.48
racecat1	White = 1	0.687	0.465
racecat2	Black = 1	0.166	0.373
Highedu	Higher education between household heads	19.444	2.923
Hhsize	Household size	3.515	1.964
Kidsnum	Number of household members (age < 18)	1.460	1.483
Oldersnum	Number of household members (age > 60)	0.239	0.519
Nmealshome	Number of times prepared food for dinner at home	5.642	2.637
Nmealstogether	Number of times family ate dinner together, at home	6.667	5.289
Health lifestyle			
Tobacco	Yes = 1	0.417	0.495
healthrate1	Health condition is excellent (Yes = 1)	0.209	0.408
healthrate2	Health condition is good (Yes = 1)	0.699	0.46
dietrate1	Diet condition is excellent (Yes = 1)	0.166	0.373
dietrate2	Diet condition is good (Yes = 1)	0.718	0.451
Nutritionfact	Always use nutrition facts (Yes = 1)	0.221	0.416
Nutritionsearch	searched internet for nutrition information (Yes = 1)	0.227	0.42
Healthycost	It costs too much to eat healthy foods (Yes = 1)	0.475	0.501
Food Security and Assistance			
Snaplastamt	Reported amount of SNAP benefits last received	292.712	189.67
adltfscat1	High food security (Yes = 1)	0.331	0.472
adltfscat2	Marginal food security (Yes = 1)	0.233	0.424
adltfscat3	Low food security (Yes = 1)	0.233	0.424
foodpantry	Household went to a food bank or food pantry in past 30 days for groceries (Yes = 1)	0.098	0.298
Food Shopping			
primstoretraveltime	One-way travel time to primary food store, in minutes	11.706	7.964
grocerylistfrequency	respondent always or very often shops with a grocery list (Yes = 1)	0.393	0.49
primstoreprices	Shop at primary store b/c has low prices/ good value (Yes = 1)	0.660	0.475
primstoreproduce	Shop at primary store b/c has good produce selection (Yes = 1)	0.148	0.356
primstoremeat	Shop at primary store b/c has a good meat department (Yes = 1)	0.130	0.337
primstorequality	Shop at primary store b/c has good quality food (Yes = 1)	0.167	0.374

Continued

Appendix Table 1 *Continued*

Variable	Explanation	Mean	SD
primstorevariety	Shop at primary store b/c has good variety of general foods (Yes = 1)	0.198	0.399
primstorespecial	Shop at primary store b/c has good variety of special foods (Yes = 1)	0.049	0.217
primstoreclose	Shop at primary store b/c is close to home (Yes = 1)	0.469	0.501
primstoreloyalty	Shop at primary store for loyalty card program (Yes = 1)	0.105	0.307
shopplace1	Household shopped for food at a convenience store (Yes = 1)	0.393	0.49
shopplace2	Household shopped for food at a discount or big box store or wholesale club (Yes = 1)	0.282	0.451
shopplace3	Household shopped for food at a dollar store (Yes = 1)	0.061	0.241
shopplace4	Household shopped for food at a bakery or meat or fish market or produce store or vegetable stand (Yes = 1)	0.043	0.203
shopmeans1	Usual means of getting to primary food store: own car (Yes = 1)	0.650	0.478
shopmeans2	Usual means of getting to primary food store: others' car (Yes = 1)	0.215	0.412
Financial Situation			
Ownhousing	Household owns residential unit	0.282	0.451
Billsontime	Household always or often pays bills on time (Yes = 1)	0.699	0.46
Finccondition	Household's reported financial condition is comfortable and secure (Yes = 1)	0.178	0.384
liqassets2000	Household has $2,000 or more in liquid assets (Yes = 1)	0.074	0.262
Observations		163	

Appendix Table 2 Specific Coding of Variables from Original Dataset

Variable	Explanation	Original dataset
Dependent variable		
ratio	Percentage of SNAP expenditure over total SNAP benefits in the first 3 days	
Family and Personal Characteristics		
Sex	Gender: male = 1 and female = 0	female = 2
Age	Year	Same
work	Yes = 1	if INCAMOUNT1 (amount, earnings from work, individual) is positive, then work = 1
racecat1	White = 1	Racecat = 1: white;
	Racecat = 1: white;	Racecat = 2: black/
racecat2	Black = 1	African American
	Racecat = 2: black/African American	Racecat = 3: American Indian or Alaska Native
		Racecat = 4: Asian
		Racecat = 5: Native Hawaiian or Other Pacific Islander
		Racecat = 6: Other race
		Racecat = 7: multiple races
highedu	Higher education between household heads	Max(edu) as highedu where relation = 0, 1, 2 (which are respondent, spouse, unmarried partner, receptively)
hhsize	Household size	
kidsnum	Number of household members (age ≤ 18)	Count household members whose age is less than or equal to 18
oldersnum	Number of household members (age > 60)	Count household members whose age is greater than 18
nmealshome	Number of times prepared food for dinner at home	Same
nmealstogether	Number of times family ate dinner together, at home	Same
Health lifestyle		
tobacco	Yes = 1	Same
healthrate1	Health condition is excellent (Yes = 1)	Healthstatus = 1: excellent
	Healthstatus = 1: excellent	Healthstatus = 2: very
healthrate2	Health condition is good (Yes = 1)	good
	Healthstatus = 2: very good+	Healthstatus = 3: good
	Healthstatus = 3: good	Healthstatus = 4: fair
		Healthstatus = 5: poor

Continued

Appendix Table 2 *Continued*

Variable	Explanation	Original dataset
dietrate1	Diet condition is excellent (Yes = 1) Dietstatuspr = 1: excellent	Dietstatuspr = 1: excellent
dietrate2	Diet condition is good (Yes=1) Dietstatuspr = 2: very good+ Dietstatuspr = 3: good	Dietstatuspr = 2: very good Dietstatuspr = 3: good Dietstatuspr = 4: fair Dietstatuspr = 5: poor
nutritionfact	Always use nutrition facts (Yes = 1) Nutritionfacts = 1: always+ Nutritionfacts = 2: most of the time	Nutritionfacts = 1: always Nutritionfacts = 2: most of the time Nutritionfacts = 3: sometimes Nutritionfacts = 4: rarely Nutritionfacts = 5: never Nutritionfacts = 6: never seen
nutritionsearch	searched internet for nutrition information (Yes = 1)	Same
healthycost	It costs too much to eat healthy foods (Yes = 1)	Same
Food Security and Assistance		
snaplastamt	Reported amount of SNAP benefits last received	Same
adltfscat1	High food security (Yes = 1) ADLTFSCAT = 1: high food security	ADLTFSCAT = 1: high food security
adltfscat2	Marginal food security (Yes = 1) ADLTFSCAT = 2: marginal food security	ADLTFSCAT = 2: marginal food security ADLTFSCAT = 3: low food security
adltfscat3	Low food security (Yes = 1) ADLTFSCAT = 3: low food security	ADLTFSCAT = 4: very low food security
foodpantry	Household went to a food bank or food pantry in past 30 days for groceries (Yes = 1)	Same
Food Shopping		
primstoretraveltime	One-way travel time to primary food store, in minutes	Same
grocerylistfrequency	respondent always or very often shops with a grocery list (Yes = 1) Grocerylistfreq = 4: most of the time+ Grocerylistfreq = 5: almost always	Grocerylistfreq = 1: never Grocerylistfreq = 2: seldom Grocerylistfreq = 3: sometimes Grocerylistfreq = 4: most of the time Grocerylistfreq = 5: almost always

Continued

Appendix Table 2 *Continued*

Variable	Explanation	Original dataset
primstoreprices	Shop at primary store b/c has low prices/good value (Yes = 1)	Same
primstoreproduce	Shop at primary store b/c has good produce selection (Yes = 1)	Same
primstoremeat	Shop at primary store b/c has a good meat department (Yes = 1)	Same
primstorequality	Shop at primary store b/c has good quality food (Yes = 1)	Same
primstorevariety	Shop at primary store b/c has good variety of general foods (Yes = 1)	Same
primstorespecial	Shop at primary store b/c has good variety of special foods (Yes = 1)	Same
primstoreclose	Shop at primary store b/c is close to home (Yes = 1)	Same
primstoreloyalty	Shop at primary store for loyalty card program (Yes = 1)	Same
shopplace1	Household shopped for food at a convenience store (Yes = 1) Shopconv	Dummy: Shopconv Shopbigbox
shopplace2	Household shopped for food at a discount or big box store or wholesale club (Yes = 1) Shopbigbox+Shopclub	Shopclub Shopdollar Shopbakery Shopmeatfish
shopplace3	Household shopped for food at a dollar store (Yes = 1) Shopdollar	Shopvegstand shopanyother
shopplace4	Household shopped for food at a bakery or meat or fish market or produce store or vegetable stand (Yes = 1) Shopbakery+Shopmeatfish+ Shopvegstand	
shopmeans1	Usual means of getting to primary food store: own car (Yes = 1) Primstoretravelmode = 1: drive own car	Primstoretravelmode = 1: drive own car Primstoretravelmode = 2: use someone else's car
shopmeans2	Usual means of getting to primary food store: others' car (Yes = 1) Primstoretravelmode = 2: use someone else's car Primstoretravelmode = 1: someone else drives me	Primstoretravelmode = 1: someone else drives me Primstoretravelmode = 1: walk Primstoretravelmode = 1: bus Primstoretravelmode = 1: taxi Primstoretravelmode = 1: ride bicycle

Continued

Appendix Table 2 *Continued*

Variable	Explanation	Original dataset
Financial Situation		
ownhousing	Household owns residential unit Housingown = 2: own	Housingown = 1: rent Housingown = 2: own Housingown = 3other
billsontime	Household always or often pays bills on time (Yes = 1) Billsontimefreq = 4: usually Billsontimefreq = 5: always	Billsontimefreq = 1: never Billsontimefreq = 2: rarely Billsontimefreq = 3: sometimes Billsontimefreq = 4: usually Billsontimefreq = 5: always
finccondition	Household's reported financial condition is comfortable and secure (Yes = 1) Fincondition = 1: very comfortable and secure Fincondition = 2: able to make ends meet without much difficulty	Fincondition = 1: very comfortable and secure Fincondition = 2: able to make ends meet without much difficulty Fincondition = 3: occasionally have some difficulty making ends meet Fincondition = 4: tough to make ends meet but keeping your head above walter Fincondition = 5: in over your head
liqassets2000	Household has $2,000 or more in liquid assets (Yes = 1)	Same

Appendix Table 3 Logit Coefficient Estimates for Group Selection Prediction Model

VARIABLES	Model 1	Model 2	Model 3	Model 4
gender	−0.599	−0.575	−0.564	−0.695
	(0.437)	(0.452)	(0.529)	(0.657)
age	0.0109	0.00893	0.0178	0.0345
	(0.0146)	(0.0151)	(0.0202)	(0.0316)
worknot	−0.305	−0.438	−0.187	−0.307
	(0.354)	(0.377)	(0.438)	(0.562)
racecat1	0.918*	0.951*	0.515	0.523
	(0.541)	(0.559)	(0.678)	(0.808)
racecat2	0.858	0.865	0.978	1.211
	(0.639)	(0.644)	(0.757)	(0.991)
highedu	0.00230	0.0184	0.0282	0.162
	(0.0633)	(0.0663)	(0.0774)	(0.107)
hhsize	0.166	0.153	0.169	−0.0239
	(0.149)	(0.148)	(0.165)	(0.254)
kidsnum	−0.0273	0.0871	0.133	0.343
	(0.208)	(0.238)	(0.249)	(0.342)
oldersnum	−0.124	−0.216	−0.385	−0.511
	(0.376)	(0.398)	(0.425)	(0.663)
nmealstogether			0.0470	0.0747
			(0.0391)	(0.0630)
nmealshome				0.0736
				(0.138)
tobacco		−0.257	−0.132	0.282
		(0.359)	(0.422)	(0.544)
healthrate1				0.875
				(1.031)
healthrate2				0.947
				(0.985)
dietrate1			−1.872*	−1.476
			(1.072)	(1.344)
dietrate2			−0.198	0.815
			(0.703)	(0.826)
Nutritionfact				0.0996
				(0.638)
nutritionsearch				0.150
				(0.643)
Healthycost				−0.873
				(0.661)
Snaplastamt		−0.00118	−0.000942	−0.00179
		(0.00117)	(0.00114)	(0.00150)
ADLTFSCAT1				−0.650
				(0.730)
ADLTFSCAT2				0.186
				(0.689)
ADLTFSCAT3				0.898
				(0.815)
Foodpantry				−0.864
				(1.301)
primstoretraveltime		0.0255	0.0351	0.0255
		(0.0228)	(0.0278)	(0.0362)

Continued

Appendix Table 3 *Continued*

VARIABLES	Model 1	Model 2	Model 3	Model 4
grocerylistfrequency			0.743*	1.007*
			(0.429)	(0.556)
primstoreprices				0.539
				(0.599)
primstoreproduce				1.788**
				(0.777)
primstoremeat				−1.926**
				(0.829)
primstorequality				0.749
				(0.704)
primstorevariety				−1.942***
				(0.744)
primstorespecial				−0.443
				(1.082)
primstoreclose				−0.492
				(0.553)
primstoreloyalty				−0.592
				(0.789)
shopplace1				0.373
				(0.687)
shopplace2				0.622
				(0.740)
shopmeans1				−0.243
				(1.066)
shopmeans2				−0.504
				(1.210)
Ownhousing				0.604
				(0.542)
Billsontime		−0.230	−0.311	−0.618
		(0.382)	(0.411)	(0.580)
finccondition				0.861
				(0.745)
liqassets2000				−0.342
				(0.942)
Constant	−2.001	−2.007	−2.955*	−7.850**
	(1.394)	(1.525)	(1.768)	(3.178)
Pseudo R-squared	0.041	0.055	0.1223	0.280
Observations	162	162	137	135

Note: *Robust standard errors in parentheses. Asterisks indicate the following:*
****= $p < 0.01$, **= $p < 0.05$, and *= $p < 0.1$.*