DISSERTATION

# THREE ESSAYS ON FOOD ECONOMICS

Submitted by

Sachintha Sarani Mendis-Murukkuwadura

Department of Agricultural and Resource Economics

In partial fulfillment of the requirements

For the Degree of Doctor of Philosophy

Colorado State University

Fort Collins, Colorado

Summer 2022

Doctoral Committee:

Advisor: Alessandro Bonanno

Joshua Berning
Jude Bayham
Rebecca Cleary
Ray Miller

ABSTRACT

THREE ESSAYS ON FOOD ECONOMICS

This dissertation is comprised of three analyses of households' food acquisition behavior. In Chapter 2, we estimate the substitution between different food categories and time allocated to food purchase and preparation using a demand system which includes both the demand for time and that for goods, by extending the Exact Affine Stone Index-EASI (Lewbel & Pendakur, 2009). This is the first study estimating Resource Engel Curves (which characterize the relationship between "total resources" and resource share), and goods-time cross price elasticities. For this analysis we created a unique dataset by merging the 2012 American Time Use Survey (ATUS) with the National Household Food Acquisition and Purchase Survey (FoodAPS), and perform the analysis for three sub-samples of households - 1) households participating in the SNAP program, 2) SNAP-eligible households that do not participate in the program, and 3) SNAP-ineligible households. The objective of Chapter 3 is to study the relationship between time allocated to different food related activities and households' diet quality of food acquisitions measured by their Healthy Eating Index - HEI, across the distribution of HEI. We utilize the same datasets developed in Chapter 2 and an Unconditional Quantile Regression estimator to perform the analysis on the same three sub-samples of households used in Chapter 2. In Chapter 4, we assess whether households whose children are exposed to Farm-to-School Programming show different fruits and vegetables purchasing patterns than those that are not. We matched two years of the USDA Farm to School Census (2013 and 2015) to Information Resource Incorporated Consumer Network Panel household-level data on Food-At-Home fruits and vegetables expenditures. We perform our analysis focusing on sub-samples of households residing in metro and non-metro areas, as well as by households below and above 185 percent of the poverty line.

ACKNOWLEDGEMENTS

There are many people behind this journey. First, I am extremely grateful to my advisor Dr. Alessandro Bonanno for his invaluable advices, continuous support, guidance, and encouragements. I really appreciate him being very thoughtful, and going above and beyond to help us to be on tract and be successful. My sincere thanks also go to my PhD committee members Dr. Jude Bayham, Dr. Joshua Berning, Dr. Rebecca Cleary, and Dr. Ray Miller for sharing their knowledge and expertise, being always available for me, and encouraging me. Further, along with my advisor, I would like to thank Dr. Marco Costanigro, Dr. Becca Jablonski, Dr. Dawn Thilmany, and again Dr. Rebecca Cleary for giving me the opportunity to work with them in research projects which helped me to gain immense knowledge and experience. Dr. Clare Cho has also been sharing her expertise throughout, and incredibly supportive. I'm very grateful for her for that. Moreover, I would like to thank our department head Dr. Hayley Chouinard for taking care of all of us. Also, thanks to all the professors for sharing their knowledge. Further, my sincere thanks go to all the department members for creating a friendly and warm work-study environment for us.

Armen, Michelan, and all my friends are my chosen family. I'm am extremely grateful for them for all the memories we shared, cheering me up, and believing in me. I was very lucky to meet them all and be life-long friends. Further, I'm forever grateful for my mother for who I am today. I would not write why I'm grateful for her, because that could be a separate series of books. Same goes to my aunt. Words cannot express my gratitude for her. I'm also thankful to Shashika for his love and support throughout, and picking me up when I fall down. Last but most importantly, I deeply appreciate everything my brother does. He is my pillar of support and has been fulfilling all of my responsibilities in my home county without any complaint, while I chase my dreams.

# DEDICATION

*Dedicated to all who contribute to the free education system in Sri Lanka.*

*If not for them, I wouldn't be here.*

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

# Chapter 1

# Introduction

Food[1] is a basic human need. In spite of nourishment being a basic need, more than 11 percent (or 14.3 million) of US households (approximately 37.2 million people) were food insecure [2] at some point during 2018, including 4.1 percent with very low food security (Coleman-Jensen et al., 2020). However, federal nutrition assistance programs such as the Supplemental Nutrition Assistance Program (SNAP); the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC); and the National School Lunch Program (NSLP) which are specifically designed to fight against hunger and food insecurity [3] are in place. In 2018, the U.S. government funded $68 billion on SNAP and food assistance programs (Center on Budget and Policy Priorities, 2019b). Further, history of nationwide food assistance programs in the U.S. date back to 1970s, and during the last five decades these programs have continuously been updated. However, 2018 Current Population Survey data revealed that 56 percent of food-insecure households participated in one or more of the three largest food assistance programs (SNAP, WIC, and NSLP) (Coleman-Jensen et al., 2019). In spite of the many changes over time, an aspect that these programs have disregarded is how household allocate their time to food production activities. In Chapter 2 and 3, we explore how households' time allocation for food purchasing and preparation activities is associated with food acquisition, and diet quality, respectively. In the fourth chapter, we contribute to the literature

---

[1]The findings and conclusions in this study are those of the author(s) and should not be construed to represent any official USDA or U.S. Government determination or policy. This study was supported in part by the U.S. Department of Agriculture, Economic Research Service. The analyses, findings, and conclusions expressed in this study also should not be attributed to Food Acquisition and Purchase Survey (FoodAPS) or Information Resources, Inc. (IRI). Funding from the National Institute of Food and Agriculture is thankfully acknowledged: "Rural Community Impacts of Farm to School: Food Supply Chains, Educational Programming, and Household Food Purchases" [Award # 2017-67023-26246].

[2]The U.S. Department of Agriculture defines household food insecurity as a household's uncertainty of having, or inability of acquiring, enough food to meet the needs of all their members during a specific time period (30 days or a year), because of insufficient resources (ERS 2019b).

[3]"Hunger" refers to a personal, physical sensation of discomfort, and "food insecurity" refers to a lack of available resources for food (Feeding America, 2021).

investigating potential spillovers of publicly funded programs to support children's nutrition by evaluating how a household's fruits and vegetables expenditure is related to children's exposure to Farm to School Program activities.

Particularly, the objective of Chapter 2 is to estimate the substitution between different food categories (classified upon their level of convenience and storability) and food purchase and preparation (P&P) time. In this chapter, we study the joint demand for Food-At-Home and Food-Away-From-Home categories, as well as the time spent on food P&P activities by modeling time and money allocation decisions for food as occurring jointly. In order to model this decision, we derive a demand system which includes both the demand for time and that for goods by extending the Exact Affine Stone Index-EASI (Lewbel & Pendakur, 2009). Then we estimate the model's parameters using a unique dataset created by merging the 2012 American Time Use Survey (ATUS) with the National Household Food Acquisition and Purchase Survey (FoodAPS) data, using the method developed by You & Davis (2019). The results of this analysis will shed light on households time saving vs. cost saving strategies, and can inform on the importance of taking time cost into consideration when designing tools to help households achieving a nutritious diet with limited resources (i.e. the TFP[4]).

Chapter 3's objective is to study the association between households diet quality measured in terms of the Healthy Eating Index - HEI, and time allocated to different food-related activities. Our claim of novelty is twofold. Fist, most of the literature assessing the relationship between time allocated to food-related activities and dietary quality, is affected by data limitations, which lead researchers to use proxies for food-related time use. By using the unique dataset created by merging the 2012 American Time Use Survey (ATUS) with the National Household Food Acquisition and Purchase Survey (FoodAPS) data, discussed in 2, we are able to circumvent this limitation. The second claim of novelty is that we investigate how the association between households' diet quality

[4]TFP has four main component: food prices, food consumption amounts, food composition data (nutrients), and dietary guidelines. Ignoring the labor cost of food P&P is a major limitation of the current TFP (C-FARE 2021).)

and time allocated to different food related activities across the distribution of the household HEI using the Unconditional Quantile Regression estimator proposed by Firpo et al. (2009).

In Chapter 4, we assess whether households whose children are exposed to Farm-to-School Programs (FTSP) show different purchasing patterns of fruits and vegetables than those that are not. FTSP was created as part of the Healthy Hunger-Free Kids Act of 2010 (Food and Nutrition Service, 2017) with two major purposes, 1) to promote local food systems and 2) to provide school children access to nutritious foods. FTSPs emphasize fresh fruits and vegetables over processed foods, small over large farmers, and local over national vendors, promoting the procurement (and consumption) of locally or regionally sourced food in schools (Allen & Guthman, 2006). We study the relationship between exposure to FTSP, captured by different measures of exposure duration and programming intensity, and a household's fruits and vegetables expenditure and expenditure shares (over the total food budget). To achieve this goal, we use two available years of the USDA Farm to School Census, matched with Information Resource Incorporated Consumer Network Panel household data on purchases of Food-at-Home. This study sheds light on the effectiveness of FTSP implementation in terms of translating knowledge to improving households' diet.

# Chapter 2

# Food Acquisition and Time Use – A Demand System Approach

## 2.1 Introduction

More than 11% (or 14.3 million) of US households (approximately 37.2 million people) were food insecure[5] at some point during 2018; more than 67% of food insecure households reporting their income, are classified as low-income households (ERS 2019a). Money and time are two of the main household resources needed to meet the basic nutritional recommendations (Davis & You, 2011). High food prices and limited time availability for food purchase and preparation (P&P) are two of the major factors associated with food insecurity (Beatty et al. 2014 Davis & You 2010a; Davis & You 2010b; Holben & Marshall 2017).

Even though the household production literature suggests that the "full price" of a good should include both observable market price and time cost (Becker, 1965), limited efforts have been given to understanding the relationship between food purchases and time allocation (Huffman, 2011). Failing to account for the time spent on food P&P may lead to underestimating the "true" cost of food (Becker 1965; Davis & You 2010a; Gronau 1986) which may, in turn, lead to formulating inefficient policies. For example, the Supplemental Nutrition Assistance Program (SNAP- formerly called Food Stamps Program) allotments are based on households following the Thrifty Food Plan (TFP) which provides healthful and minimal cost meal plans satisfying the recommendations of the Dietary Guidelines for Americans (Wilde & Llobrera, 2009). SNAP recipients are meant to receive enough benefits to purchase and consume meals based on the TFP, however, they may not

[5]The U.S. Department of Agriculture (USDA) defines household food insecurity as a household's uncertainty of having, or inability of acquiring, enough food to meet the needs of all their members during a specific time period (30 days or a year), because of insufficient resources (ERS 2019b).

achieve the TFP dietary targets because of the limited time availability for food preparation (Davis & You, 2010a, 2011).

To the best of our knowledge, only a few studies have assessed the relationship between food demand and time allocation. Although time and money allocation could differ based on food categories, existing studies have considered food as a single category, analyzing the association between time allocation and either total food expenditure or the average price of a food basket (Aguiar & Hurst 2007; Baral et al. 2011; Davis & You 2013;Hamermesh 2008;Khitarishvili et al. 2015). Also, some studies estimate goods-time elasticity of substitution which measures the substitutability between food expenditure per hour allocated to food P&P, and a unitary (hourly) cost of time (e.g. Hamermesh 2008; Baral et al. 2011; Davis & You 2013; Khitarishvili et al. 2015). However, the elasticity of substitution between expenditure and time value does not provide information on how quantities purchased vary with time cost and time allocation.

This chapter studies the joint demand for Food-At-Home (FAH) and Food-Away-From-Home (FAFH) categories, as well as the time spent on food P&P activities. Our objective is to estimate the substitution between different food categories (classified based upon the level of convenience and storability) and food P&P time, while accounting for household heterogeneity. We further contribute to the time use literature by deriving a demand system which includes both the demand for time and that for goods by extending the Exact Affine Stone Index-EASI (Lewbel & Pendakur, 2009). We model time and money allocation decisions for food as occurring jointly, accounting for Becker (1965)'s "full [6] price[7]" of goods which consists of time and monetary cost. In addition, we obtain "Resource Engel Curves" which characterize the relationship between "total resources" and resource shares. Using a demand system based on the EASI model, allows us to generate fully unrestricted Engel curves. Another novel and unique contribution is the estimation of goods-time cross price elasticities. Calculating cross -price elasticities of food P&P time with respect to food price, and the cross-price elasticities of food with respect to time cost, we can help to develop

[6]Note that, following Becker (1965), we use "full" to represent the inclusion of both monetary and time components.

[7]We will use the terms full price and also total resources interchangeably to indicate cost of both money and time.

a better understanding of the trade-offs between the costliness of food and time allocation, and costliness of time and food demanded.

The model is estimated using a dataset created by merging the 2012 American Time Use Survey (ATUS) with the National Household Food Acquisition and Purchase Survey (FoodAPS) data, using the method developed by You & Davis (2019). This method consists of predicting the amount of time allocated to food P&P in a given day of the week, aggregated at the weekly level. Then, following Hamermesh (2008) and You & Davis (2019), we match individuals in ATUS and FoodAPS using propensity scores assigned based on individuals', households', and location characteristics.

Additionally, since price - time allocation trade-offs are likely heterogeneous (Khitarishvili et al., 2015), differing by SNAP participation status (Davis & You 2010b; Hamermesh 2008), we estimate our model dividing our sample in three sub-populations based on households' SNAP recipient/eligibility status: SNAP participants, SNAP-eligible nonparticipants, and SNAP-ineligible.

The demand system includes five FAH categories, classified according to their storability (shelf life) and convenience (i.e. time saving features) or as prepared foods, and two FAFH categories (from restaurants and fast food chains). Along with the FAH and FAFH categories, the time allocated to FAH purchase and preparation, and FAFH purchase is included in the demand system.

Our analysis can shed light on households time saving vs. cost saving strategies, and can inform on the importance of taking time cost into consideration when designing tools to help households achieving a nutritious diet with limited resources (i.e. the TFP[8]). Understanding the relationship between consumer demand for food and time allocation is timely and of policy interest. Recently proposed changes to SNAP include a 20.3% increase in total monthly SNAP benefits, and re-evaluating whether to revise the method used to determine SNAP benefits (C-FARE 2021). Including FAFH categories in the analysis will account for the role of FAFH prices and time saving

[8]TFP has four main component: food prices, food consumption amounts, food composition data (nutrients), and dietary guidelines. Ignoring the labor cost of food P&P is a major limitation of the current TFP (C-FARE 2021).)

on FAH demand, which is likely to affect a household's decision on how to allocate resources for FAH (particularly low-income households)[9].

This chapter proceeds as follows: first, we derive the modified EASI demand model from a set of primitives, followed by an illustration of the estimable system of equations, and the associated elasticities. Then we describe in more detail the two main data sources used (ATUS and FoodAPS), the methodology used to merge them, and some important features of the data. After illustrating the estimation techniques used (including corrections to account for non-purchasing households in the data) we discuss the estimated parameters and elasticities. Last, concluding remarks and future research avenues are discussed.

## 2.2 The Model

### 2.2.1 *Theoretical Framework*

The model that follows builds upon the standard household production theory discussed by Gronau (1980), and its modifications in Davis & You (2010b). Household utility is assumed to take the following form

$$U = U(X, L) \tag{2.1}$$

where $X$ denotes consumption goods and $L$ denotes leisure. Consumption goods are comprised by $X_H$, home produced goods and $X_M$, market goods, which are assumed not to require processing at home:

$$X = X_H + X_M \tag{2.2}$$

[9]Because dining at a full-service restaurant can require a similar time involvement as preparing and cleaning up after a meal at home, (Stewart et al., 2004) suggests that there is neither a theoretical nor an empirical relationship between a household's demand for food at full-service restaurants and time constraints. However, (Devine et al., 2009) suggest that households rely more on takeouts, restaurant meals and other prepared entrées and other quick options to cope with low time availability. Also, purchasing fast food could be a convenient FAFH meal option Stewart et al. (2004). Thus, we include FAFH along with FAH to account for the trade-off between them with time availability. Since, different types of FAFH may require different amounts of time, we categorize FAFH based on the place: restaurants and fast food chains.

The production function of $X_H$ can be expressed as

$$X_H = f(X_{input}, T_{home}, HHch) \tag{2.3}$$

where $X_{input}$ is market inputs, $T_{home}$ is time spent on home production (which includes time spent on food preparation, presentation, and cleanup), and $HHch$ represents household characteristics that affect productivity and production decisions. Following Davis & You (2010a) we specify the resource constraint for acquiring market goods ($X_M$) and market inputs for production ($X_{input}$), which must not exceed the sum of available monetary ($gT_{labor} + v$) and time ($\theta T_{acq}$ ) resources, or

$$F_M X_M + F_{input} X_{input} \leq gT_{labor} + v + \theta T_{acq} \tag{2.4}$$

where $F_M$ is the full resource allocation or full price of market goods which comprises both market price ($P$) and time cost, $F_{input}$ is the full resource allocation or full price of market inputs, $g$ is the market wage rate, $T_{labor}$ is the time allocated to labor (to generate income), $v$ is non-labor income, $\theta$ is the cost of time, and $T_{acq}$ is the non-labor time spent on acquiring market goods and inputs for home production such as travel and shopping, or waiting time for home delivery. While the traditional budget constraint only includes the monetary cost ($gT_{labor} + v$) on the right side of Equation 2.4, we include time cost ($\theta T_{acq}$) as well, to capture the "full price" of goods acquired. The time constraint is

$$T_{total} = T_{labor} + T_{acq} + T_{home} + T_{leisure}. \tag{2.5}$$

Given that consumers' optimization problem is subject to the resource constraint in Equation 2.4 suggests that the demand for $X_{input}$ is a function of both time and income. Also, since $X_{input}$

is affected by household characteristics[10][11] ($H\tilde{H}ch$), we can write the demand function for $X_{input}$ as,

$$X_{input} = f_{input}(gT_{labor} + v, \theta, T_{acq}, P, H\tilde{H}ch) \tag{2.6}$$

where $P$ is a vector of market prices. By replacing Equation 2.6 into 2.3, and assuming household characteristics affecting demand for home production inputs ($H\tilde{H}ch$) can be surmised in those affecting productivity and production decisions ($HHch$), the demand function for home produced goods is

$$X_H = f_H(gT_{labor} + v, T_{acq}, T_{home}, \theta, P, HHch). \tag{2.7}$$

Thus, the total non-labor time involvement in home food production activities $X_H$ is $T_{home}$ (time spent of food preparation, presentation, and clean up) plus the proportion of $T_{acq}$ spent on acquiring $X_{input}$.

Similar to Equation 2.6, one can express the demand function for $X_M$ as

$$X_M = f_M(gT_{labor} + v, T_{acq}, T_{home}, \theta, P, HHch) \tag{2.8}$$

Total resources will be comprised by money and time: $gT_{labor} + v + \theta_{Tacq}T_{acq} + \theta_{Thome}T_{home}$, where $\theta_{Thome}$ is the cost of time spent for home production $T_{home}$, and $\theta_{Tacq}$ is the cost of time allocated to non-labor activities to acquire consumption goods. Thus $w$, the share of resources (i.e. the resource share) allocated to food can be expressed as follows.

$$w = \frac{\sum_i P_i Q_i + \sum_a \theta_a T_a}{gT_{labor} + v + \theta_{Tacq}T_{acq} + \theta_{Thome}T_{home}} \tag{2.9}$$

---

[10]For instance, larger households may may demand a higher quantity of food

[11]Later we assume the household characteristics that affect the purchasing decision of $X_{input}$ - $H\tilde{H}ch$ in Equation 2.6 - and productivity of producing $X_H$ - $HHch$ in Equation 2.3 - are similar.

where the subscript $i$ represents food category, $a$ represents food related activities where time is allocated to, $P_i$ is the price of the $i^{th}$ food category purchased, $Q_i$ is it's quantity and $\sum_i P_iQ_i$ is the total monetary amount spent on food; $\theta_a$ is the unitary cost of time allocated to the $a^{th}$ activity, $T_a$ is the time allocated to such activity and $\sum_a \theta_a T_a$ represents the total value of time allocated to food P&P.

Combining Equations 2.7 2.8, and 2.9, gives

$$\begin{aligned} w =& \frac{\sum_i P_iQ_i + \sum_a \theta_a T_a}{gT_{labor} + v + \theta_T T_{acq} + \theta_{THome} T_{home}} \\ =& f(gT_{labor} + v, T_{acq}, T_{home}, \theta, P, HHch) \\ & . \end{aligned} \tag{2.10}$$

Define the numerator of equation 2.10 as $R_F$, total resources allocated to food, and the amount of resources allocated food category $i$ as $R_{F_i}$ or

$$\begin{aligned} R_{F_i} &= P_iQ_i + \sum_a \theta_a T_{aF_i} \\ R_F &= \sum_i R_{F_i} = \sum_i P_iQ_i + \sum_i \sum_a \theta_a T_{aF_i} = \sum_i P_iQ_i + \sum_a \theta_a T_a \end{aligned} \tag{2.11}$$

where $T_{aF_i}$ is the time allocated to the $i^{th}$ food's P&P activities. The unconditional resource share allocated to food $i$: $w_{uncond}$,

$$w_{uncond} = \frac{P_iQ_i + \sum_a \theta_a T_{aF_i}}{gT_{labor} + v + \theta_T T_{acq} + \theta_{THome} T_{home}}. \tag{2.12}$$

By dividing 2.12 by 2.10, the conditional - on the resource allocated to food - resource share of food category $i$ ($w_{F_i}$) is defined as:

$$w_{F_i} = \frac{P_iQ_i + \sum_a \theta_a T_{aF_i}}{\sum_i P_iQ_i + \sum_a \theta_a T_a} \tag{2.13}$$

which can be further divided into $w^M_{F_i}$, the monetary/food expenditure resource share of allocated to food $i$, and $w^T_{F_i}$ the resource share of the value of time allocated to $i$.

$$w_{F_i} = w^M_{F_i} + w^T_{F_i} = \frac{P_i Q_i}{\sum_i P_i Q_i + \sum_a \theta_a T_a} + \frac{\sum_a \theta_a T_{aF_i}}{\sum_i P_i Q_i + \sum_a \theta_a T_a} \tag{2.14}$$

Note that we can only observe the overall amount of time dedicated to the $a^{th}$ P&P activity across all foods, thus $T_{aF_i}$ is not directly observable. As a result, we cannot calculate $w^T_{F_i}$, but only $w^{T_a}_{F_a}$, that is, the resource shares allocated to the $a^{th}$ P&P activity or $w^{T_a}_{Fa} = \sum_i w^{T_a}_{F_i}$. In the section that follows, we derive an incomplete demand system for conditional goods resource shares - $w^M_{F_i}$, and conditional time resource shares - $w^{T_a}_{F_a}$;

$$\begin{aligned} w^M_{F_i} &= \frac{P_i Q_i}{\sum_i P_i Q_i + \sum_a \theta_a T_a} \\ w^{T_a}_{F_a} &= \frac{\theta_a T_a}{\sum_i P_i Q_i + \sum_a \theta_a T_a} \end{aligned} \tag{2.15}$$

### 2.2.2 *A Demand System for Goods and Time Allocation*

In this section, we derive an estimable demand system where the demand for goods and time is expressed in a way consistent with the framework illustrate above, using a household dual problem (expenditure minimization) that incorporates time cost.

Demand systems such as Deaton & Muellbauer (1980)'s Almost Ideal Demand System and Lewbel & Pendakur (2009)'s Exact Affine Stone Index are derived to represent utility maximizing consumers' behavior constrained by expenditure. In this section, our goal is to derive a demand system that represents utility maximizing consumers' behavior constrained by resources, as in Equation 2.4. Deaton & Muellbauer (1980) and Lewbel & Pendakur (2009) specify $PIGLOG$ class expenditure functions to derive their demand systems because the $PIGLOG$ model treats aggregate consumer behavior as if it were the outcome of a single utility maximizing consumer (Blisard et al., 1999). Modifying the problem illustrated by Lewbel & Pendakur (2009), we specify a rational representative consumer's minimum resource allocation (instead of expenditure allocation) to obtain a specific utility level ($U$) as a function of prices ($P$) and cost of time ($\theta$); $R(U, P, \theta)$. We assume that $R(U, P, \theta)$ belongs to a $PIGLOG$ class expenditure function [12].

$$log\{R(U,P,\theta)\} = (1-U)log\{a(P,\theta)\} + Ulog\{b(P,\theta)\} \tag{2.16}$$

where,

$$\begin{aligned} log\{a(P,\theta)\} = \alpha_0 + \sum_i \alpha_k logP_i + \sum_a log\theta_a + \sum_i \sum_j \frac{1}{2}\gamma_{ij} logP_i logP_j \\ + \sum_a \sum_b \frac{1}{2}\gamma_{ab} log\theta_a log\theta_b + \sum_j \sum_b \frac{1}{2}\gamma_{jb} logP_j log\theta_b \end{aligned} \tag{2.17}$$

$$log\{b(P,\theta)\} = log\{a(P,\theta)\} + \beta_0 \prod_i P_i^{\beta_i} . \prod_a \theta_a^{\beta_a} \tag{2.18}$$

in which $i$ and $j$ represent food categories, and $a$ and $b$ represent food related activities' time allocation. $\alpha$, $\beta$, and $\gamma$ are parameters. The resource expenditure becomes,

$$\begin{aligned} log\{R(U,P,\theta)\} = \alpha_0 + \sum_i \alpha_i logP_i + \sum_a \alpha_a log\theta_a + \sum_i \sum_j \frac{1}{2}\gamma_{ij} logP_i logP_j \\ + \sum_a \sum_b \frac{1}{2}\gamma_{ab} log\theta_a log\theta_b + \sum_j \sum_b \frac{1}{2}\gamma_{jb} logP_j log\theta_b \\ + U\beta_0 \prod_i P_i^{\beta_i} . \prod_a \theta_a^{\beta_a} \end{aligned} \tag{2.19}$$

Using Sheppard's Lemma $\partial R(U, P, \theta)/\partial P_i = Q_i$ and multiplying both sides of this derivative by $P_i/R(U, P, \theta)$, we obtain an expression for the conditional resource shares of goods as

[12]Note that we derive an incomplete demand systems for food demand and time allocation. This is assuming the food expenditure is weakly separable from expenditure on other commodities and time allocation for food P&P activities is weakly separable from allocation for other activities such as work, sleep, leisure, personal care, child care etc.

$$
\begin{aligned}
\frac{\partial log\{R(U,P,\theta)\}}{\partial log P_i} &= \frac{P_i Q_i}{R(U,P,\theta)} \\
&= \alpha_i + \sum_j \gamma_{ij} log P_j + \sum_b \gamma_{ib} log\theta_b + \beta_i U \beta_0 \prod_i P_i^{\beta_i} \cdot \prod_a \theta_a^{\beta_a}
\end{aligned}
\tag{2.20}
$$

Similarly, differentiating $R(U,P,\theta)$ with respect to $\theta_a$ we have $\partial R(U,P,\theta)/\partial\theta_a = T_a$ and multiplying both sides by $\theta_i/R(U,P,\theta)$ results in

$$
\begin{aligned}
\frac{\partial log\{R(U,P,\theta)\}}{\partial log\theta_a} &= \frac{T_a \theta_a}{R(U,P,\theta)} \\
&= \alpha_a + \sum_b \gamma_{ab} log\theta_b + \sum_j \gamma_{aj} log P_j + \beta_a U \beta_0 \prod_i P_i^{\beta_i} \cdot \prod_a \theta_a^{\beta_a}
\end{aligned}
\tag{2.21}
$$

Using Equation 2.19, we can derive an indirect utility function whose arguments are $R$, $p$, and $\theta$. Substituting $U$ in Equations 2.20 and 2.21 we obtain the following expression of resource shares ($w$) as functions of $R$, $p$, and $\theta$.

$$
\frac{P_i Q_i}{R} = \alpha_i + \sum_j \gamma_{ij} log P_j + \sum_b \gamma_{ib} log\theta_b + \beta_i[log(e) - f(Prices,\theta)] \tag{2.22}
$$

$$
\frac{T_a \theta_a}{R} = \alpha_a + \sum_b \gamma_{ab} log\theta_b + \sum_j \gamma_{aj} log P_j + \beta_a[log(e) - f(Prices,\theta)] \tag{2.23}
$$

Equations 2.22 and 2.23 lead to an estimable demand system using, on the LHS resource shares consistent with $w_{F_i}^{M}$ and $w_{F_a}^{T_a}$ in Equation2.15.

We specify a demand system extending Exact Affine Stone Index (EASI) proposed by Lewbel & Pendakur (2009) which allows for unobserved preference heterogeneity, and flexible Engel curves that can have any shape over real resource expenditure which consists of both monetary and time costs. We also incorporate translating functions to account for observed households heterogeneity (Lewbel, 1985).

Let $w_{zrt}$ denote the resource share of $z$ (where $z$ can refer to a food category $i$ or an activity $a$) spent by household $r$ during time period $t$; $T_{brt}$ is the time spent on activity $b$ by household

$r$ at time $t$; $\theta_{brt}$ the cost of time allocated to the $b^{th}$ activity by household $r$ at time $t$; $Y_{rt}$ is the real full expenditure; $N$ is the number of different food categories; $A$ represents the number of different activities related to the commodities of interest; $L$ represents the highest order of polynomial of real expenditure; $Z$ represents the number of resource shares (food categories and time); $\xi_{zrt}$ denotes household $r$'s unobserved heterogeneity; and $\alpha_{z0}$, $\beta_{zl}$, $\gamma_{zj}$, $\gamma_{zb}$ and $\varphi_{zc}$ denote parameters to be estimated. The modified linear-approximated EASI demand system with time use component (hereafter TU-EASI) can be specified as follows.

$$\begin{aligned} w_{zrt} =& \alpha_{z0} + \sum_{l=1}^{L} \beta_{zl} Y_{rt}^{l} + \sum_{j=1}^{N} \gamma_{zj} log(P_{jrt}) + \sum_{b=1}^{A} \gamma_{zb} log(\theta_{brt}) \\ &+ \sum_{c=1}^{C} \varphi_{zc} HHch_{crt} + \xi_{zrt}, \end{aligned} \tag{2.24}$$

$\forall i, j = 1, ..., N; a, b = 1, ..., A; z = 1, ..., Z; a; l = 1, ..., L; r = 1, ..., R;$
$t = 1, ..., T; c = 1, ..., C$

where, similar to Pendakur (2009), the real full expenditure $Y_{rt}$ is specified as the Stone price-deflated real full expenditures.

$$Y_{rt} = log(\sum_{j} P_{jrt} Q_{jrt} + \sum_{b} \theta_{brt} T_{brt}) - \sum_{j=1}^{N} w_{jrt} log(P_{jrt}) - \sum_{b=1}^{A} w_{brt} log(\theta_{brt}) \tag{2.25}$$

Time spent on food P&P activities cannot be disaggregated across the $N$ different food categories, since consumers buy multiple food categories during a single shopping trip and use multiple food categories when preparing meals. Considering all the $A$ activities and $N$ commodities, the resulting demand system consists of $N + A = Z$ equations; the Left-hand Side of the equations representing monetary and time shares, respectively, can be expressed as follows. Note that Equation 2.26 and 2.27 are consistent with Equation2.15 elaborated in the theoretical framework.

$$w_{irt} = \frac{P_{irt}Q_{irt}}{\sum_{j=1}^{N} P_{jrt}Q_{jrt} + \sum_{b=1}^{A} \theta_{brt}T_{brt}} \tag{2.26}$$

$$w_{art} = \frac{\theta_{art}T_{art}}{\sum_{j=1}^{N} P_{jrt}Q_{jrt} + \sum_{b=1}^{A} \theta_{brt}T_{brt}} \tag{2.27}$$

The demand system in Equation 2.24 satisfies the theoretical restrictions of aggregation, homogeneity, and symmetry as specified below, which guarantee integrability of the demand model (Pendakur 2009 [13]).

$$\begin{aligned}
&\sum_z \alpha_{z0} = \sum_i \alpha_{i0} + \sum_a \alpha_{a0} = 1, \\
&\sum_z \beta_{zl} = \sum_i \beta_{i0} + \sum_a \beta_{a0} = 0, \\
&\sum_i \gamma_{ij} + \sum_a \gamma_{aj} = 0, \\
&\sum_i \gamma_{ib} + \sum_b \gamma_{ab} = 0, \\
&\forall i = 1, ..., N; a = 1, ..., A \\
&\gamma_{ij} = \gamma_{ji} \\
&\gamma_{ab} = \gamma_{ba} \\
&\gamma_{ia} = \gamma_{ai} \\
&\forall j \neq i; \forall b \neq a
\end{aligned} \tag{2.28}$$

In addition, we impose adding up restriction so that resource shares sum to one. As we include $HHch$ in the demand system, we impose the following restrictions as well.

$$\sum_z \varphi_{zc} = \sum_i \varphi_{ic} + \sum_a \varphi_{ac} = 0 \tag{2.29}$$

[13]Note that homogeneity applied for price and opportunity cost of time simultaneously, because opportunity cost is also a "price" in the demand system: the "price" of time.

Expenditure, Marshallian, and Hicksian price elasticities of demand are obtained following Zhen et al. (2014).

$$EE = (diag(W))^{-1}[(I_Z + B\overline{P}^t)^{-1}B] + 1_Z \tag{2.30}$$

where $EE$ is the $X \times 1$ expenditure elasticity vector which includes $N$ food category and $A$ time expenditure elasticities, $W$ represents the $Z \times 1$ vector of predicted food category and activity resource shares, $I$ is an $Z \times Z$ identity matrix, $B$ is a $Z \times 1$ vector whose $z^{th}$ element is represented by $\sum_{l=1}^{L} \beta_{zl} l Y^{l-1}$, $\overline{P}$ is the $Z \times 1$ vector of log prices (including cost of time $\theta$), and $1_Z$ is a $Z \times 1$ vector of ones.

Hicksian price and time cost elasticities are

$$e_{z\tilde{z}}^{Hicks} = \frac{\gamma_{z\tilde{z}}}{W_z} + W_j - KD_{z\tilde{z}} \tag{2.31}$$

where $\tilde{z}$ represents $j^{th}$ food category or $b^{th}$ activity, $e_{z\tilde{z}}^{Hicks}$ is the Hicksian price elasticity of demand for food category $i$ or time allocated activity $a$ with respect to price of food category $j$ or time-cost of activity $a$, $KD_{z\tilde{z}}$ is the Kronecker delta equal to 1 if $z = \tilde{z}$, and 0 otherwise.

Using the Slutsky equation, Marshallian price and time cost elasticities are

$$e_{z\tilde{z}}^{Marsh} = e_{z\tilde{z}}^{Hicks} - W_{\tilde{z}} e_z \tag{2.32}$$

where $e_{z\tilde{z}}^{Marsh}$ is the Marshallian elasticity of demand for food category $i$ or activity $a$ with respect to price of food category $j$ or price of activity $a$ time was allocated to, and $e_z$ is expenditure elasticity of food category $i$ or activity $a$.

## 2.3 Data, Variables, and Empirical Model

The main data source used in our analysis is the restricted access USDA's National Household Food Acquisition and Purchase Survey (FoodAPS), from which we obtain food expenditure and households characteristics. We use FoodAPS for two reasons. First, FoodAPS records acquisition of both FAH and FAFH. Second, FoodAPS is nationally representative and it over-samples SNAP participant households, and SNAP-eligible nonparticipants, two groups of households whose resources may be particularly limited - both time and income. Time spent on different food P&P activities are obtained from the 2012 ATUS time diaries. In this section we discuss the methods used to merge FoodAPS and ATUS, how food and time categories are defined, the imputation of missing prices for non-purchasing households, the empirical approach to account for zero purchases, and the control variables used in the demand system.

### 2.3.1 Merging FoodAPS with ATUS, and creating Time Allocation variable

We use data from the ATUS time diaries to measure time spent on different food P&P activities. The ATUS data include information on time use of U.S. residents that are at least 15 years of age during both weekdays and weekends. We consider eight time categories available in the ATUS which are related to food P&P activities: Food and Drink Preparation (ATUS Code 020201), Food Presentation (ATUS Code 020202), Kitchen and Food Clean-up (ATUS Code 020203), Grocery Shopping (ATUS Code 070101), Travel for Grocery Shopping (ATUS Code 180701), Purchasing Food -Not Groceries- (ATUS Code 070103), Waiting Associated with Eating and Drinking (ATUS Code 110201), and Travel Related to Purchasing Food -not groceries- (ATUS Code 180703).

The ATUS reports individuals' time allocation based on a given day's observation, whereas FoodAPS food acquisitions are measured over a week. Thus, we have to estimate individuals' weekly time allocation before merging the two data sets. For the ATUS, if an individual was surveyed on a day when they did not spend any time on food P&P activities, we would observe a "zero" time allocation. In order to resolve this issue, we follow the approach of You & Davis (2019), who treat these "zeros" as the result of a sampling issue and uses imputed positive values to replace the zeros. Similar to You & Davis (2019), we use a two-part model to estimate (i) the probability an individual allocates time for food P&P on a given day of the week - using a probit estimator, and (ii) the time allocated to food P&P given that the probability of allocating time to food P&P is greater than zero on that specific day of the week, using a conditional exponential model. In other words, we estimate,

$$Pr(t_d > 0|X_{indiv}, X_{house}, Month, Day; \mu_1) = \Phi(X_{indiv}, X_{house}, Month, Day; \mu_1) \tag{2.33}$$

$$E(t_d|t_{id} > 0|X_{indiv}, X_{house}, Month, Day; \mu_2) = X_{indiv}, X_{house}, Month, Day; \mu_2 \tag{2.34}$$

where $t_d$ is the time spent on food P&P activity; $X_{indiv}$ is a vector of individual's demographic characteristics: a set of binary indicator variables capturing age groups (20-29, 30-39, 40-49, 50-59, 60-69,and $\geq 70$), other binary indicators for, respectively, the respondent being female, single, employed, ethnicity / race groups' the respondent belongs to (Hispanic, white, black, Native American, Asian or pacific islanders, and multiple races), education-level of the respondent (for $\leq 10^{th}$ grade, $> 10^{th}$ grade but no diploma, high school graduate, some college or associate degree, bachelor's degree, and $\geq$ master's degree); $X_{house}$ is a vector of household characteristics including: households size, two indicator variables for households with children under 5 years of age and under, and with children older than 5 and younger than 18 (respectively), and an indicator variable for respondents residing in non-metro areas[14]; $Month$ is a vector of indicators for the calendar month when the survey was collected; and $Day$ is a set of binary indicators for days of the week[15].

Using Equations 2.33 and 2.34 and ATUS data. we first predict the probability ($(\widehat{Pr(t_d > 0)})$ and the amount ($E(\widehat{t_d|t_d > 0})$) of time allocated to a food P&P activity [16] on a given day, and then we obtain the weekly time allocation for each activity ($t_w$) calculated as $t_w = \sum_d (Pr(t_d > 0) * E(t_d|t_d > 0)$.

Once time allocation for food P&P activities are predicted, we match individuals in ATUS with FoodAPS household heads and their spouses or partners, using propensity score matching (nearest

[14]The RUCCs range from 1 to 9, 1 indicating largely populated metro areas, 9 low-population rural areas. For details, see https://www.ers.usda.gov/data-products/rural-urban-continuum-codes.aspx

[15]Including $Day$ allows us to predict time use of each day of the week, that in return allows us to calculate weekly time use (You & Davis, 2019)

[16]Time allocated to food preparation is the total time for Food and Drink Preparation (ATUS Code 020201), Food Presentation (ATUS Code 020202), and Kitchen and Food Clean-up (ATUS Code 020203). Time allocated to FAH purchases is the total time allocated to Grocery Shopping (ATUS Code 180701) and Travel for Grocery Shopping (ATUS Code 180701). Time allocated to FAFH purchases is the total time for urchasing food -not groceries- (ATUS Code 070103), waiting associated with eating and drinking (ATUS Code 110201), and travel related to purchasing food -not groceries- (ATUS Code 180703).

neighbour matching) similar to Hamermesh (2008) [17]. The variables used in this process are the same variables used in Equations 2.33 and 2.34, except month and day indicators. Our assumption is that individuals in FoodAPS and ATUS, showing the same characteristics, will spend the same amount of time on food P&P activities. Out of the 4,826 households (Economic Researach Service, 2019) included in FoodAPS, 4,317 were retained in the data as they could be matched with ATUS respondents.[18]

### 2.3.2 Dependent variables: Food categories, Activities and Resource Shares

To estimate the substitutability / complementarity of food categories classified based on perishability and ease of use, and food P&P time allocation, we use 5 FAH categories, one of which is prepared foods, and 2 FAFH categories along with time use. We define four of our FAH categories (excluding prepared foods) using a combination of the foods' shelf-life (storability) and the time needed for their preparation (convenience):

- non-storable/low-convenience (FAH-NS-LC)
- storable/low-convenience (FAH-S-LC)
- non-storable/convenience (FAH-NS-C) and
- storable-convenience (FAH-S-C).

Products such as fresh vegetables, meat, and seafood, which are more perishable and require more preparation time are categorized under *FAH-NS-LC*. Foods such as pasta, rice, beans, and lentils which are in dry form, and frozen unprocessed meats which require more preparation time but can be stored for a long time, are included in *FAH-S-LC*. *FAH-NS-C* consists of foods such as

[17] Hamermesh (2008) used a nearest neighbor matching technique to fill the missing spousal time use

[18] Following Aguiar & Hurst (2007), we also tried combining ATUS and FoodAPS by creating demographic cells in both data sets defined by demographic characteristics of the household members (binary indicator variables for five age categories (20-35, 36-59, 60-65, 66-70, and>70), gender, marital status, education level, employment status and being out of work because of disability) and by the US regions and metro vs. non-metro status of the location where they live. 4,560 households were retained after the merge, however this method limits the variation in the predicted time allocation. Although variation could have been increased by imputing time use for households showing common support in ATUS to predict FoodAPS' households time use (for instance by sub-samples based on SNAP eligibility/recipient status), the final size of the retained sample would be too small.

fruits, milk, breads, and cheese which do not require much (or any) time for preparation, but are perishable. Storable food that take less time to prepare such as breakfast cereal, frozen and canned fruits and vegetables, dried fruits, nuts, seeds, salad dressings, spices and condiments, beverages are included in *FAH-S-C*. The fifth FAH category is prepared food bought from the same stores where FAH was purchased *Grocery-PreparedF*. The FAFH categories we include are

- FAFH bought from restaurants (FAFH Restaurant) and
- FAFH bought from fast-food chains (FAFH Fastfood).

In addition to FAH and FAFH categories, time allocated to food P&P activities also enters the demand system. Note that we include a single time category representing the total time allocated for FAH purchase, preparation, and FAFH purchase [19] (Food P&P Time).

We estimate our demand system for three sub-samples of the data, divided according to households' SNAP recipient/eligibility status: SNAP recipients (1,324 households), SNAP-eligible nonparticipants (1,089 households), and SNAP-ineligible (1,904 households). A household is considered as a SNAP recipient if anyone in the household received SNAP benefits at the time when the FoodAPS survey was conducted. A household is considered as SNAP-eligible nonparticipants if no one in the household received SNAP benefits, but was eligible to receive them [20]

Summary statistics of resource shares by household sub-samples are reported in Table 2.1. The highest monetary share of resources [21] of full expenditure goes to *FAH-S-C* in every sub-sample - SNAP recipient, SNAP-eligible nonparticipant, and SNAP-ineligible households spend 27.2%, 23.4%, and 23.9%respectively out of monetary expenditure on *FAH-S-C*. The second-highest monetary shares by SNAP recipient and SNAP-eligible nonparticipant are spent on *FAH-NS-C*,

[19] Although time spent on comparison shopping (researching purchases) is reported in ATUS, we do not include that in our analysis because it applies to all types of shopping, not just groceries.

[20] In FoodAPS, four different models are used to predict household SNAP eligibility status. We use the results from the first model to determine whether a household is eligible to receive SNAP benefits - valiable named "elig_units1". This model uses households' characteristics such as income, assests, and having households members who are elderly, welfare recipients, SSI recipients, students, to preditc households' SNAP eligibility. The criteria and methods used to identify whether a household is SNAP eligible are described in the Household Codebook and SNAP Eligible Estimation Codebook of the FoodAPS Documentation (ERS 2016).

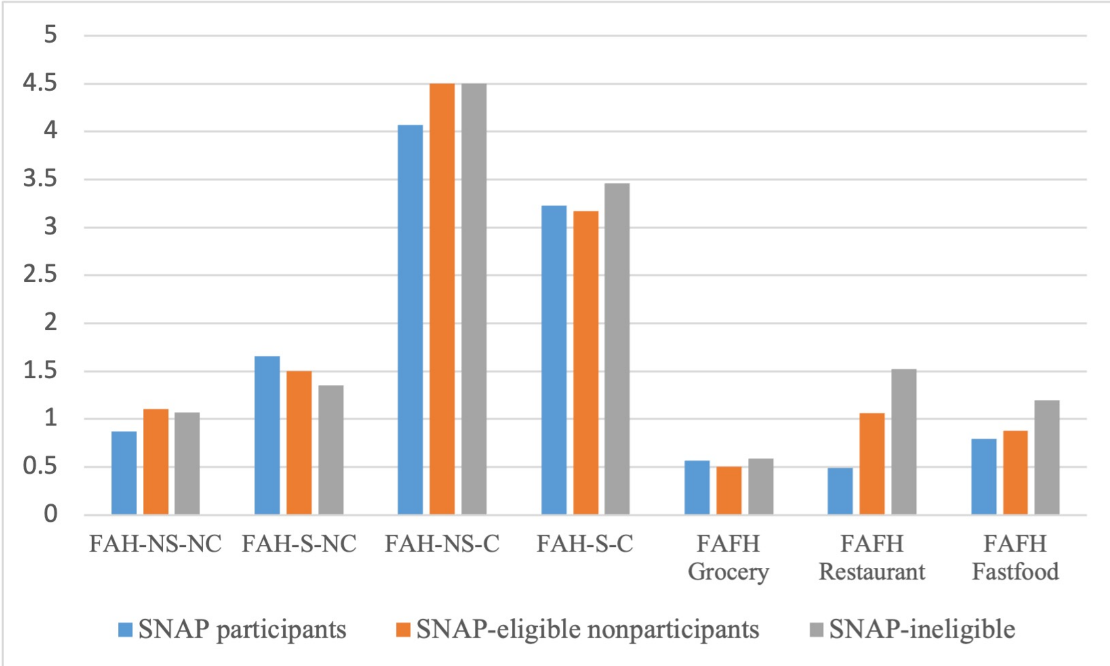
[21] comparing resource shares for food categories

**Table 2.1:** Summary statistics of resource shares

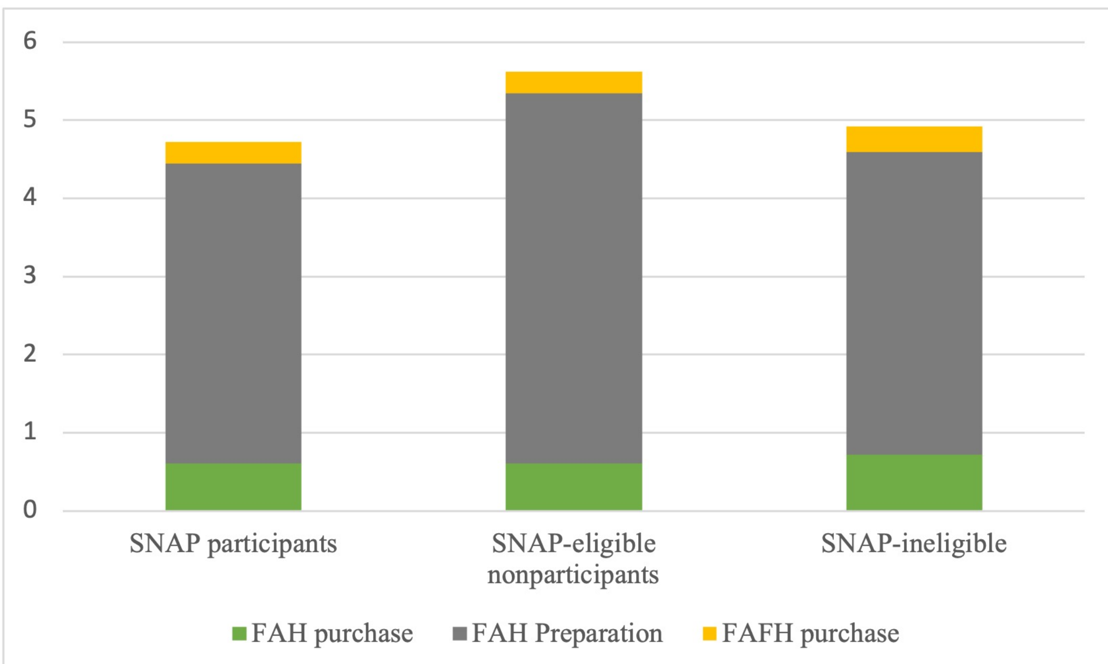
| Resources Shares | SNAP participants | | SNAP-eligible non-participants | | SNAP-ineligibles | |
|---|---|---|---|---|---|---|
| | **Mean** | **Std. Dev.** | **Mean** | **Std. Dev.** | **Mean** | **Std. Dev.** |
| FAH-NS-LC | 0.086 | 0.108 | 0.075 | 0.091 | 0.056 | 0.074 |
| FAH-S-LC | 0.098 | 0.110 | 0.082 | 0.097 | 0.061 | 0.072 |
| FAH-NS-C | 0.129 | 0.110 | 0.122 | 0.105 | 0.092 | 0.077 |
| FAH-S-C | 0.207 | 0.169 | 0.161 | 0.143 | 0.140 | 0.125 |
| Grocery-PreparedF | 0.041 | 0.098 | 0.028 | 0.077 | 0.024 | 0.058 |
| FAFH Restaurant | 0.075 | 0.148 | 0.109 | 0.170 | 0.120 | 0.148 |
| FAFH Fastfood | 0.124 | 0.180 | 0.111 | 0.158 | 0.093 | 0.126 |
| Food P&P Time | 0.239 | 0.219 | 0.313 | 0.220 | 0.414 | 0.227 |

Source: Authors' elaboration on USDA FoodAPS and ATUS data

and SNAP-ineligible households spend their second-highest monetary share on *FAFH Restaurant*. Considering expenditure on FAFH categories, SNAP recipients and SNAP-eligible nonparticipant spend a higher monetary share on *FAFH Fastfood*, compared to other FAFH categories, and SNAP-ineligible households spend a higher share on *FAFH Restaurant*. The data further show that across samples, about 24% (SNAP recipients) to 42% (SNAP ineligible) of resources go to time allocated to food P&P activities. The reason for SNAP-ineligible households' higher *Food P&P Time* share could be their higher cost of time, which will be discussed later in this section. Figure 1 presents a breakdown of the quantity purchased of the seven food categories (top panel) and weekly time allocated to *Food P&P* (bottom panel) for the three household sub-samples. Figure 2.1a shows the quantities of food (in pounds) purchased per household by food categories and sub-samples. Figure 2.1b shows the time spent on food P&P (in hours) per person by activities and sub-samples. According to Figure 2.1a, SNAP recipient households purchase less amount of non-storable FAH (both *FAH-NS-LC* and *FAH-NS-C*) per person compared to other household sub-groups. SNAP recipients purchase more *FAH-S-LC* compared to other sub-groups. Considering convenience food categories ( *FAH-NS-C* and *FAH-S-C*), the gap between SNAP-ineligible households' and SNAP recipients' purchases is lower for storable category. These may suggest that SNAP recipients tend to purchase more storable food. Further, 2.1b depicts that SNAP recipients spend less time on *Food P&P Time*, and this may be the reason behind the tendency to buy more storable food.




**(a)** Weekly quantity of food purchased (in pounds) per member of a household by categories and sub-samples




**(b)** Weekly time spent on food P&P (in hours) per household by sub-samples

**Figure 2.1:** Quantities of FAH purchased and time allocation

### 2.3.3 Imputing missing Prices and calculating Value of Time

Unit values are used as proxies for prices paid, calculated dividing the expenditure for a given food category by the quantity purchased. Not every household purchased all food categories during the FoodAPS data collection week. Out of 4,317 households matched with the ATUS, 1,463(33.9%), 1,310(30%), 676(15.7%), 767(17.8%), 3,370(78%), 2,182(50.0%), and 1,674(38.8%) households have not purchased, respectively *FAH-NS-LC*, *FAH-S-LC*, *FAH-NS-C*, *FAH-S-C*, *Grocery-PreparedF*, *FAFH Restaurant*, and *FAFH Fastfood*. We follow Zhen et al. (2014), and impute prices for non-purchasing households using a two-step procedure. First, we regressed, for each category, the logarithm of the observed unit values by the purchasers on household characteristics (household size, number of children, number of household members in retirement age, race[22], employment [23], education [24], having a vehicle and house ownership), location (region, and metro/non-metro), time (indicator variables for month, and a trend variable for the week of the month), and region-month interactions. Second, we impute the missing unit values for each category using the estimated coefficients from the previous step and characteristics of the household showing zero purchases, that is using out-of-sample predictions (Park et al. 1996, Zhen et al. 2014, Lopez 2011). Summary statistics of unit prices after imputing the missing values are in Table 2.2.

Two approaches are used to find the value of time for non-market activities, such as food P&P: (i) the market substitution approach and (ii) the opportunity cost approach (Murphy, 1978). The market substitution approach suggests using wages paid for performing the market counterpart of the non-market activity. Using this approach, the cost of time allocated to food P&P could be measured as the wage paid to someone so that household members would not have to shop and prepare meals by themselves (Castagnini et al., 2004). The opportunity cost approach is instead based on an individual's time allocation between work, leisure, and home production. The rationale

[22]hispanic or not, black, Native American, Asian or Native Hawaiian or Other Pacific Islander, other races, and multiple races

[23]working, with a job but not at work, unemployed, not employed because retired, and not employed because disabled

[24]less than or equal to $10^{th}$ grade, $11^{th}$ or $12^{th}$ years, high school graduate, some college or associate degree, bachelor's degree, and master's degree or higher education

behind this approach is that a utility maximizing individual allocates time to both work and home production up to the point where the marginal yield of the last hour spent is the same for work and home production. Thus, the marginal wage rate of that individual represents the cost of time spent on home production. Following the existing literature, we use the opportunity cost approach to estimate the cost of time. An advantage of using this approach over the market approach is that it allows to preserve the variability of time cost data [25] [26]. Here we assume that the cost of time spent on FAH and FAFH purchasing and FAH preparation are the same. Summary statistics of time cost (in dollars per hour spent on food P&P) are in Table 2.2.

### 2.3.4 Empirical Model

As mentioned in Section 2.3.3, we observe a large number of zero purchases in the data. Failing to account for the presence of censoring and the difference between limit observations and non-limit observations is likely to yield biased results. We account for the presence of non-purchasing households using the two-step estimation procedure proposed by Shonkwiler & Yen (1999). Specifically, we first estimate a probit model for the probabilities of purchasing food category $i$ ($\widehat{dw_i}$) - where the dependent variable is $dw_i$ and $dw_i = 1$ if $w_i > 0$ and $dw_i = 0$ if $w_i = 0$ for each $i$ household. We then predict, for each household in the sample, the PDF ($\phi(\widehat{dw_i})$) and CDF ($\Phi(\widehat{dw_i})$) of the probability that they purchase a given category. Then, we adjust the original demand system's (in Equation 2.24) equations as in Equation 2.35, using these estimated $\phi(\widehat{dw_i})$ and $\Phi(\widehat{dw_i})$ to account for censored resource shares. Note that we only adjust equations for food

[25] We attempt using market substitution approach as well. In particular, we obtain wage rates for a person who is employed by a household to primarily engage in activities concerned with the operations of the household (NAICS Code 814110) from the U.S. Bureau of Labor Statistics' Quarterly Census of Employment and Wage (QCEW). This category includes wages paid to individuals employed by private households such as cooks, maids, nannies, butlers, and outside workers including gardeners, caretakers, and other maintenance workers. However, due to the limited variation in cost of time resulted by using the market approach, we proceeded with using the opportunity cost approach.

[26] One criticism of using wage rates to represent cost of time is in the assumption that the marginal yield of the last hour spent is the same for work and home production (interior solution of the utility maximization problem), which can only be true for individuals who both work and are involved in home activities, and working is the next best alternative to home activities. If the wage rate is greater than the cost of home activities, the individual would only work, and *vice versa* (corner solutions) (James Jr 1996 Kiker & de Oliveira 1990, Davis & You 2010b). For simplicity, we do not account for this fact.

categories, but not time use equation [27].

$$w_{irt} = \Phi(\widehat{dw_i})(\alpha_{i0} + \sum_{l=1}^{L} \beta_{il} Y_{rt}^{l} + \sum_{j=1}^{N} \gamma_{ij} log(P_{jrt}) + \gamma_{ia} log(\theta_{art}) \\ + \sum_{c=1}^{C} \varphi_{ic} HHch_{crt}) + \delta\phi(\widehat{dw_i}) + \xi_{irt}, \tag{2.35}$$

$\forall i, j = 1, ..., N; a, b = 1, ..., A; a; l = 1, ..., L; r = 1, ..., R;$

$t = 1, ..., T; c = 1, ..., C.$

In this demand system, we control for a set of demographic characteristics. Having a vehicle may lead households to face different commuting times. Nonworking adults tend to prepare meals from scratch. Thus, households with relatively more working member should spend less time in food preparation activities (Mancino & Newman, 2007). Also, time allocation for food P&P activities changes when people retire (Aguiar & Hurst, 2007). Similarly, presence of children is associated with adults allocating more time for food P&P (Vernon, 2005), as the opportunity cost of time allocated to food P&P activities and the marginal product of parents' housework increases in the presence of young children (Kerkhofs & Kooreman 2003 as in Huffman 2011). Moreover, living in metro and non-metro areas may have an impact on commuting times. Thus, we include an indicator variable for vehicle ownership ($Vehicle$), number of household members ($HHsize$), share of adults (age>17) in the household who are working ($working\_share$), the share of household members who are retirees ($Retirees\_share$), the share of children in the household who are five years of age or under ($children\_share$), and an indicator variable for residing in non-metropolitan areas ($Nonmetro$). Variable definitions and descriptive statistics are presented in Table 2.2.

Following Lewbel & Pendakur (2009), we estimate our system of equations (7 Equation 2.35s for each food category and, 1 Equation 2.24 for time allocation) using Zellner (1962)'s Seemingly Unrelated Regression estimator. We drop one equation (*Food P&P Time*) to circumvent the fact that errors in demand equations are not linearly independent, and recover its parameters using the theoretical restrictions of aggregation, homogeneity, and symmetry.

[27]Because, aftre the merging process, we only use the households we could impute food P&P time from ATUS. Thus, food P&P time is non-zero for all households.

**Table 2.2:** Definitions and descriptive statistics of the independent variables

| Variable | Definition | SNAP participants | | SNAP-eligible nonparticipants | | SNAP-ineligible | |
|---|---|---|---|---|---|---|---|
| | | Mean | Std. Dev. | Mean | Std. Dev. | Mean | Std. Dev. |
| **P(FAH-NS-LC)** | Price of a pound of non storable-low convenient food (in $) | 5.441 | 8.482 | 6.355 | 35.255 | 4.957 | 9.032 |
| **P(FAH-S-LC)** | Price of a pound of storable-low convenient food (in $) | 4.528 | 17.533 | 3.989 | 7.414 | 4.480 | 14.038 |
| **P(FAH-NS-C)** | Price of a pound of non storable-convenient food (in $) | 1.972 | 10.150 | 1.931 | 4.325 | 2.081 | 4.823 |
| **P(FAH-S-C)** | Price of a pound of storable- convenient food (in $) | 3.798 | 5.367 | 3.840 | 5.236 | 4.467 | 12.545 |
| **P(Grocery-Prepared F)** | Price of a pound of Grocery Prepared F (in $) | 3.905 | 5.639 | 3.905 | 2.961 | 4.550 | 9.915 |
| **P(FAFH-Restaurant)** | Price of a pound of FAFH-Restaurant (in $) | 7.455 | 8.118 | 6.883 | 4.986 | 7.564 | 5.657 |
| **P(FAFH-Fastfood)** | Price of a pound of FAFH-Fastfood (in $) | 5.058 | 3.444 | 5.231 | 4.112 | 5.075 | 4.303 |
| **Time cost** | Price of an hour allocated to food P&P (in $) | 4.540 | 4.819 | 7.147 | 7.814 | 15.861 | 15.530 |
| **Vehicle** | =1 if household as at leats one vehicle, =0 otherwise | 0.729 | 0.508 | 0.879 | 0.879 | 1.014 | 0.345 |
| **Hhsize** | Numer of member in the housheold | 3.053 | 1.878 | 2.225 | 2.225 | 2.407 | 1.346 |
| **Working_share** | Share of adult household members who are working12 | 0.242 | 0.290 | 0.377 | 0.377 | 0.546 | 0.392 |
| **Retirees_share** | Share of retirees in the household | 0.118 | 0.291 | 0.274 | 0.274 | 0.189 | 0.368 |
| **Children_share** | Share of children who are 5 years old or younger in the household | 0.248 | 0.274 | 0.122 | 0.122 | 0.139 | 0.228 |
| **Nonmetro** | =1 if household is resided in a non metropolitan area, =0 otherwise | 0.144 | 0.351 | 0.131 | 0.338 | 0.130 | 0.337 |

Source: Authors' elaboration on USDA FoodAPS and ATUS data

## 2.4 Results and Discussion

### 2.4.1 Estimated coefficients

The estimated coefficients of the TU-EASI demand system for FAH, FAFH and time allocated to P&P are presented, respectively, in Table 2.3a, 2.3b, and 2.3c for SNAP recipient, SNAP-eligible nonparticipants, and SNAP-ineligible households. The fifth order polynomial was found to be the best fitting order for the real full expenditure ($Y_{rt}$) [28]

The majority of the parameters associated with cost of time are statistically different from zero. For SNAP recipient households, low-convenience FAH resource shares (both *FAH-NS-LC* and *FAH-S-LC*) are negatively associated with time cost, while that of *Grocery-PreparedF* and *FAFH Restaurant* are positively associated with time cost. For SNAP-eligible nonparticipants, association between all types of FAH resource shares and time cost is not significantly different from zero. However, *Grocery-PreparedF* and *FAFH Restaurant* (*FAFH Fastfood*) resource shares are positively (negatively) related to cost of time. SNAP-ineligible households' FAH resource shares are negatively associated with cost of time, but similar to other two sub-samples of households, their *Grocery-PreparedF* and *FAFH Restaurant* resource shares are positively associated with cost of time.

Estimated coefficients for SNAP recipients suggest that having a vehicle is negatively associated with their *FAH-NS-LC*, but positively associated with *FAFH Restaurant*, and *Food P&P*. For SNAP-eligible nonparticipants, *vehicle* is negatively related to *FAH-NS-C* and *FAFH Fastfood* acquisition, and positively related to *FAFH Restaurant*. SNAP-ineligible households' *FAH-S-C* (*Grocery-PreparedF*) resource share is negatively (positively) related to having a vehicle. Also, as expected, higher household size is associated with higher *Food P&P* resource shares in all sub-samples. In SNAP recipient households, higher *working_share* is positively associated with *FAFH Restaurant* resource share, but negatively associated with *FAFH Fastfood*'s. Also, their *FAH-NS-*

[28]We started from a second order polynomial and then added one higher degree polynomial at a time, monitoring the significance of the coefficients. Adding the sixth degree polynomial, most of the full expenditure's polynomials coefficients were not statistically different from zero, while those obtained using the fifth decree polynomial are mostly statistically significant.

*LC* (*FAH-S-C*) resource share is positively (negatively) related to *working_share*. In SNAP-eligible nonparticipant households, *working_share* has a negative relationship with convenience FAH resource shares (both *FAH-NS-C* and *FAH-S-C*) and *FAFH Fastfood*, but a positive relationship with *FAFH Restaurant*'s. Further, *Food P&P* resource share of households in this sub-sample is negatively related to *working_share* suggesting their time becomes more limited when more households members are working. SNAP-ineligible households' *working_share* has a negative relationship with resource shares for *FAH-S-LC*, *FAH-NS-C*, and *FAFH Fastfood*, and a positive relationship with *Grocery-PreparedF*'s. For SNAP recipient households, having a higher share of retired household members is positively associated with the resource shares of non-storable FAH (*FAH-NS-LC* and *FAH-NS-C*), and negatively associated with that of *FAFH Fastfood*. In SNAP-ineligible nonparticipant households, having a higher share of retired household members is positively associated with higher time spent on food P&P. Having a higher share of children in the household has a negative relationship with *Food P&P* resource share for SNAP participants' and SNAP-eligible nonparticipants, but not for SNAP-ineligible household, suggesting that the presence of children may limit low-income households' time allocation to food P&P activities. SNAP recipients show a positive association between *children_share* and convenience FAH resource shares (*FAH-NS-C* and *FAH-S-C*). SNAP-eligible nonparticipants and SNAP-ineligible households show a positive association between *children_share* and *Grocery-PreparedF*. Across all household groups, residing in a non-metro area is positively associated with the resource share of *Grocery-PreparedF*, and negatively associated with that of *FAFH Restaurant*.

**Table 2.3:** Estimated Coefficients of a modified LA/EASI demand system. Panel (a) SNAP recipient households; Panel (b) SNAP-eligible nonparticipant households; and Panel (c) SNAP-ineligible households.

**(a)** Estimated Coefficients for SNAP recipient households.

| Variables | Resource Share Equation | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **FAH-NS-LC** | **FAH-S-LC** | **FAH-NS-C** | **FAH-S-C** | **Grocery-PreparedF** | **FAFH Restaurant** | **FAFH Fastfood** | **Food P&P Time** |
| **logP(FAH-NS-LC)** | 0.0301 *** | 0.0070 ** | -0.0054 * | 0.0008 | 0.0027 | -0.0175 *** | -0.0080 | -0.0097 ** |
| | (0.0043) | (0.0032) | (0.0031) | (0.0039) | (0.0045) | (0.0050) | (0.0054) | (0.0039) |
| **logP(FAH-S-LC)** | | 0.0256 *** | 0.0041 | -0.0133 *** | -0.0056 | -0.0035 | -0.0039 | -0.0105 *** |
| | | (0.0046) | (0.0033) | (0.0039) | (0.0044) | (0.0049) | (0.0054) | (0.0038) |
| **logP(FAH-NS-C)** | | | 0.0038 | -0.0014 | 0.0019 | -0.0013 | 0.0002 | -0.0018 |
| | | | (0.0045) | (0.0038) | (0.0041) | (0.0046) | (0.0051) | (0.0036) |
| **logP(FAH-S-C)** | | | | 0.0377 *** | -0.0057 | 0.0032 | -0.0121 * | -0.0092 ** |
| | | | | (0.0064) | (0.0052) | (0.0059) | (0.0064) | (0.0042) |
| **logP(Grocery-PreparedF)** | | | | | 0.0016 | -0.0084 | -0.0041 | 0.0178 *** |
| | | | | | (0.0095) | (0.0083) | (0.0075) | (0.0057) |
| **logP(FAFH-Restaurant)** | | | | | | 0.0317 *** | -0.0205 ** | 0.0164 *** |
| | | | | | | (0.0118) | (0.0088) | (0.0060) |
| **logP(FAFH Fastfood)** | | | | | | | 0.0390 *** | 0.0094 |
| | | | | | | | (0.0124) | (0.0060) |
| **log(time cost)** | | | | | | | | 0.0123 *** |
| | | | | | | | | (0.0030) |
| **Y** | -0.1660 | -0.0109 | -0.1333 *** | -0.1237 | 0.0455 | 0.1429 | 0.1855 | 0.0600 |
| | (0.2115) | (0.1975) | (0.0373) | (0.1825) | (0.2764) | (0.2611) | (0.1960) | (0.0409) |
| **$Y^2$** | 0.1696 | 0.0602 | 0.1694 *** | 0.1679 | -0.2153 | -0.2052 | 0.0333 | -0.1800 *** |
| | (0.2226) | (0.2095) | (0.0361) | (0.1964) | (0.2996) | (0.3061) | (0.2229) | (0.0416) |
| **$Y^3$** | -0.0588 | -0.0319 | -0.0697 *** | -0.0632 | 0.1262 | 0.0890 | -0.0686 | 0.0771 *** |
| | (0.0883) | (0.0836) | (0.0181) | (0.0807) | (0.1239) | (0.1382) | (0.1012) | (0.0220) |
| **$Y^4$** | 0.0092 | 0.0070 | 0.0126 *** | 0.0114 | -0.0262 | -0.0167 | 0.0175 | -0.0148 *** |
| | (0.0153) | (0.0146) | (0.0040) | (0.0146) | (0.0223) | (0.0270) | (0.0202) | (0.0051) |
| **$Y^5$** | -0.0005 | -0.0005 | -0.0009 *** | -0.0008 | 0.0018 | 0.0012 | -0.0013 | 0.0010 ** |
| | (0.0010) | (0.0009) | (0.0003) | (0.0010) | (0.0015) | (0.0019) | (0.0015) | (0.0004) |
| $\delta$ | 0.0412 | 0.0676 * | -0.0134 | 0.1121 ** | 0.1404 ** | -0.0223 | -0.3256 *** | |
| | (0.0346) | (0.0356) | (0.0450) | (0.0478) | (0.0585) | (0.0800) | (0.0723) | |
| **vehicle** | -0.0089 *** | -0.0120 | 0.0034 | -0.0053 | -0.0232 | 0.0427 ** | -0.0157 | 0.0190 ** |
| | (0.0078) | (0.0073) | (0.0064) | (0.0089) | (0.0141) | (0.0168) | (0.0142) | (0.0090) |
| **Hhsize** | 0.0033 *** | -0.0025 | 0.0011 | -0.0171 *** | 0.0015 | -0.0019 | 0.0099 ** | 0.0057 * |
| | (0.0026) | (0.0025) | (0.0023) | (0.0033) | (0.0048) | (0.0057) | (0.0048) | (0.0031) |
| **working_share** | 0.0342 ** | -0.0040 | -0.0120 | -0.0503 *** | -0.0329 | 0.1364 *** | -0.1072 *** | 0.0308 |
| | (0.0164) | (0.0139) | (0.0136) | (0.0187) | (0.0329) | (0.0391) | (0.0327) | (0.0187) |
| **retirees_share** | 0.0228 * | -0.0002 | 0.0280 * | -0.0154 | -0.0217 | 0.1092 ** | -0.1275 *** | 0.0047 |
| | (0.0179) | (0.0165) | (0.0147) | (0.0202) | (0.0487) | (0.0503) | (0.0485) | (0.0214) |
| **children_share** | -0.0307 | -0.0466 *** | 0.0470 *** | 0.0807 *** | -0.0103 | 0.0183 | 0.0561 | -0.1144 *** |
| | (0.0189) | (0.0174) | (0.0154) | (0.0211) | (0.0352) | (0.0408) | (0.0349) | (0.0217) |
| **nonmetro** | -0.0195 | -0.0152 | 0.0085 | 0.0114 | 0.0655 ** | -0.0644 ** | 0.0285 | -0.0148 |
| | (0.0136) | (0.0126) | (0.0110) | (0.0154) | (0.0268) | (0.0301) | (0.0258) | (0.0160) |
| **constant** | 0.0436 *** | 0.0283 ** | 0.0697 *** | 0.0641 *** | 0.0099 | 0.1002 *** | 0.1842 *** | 0.4999 *** |
| | (0.0128) | (0.0135) | (0.0223) | (0.0238) | (0.0090) | (0.0186) | (0.0329) | (0.0244) |

Bootstrapped standard errors in parenthesis. *, **, and *** represent, respectively, estimated parameters statistically different from zero at the 10%, 5% and 1% significance level.

**(b)** Estimated Coefficients for SNAP-eligible nonparticipant households.

| Variables | Resource Share Equation | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **FAH-NS-LC** | **FAH-S-LC** | **FAH-NS-C** | **FAH-S-C** | **Grocery-PreparedF** | **FAFH Restaurant** | **FAFH Fastfood** | **Food P&P Time** |
| **logP(FAH-NS-LC)** | 0.0280 *** | -0.0034 | -0.0115 *** | -0.0004 | -0.0061 | -0.0022 | -0.0019 | -0.0025 |
| | (0.0041) | (0.0031) | (0.0033) | (0.0035) | (0.0042) | (0.0049) | (0.0050) | (0.0037) |
| **logP(FAH-S-LC)** | | 0.0208 *** | -0.0051 | -0.0021 | 0.0146 *** | -0.0133 ** | -0.0076 | -0.0039 |
| | | (0.0046) | (0.0034) | (0.0038) | (0.0044) | (0.0053) | (0.0053) | (0.0039) |
| **logP(FAH-NS-C)** | | | 0.0241 *** | -0.0071 * | -0.0030 | 0.0039 | 0.0026 | -0.0040 |
| | | | (0.0050) | (0.0039) | (0.0045) | (0.0049) | (0.0051) | (0.0036) |
| **logP(FAH-S-C)** | | | | 0.0223 *** | -0.0182 *** | -0.0015 | 0.0099 | -0.0029 |
| | | | | (0.0062) | (0.0051) | (0.0060) | (0.0060) | (0.0042) |
| **logP(Grocery-PreparedF)** | | | | | -0.0160 * | -0.0243 *** | 0.0187 ** | 0.0343 *** |
| | | | | | (0.0086) | (0.0083) | (0.0076) | (0.0067) |
| **logP(FAFH-Restaurant)** | | | | | | 0.0426 *** | -0.0258 *** | 0.0206 *** |
| | | | | | | (0.0134) | (0.0086) | (0.0061) |
| **logP(FAFH Fastfood)** | | | | | | | 0.0214 * | -0.0173 *** |
| | | | | | | | (0.0118) | (0.0057) |
| **log(time cost)** | | | | | | | | 0.0242 *** |
| | | | | | | | | (0.0030) |
| **Y** | 0.3729 | -0.4790 | 0.4331 ** | 0.1151 | -0.7995 ** | -0.8960 *** | 1.6022 *** | -0.3487 *** |
| | (0.2290) | (0.2944) | (0.1856) | (0.2440) | (0.3616) | (0.3202) | (0.2392) | (0.1320) |
| $\mathbf{Y}^2$ | -0.3056 | 0.5495 * | -0.4330 ** | -0.1293 | 0.7175 * | 0.7336 * | -1.3433 *** | 0.2107 |
| | (0.2616) | (0.3304) | (0.2120) | (0.2776) | (0.4033) | (0.3843) | (0.2716) | (0.1576) |
| $\mathbf{Y}^3$ | 0.1120 | -0.2145 | 0.1798 * | 0.0587 | -0.2778 | -0.2559 | 0.4831 *** | -0.0855 |
| | (0.1127) | (0.1395) | (0.0930) | (0.1213) | (0.1743) | (0.1785) | (0.1249) | (0.0762) |
| $\mathbf{Y}^4$ | -0.0197 | 0.0355 | -0.0326 * | -0.0100 | 0.0508 | 0.0416 | -0.0812 *** | 0.0155 |
| | (0.0213) | (0.0259) | (0.0180) | (0.0234) | (0.0333) | (0.0362) | (0.0253) | (0.0161) |
| $\mathbf{Y}^5$ | 0.0013 | -0.0021 | 0.0022 * | 0.0006 | -0.0035 | -0.0026 | 0.0052 *** | -0.0010 |
| | (0.0015) | (0.0018) | (0.0013) | (0.0017) | (0.0023) | (0.0027) | (0.0019) | (0.0012) |
| $\delta$ | -0.0891 ** | 0.0505 | 0.0696 | 0.1400 *** | 0.2009 *** | 0.0333 | -0.4052 *** | |
| | (0.0363) | (0.0366) | (0.0466) | (0.0527) | (0.0406) | (0.0723) | (0.0643) | |
| **vehicle** | -0.0076 | -0.0075 | -0.0161 ** | 0.0107 | 0.0199 | 0.0532 *** | -0.0547 *** | 0.0021 |
| | (0.0083) | (0.0084) | (0.0075) | (0.0100) | (0.0144) | (0.0196) | (0.0150) | (0.0099) |
| **Hhsize** | 0.0045 | -0.0032 | 0.0013 | -0.0148 *** | 0.0027 | 0.0071 | -0.0009 | 0.0032 |
| | (0.0030) | (0.0030) | (0.0029) | (0.0038) | (0.0049) | (0.0071) | (0.0053) | (0.0039) |
| **working_share** | 0.0093 | 0.0028 | -0.0240 ** | -0.0383 ** | 0.0224 | 0.1382 *** | -0.0831 *** | -0.0259 * |
| | (0.0123) | (0.0113) | (0.0116) | (0.0152) | (0.0263) | (0.0326) | (0.0246) | (0.0153) |
| **retirees_share** | 0.0113 | -0.0068 | -0.0103 | 0.0090 | -0.0477 | 0.0280 | -0.0046 | 0.0211 |
| | (0.0122) | (0.0122) | (0.0113) | (0.0150) | (0.0298) | (0.0362) | (0.0310) | (0.0160) |
| **children_share** | 0.0236 | -0.0276 | 0.0056 | 0.0176 | 0.0803 ** | 0.0081 | -0.0515 | -0.0561 ** |
| | (0.0215) | (0.0209) | (0.0196) | (0.0255) | (0.0355) | (0.0507) | (0.0378) | (0.0264) |
| **nonmetro** | -0.0263 ** | 0.0124 | 0.0067 | -0.0006 | 0.0536 ** | -0.0535 | -0.0093 | 0.0169 |
| | (0.0124) | (0.0130) | (0.0119) | (0.0155) | (0.0238) | (0.0325) | (0.0254) | (0.0165) |
| **constant** | 0.0296 ** | 0.0229 * | 0.0110 | 0.0118 | 0.0039 | 0.1546 *** | 0.0445 | 0.7217 *** |
| | (0.0127) | (0.0124) | (0.0211) | (0.0247) | (0.0052) | (0.0272) | (0.0317) | (0.0305) |

Bootstrapped standard errors in parenthesis. *, **, and *** represent, respectively, estimated parameters statistically different from zero at the 10%, 5% and 1% significance level.

**(c)** Estimated Coefficients for SNAP-ineligible households.

| Variables | Resource Share Equation | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | FAH-NS-LC | FAH-S-LC | FAH-NS-C | FAH-S-C | Grocery-PreparedF | FAFH Restaurant | FAFH Fastfood | Food P&P Time |
| **logP(FAH-NS-LC)** | 0.0242 *** | -0.0032 * | -0.0049 *** | 0.0029 | -0.0010 | -0.0105 *** | -0.0032 | -0.0042 |
| | (0.0026) | (0.0019) | (0.0017) | (0.0022) | (0.0024) | (0.0030) | (0.0030) | (0.0027) |
| **logP(FAH-S-LC)** | | 0.0207 *** | 0.0026 | -0.0066 *** | -0.0067 *** | -0.0038 | -0.0028 | -0.0001 |
| | | (0.0027) | (0.0019) | (0.0023) | (0.0025) | (0.0029) | (0.0030) | (0.0027) |
| **logP(FAH-NS-C)** | | | 0.0121 *** | 0.0019 | 0.0003 | -0.0065 ** | 0.0002 | -0.0056 ** |
| | | | (0.0025) | (0.0021) | (0.0023) | (0.0026) | (0.0027) | (0.0024) |
| **logP(FAH-S-C)** | | | | 0.0131 *** | -0.0034 | 0.0023 | -0.0026 | -0.0077 ** |
| | | | | (0.0037) | (0.0029) | (0.0036) | (0.0036) | (0.0032) |
| **logP(Grocery-PreparedF)** | | | | | -0.0072 | 0.0017 | -0.0078 * | 0.0241 *** |
| | | | | | (0.0047) | (0.0039) | (0.0040) | (0.0043) |
| **logP(FAFH-Restaurant)** | | | | | | 0.0255 *** | -0.0221 *** | 0.0134 *** |
| | | | | | | (0.0072) | (0.0050) | (0.0041) |
| **logP(FAFH Fastfood)** | | | | | | | 0.0397 *** | -0.0015 |
| | | | | | | | (0.0068) | (0.0040) |
| **log(time cost)** | | | | | | | | 0.0184 *** |
| | | | | | | | | (0.0026) |
| **Y** | -0.2623 | -0.0813 | 0.1229 | 0.0465 | 0.5681 ** | -0.5901 *** | 0.3163 * | -0.1201 |
| | (0.1924) | (0.1607) | (0.1158) | (0.1699) | (0.2279) | (0.2109) | (0.1736) | (0.1245) |
| **$Y^2$** | 0.2025 | 0.1403 | -0.1026 | -0.0830 | -0.7434 *** | 0.5548 ** | -0.0717 | 0.1030 |
| | (0.2269) | (0.1910) | (0.1369) | (0.2015) | (0.2641) | (0.2673) | (0.2079) | (0.1541) |
| **$Y^3$** | -0.0494 | -0.0714 | 0.0479 | 0.0666 | 0.3215 *** | -0.2029 | -0.0293 | -0.0830 |
| | (0.1008) | (0.0859) | (0.0630) | (0.0926) | (0.1182) | (0.1295) | (0.0994) | (0.0766) |
| **$Y^4$** | 0.0038 | 0.0160 | -0.0102 | -0.0170 | -0.0589 ** | 0.0330 | 0.0118 | 0.0214 |
| | (0.0197) | (0.0170) | (0.0128) | (0.0188) | (0.0235) | (0.0274) | (0.0209) | (0.0168) |
| **$Y^5$** | 0.0000 | -0.0013 | 0.0008 | 0.0015 | 0.0040 ** | -0.0020 | -0.0011 | -0.0018 |
| | (0.0014) | (0.0012) | (0.0010) | (0.0014) | (0.0017) | (0.0021) | (0.0016) | (0.0013) |
| $\delta$ | 0.0587 *** | 0.0621 ** | -0.0044 | 0.1083 *** | 0.1026 *** | -0.0041 | -0.3232 *** | |
| | (0.0216) | (0.0256) | (0.0292) | (0.0351) | (0.0259) | (0.0382) | (0.0460) | |
| **vehicle** | 0.0013 | 0.0022 | -0.0054 | -0.0216 *** | 0.0147 * | 0.0110 | -0.0097 | 0.0074 |
| | (0.0058) | (0.0055) | (0.0049) | (0.0073) | (0.0077) | (0.0119) | (0.0099) | (0.0086) |
| **HHsize** | 0.0047 ** | -0.0020 | -0.0027 | -0.0204 *** | 0.0001 | 0.0035 | 0.0087 ** | 0.0082 ** |
| | (0.0021) | (0.0021) | (0.0018) | (0.0028) | (0.0029) | (0.0045) | (0.0036) | (0.0034) |
| **working_share** | -0.0025 | -0.0207 *** | -0.0269 *** | 0.0017 | 0.0321 ** | 0.0272 | -0.0458 *** | 0.0170 |
| | (0.0084) | (0.0065) | (0.0067) | (0.0103) | (0.0126) | (0.0174) | (0.0150) | (0.0120) |
| **retirees_share** | 0.0096 | -0.0054 | -0.0011 | 0.0110 | -0.0062 | 0.0086 | -0.0493 ** | 0.0328 ** |
| | (0.0096) | (0.0082) | (0.0078) | (0.0118) | (0.0162) | (0.0206) | (0.0201) | (0.0139) |
| **children_share** | -0.0357 *** | -0.0094 | 0.0052 | 0.0405 *** | 0.0520 *** | -0.0124 | -0.0232 | -0.0170 |
| | (0.0129) | (0.0111) | (0.0102) | (0.0155) | (0.0171) | (0.0250) | (0.0213) | (0.0193) |
| **nonmetro** | -0.0004 | -0.0163 ** | -0.0004 | 0.0143 | 0.0226 * | -0.0407 ** | 0.0080 | 0.0129 |
| | (0.0080) | (0.0075) | (0.0064) | (0.0098) | (0.0125) | (0.0182) | (0.0144) | (0.0114) |
| **constant** | 0.0207 ** | 0.0080 | 0.0318 ** | 0.0056 | -0.0030 | 0.1421 *** | 0.1086 *** | 0.6863 *** |
| | (0.0084) | (0.0105) | (0.0143) | (0.0165) | (0.0042) | (0.0196) | (0.0271) | (0.0237) |

Bootstrapped standard errors in parenthesis. *, **, and *** represent, respectively, estimated parameters statistically different from zero at the 10%, 5% and 1% significance level.

### 2.4.2 Marshallian, Hicksian, and resource elasticities, and resource Engel curves

The Marshallian elasticities of demand for food categories and food P&P activities are reported in Table 2.4 for SNAP recipient, eligible non-participant and non-eligible, respectively in the top, middle and bottom panel. The own-price elasticities of demand for the food categories are negative and statistically significant, as expected. The estimated own-price elasticities of demand for *Food P&P Time* are also negative, consistent with previous research - (Aguiar & Hurst, 2007) - suggesting that time allocation for food related activities decreases when the cost of time increases. The magnitude of the own-price elasticity of time allocated to food P&P activities is the highest for SNAP participant households (-0.83); the second highest is for SNAP-eligible nonparticipant households (-0.80); and the lowest is for SNAP-ineligible households (-0.79), however they are not statistically different from one another. Given that the average weekly number of hours allocated to food P&P are 4.72, 4.74, and 4.92 by SNAP participant, SNAP-eligible nonparticipant, and SNAP-eligible nonparticipant households, respectively, the magnitude of the estimated elasticities indicate that for the three groups of households, when the cost of time increases by 1%, they spend 2.35 minutes, 2.28 minutes, and 2.34 minutes less in food P&P activities. Since we use wages as opportunity cost of time, if the hourly wage rate received by SNAP participant, SNAP-eligible nonparticipant, and SNAP-ineligible households increased by 1.10\$, 1.83\$, and 4.06\$ per hour, respectively, households will spend one less hour per week in food P&P activities. Assuming a 40-hour workweek, these results suggest that SNAP participant, SNAP-eligible nonparticipant, and SNAP-ineligible households should be given, respectively, \$44, \$73.2, and \$162.4 in order for them to spend an additional hour per week on food P&P. That is about roughly 10 times of their current opportunity cost of time.

Considering the cross-price elasticities, for most food categories we find that as the opportunity cost of time increases, the quantity demanded increases (except for four goods-time cross-price elasticities not to being statistically different from zero: *FAH-NS-LC* and *FAH-S-LC* for SNAP participating households, and *FAH-S-LC* and *Fastfood* for SNAP-eligible nonparticipant households).

Across all groups of households, the positive signs and the magnitude of the goods-time cross-price elasticities suggest that convenience food, prepared food from grocery stores, and FAFH are substitutes of time allocated to food P&P. Out of those substitutes, *Grocery-PreparedF* and *FAFH-Restaurants* (also SNAP recipient households' *FAFH-Fastfood*) quantities demanded are to increase the most when time is limited. These results suggest that households' *Grocery-PreparedF* and *FAFH-Restaurants* purchases are more responsive to time cost, compared to FAH. Further, convenience FAH is more responsive to time cost compared to low-convenience FAH. In other words, one may expect households to buy more *Grocery-PreparedF* and *FAFH-Restaurants* (and SNAP recipient households would buy more *FAFH-Fastfood* in additioan to these two types) when time for food P&P is limited. Moreover, for households with time limitations, the demand for convenience FAH would be larger than that for low-convenience FAH.

The results in Tables 2.4a, 2.4b, and 2.4c further suggest that the higher price of FAH, the lower the time allocated to food P&P. In other words, food P&P is a gross complement to FAH. Time-goods cross-price elasticities for SNAP participating households are larger in magnitude for low-convenience FAH compared to convenience FAH. For SNAP participating households' and SNAP-eligible non-participating households' time allocated to food P&P is not responsive to increasing *Grocery-PreparedF* prices, but for SNAP-ineligible households, the time-*Grocery-PreparedF* cross-price ealsticity is positive and statistically significant. Across the three household sub-samples, time allocated to food P&P increase in a statistically significantly way when price of FAFH increases (except that of *FAFH-Fastfood* for SNAP-eligible non-participating households and *FAFH-Restaurants* for SNAP-ineligible households) suggesting food P&P is also a gross substitute to FAFH.

Hicksian price elasticities for SNAP participants, SNAP-eligible nonparticipants and SNAP-ineligible households are reported in Table 2.5a, 2.5b, and 2.5c, respectively. As expected, the Hicksian demand elasticities of food and time categories with respect to their own price are negative. All goods-time Hicksian cross price elasticites are positive and statistically significantly different from zero. For all types of households, the own-price elasticities of convenience FAH are greater than those of low-convenience FAH; the responsiveness of *FAH-S-C* to its own price is the highest. When considering *Grocery-PreparedF* and FAFH, an increase in time cost for SNAP participating households results in larger increases in the percentage of *FAFH Fastfood* quantity demanded compared to prepared food purchased from grocery stores and restaurants; for the other two groups of housheolds, the largest Hicksian goods-time cross-price elasticity is that of *FAFH-Restaurants*. These results suggest that, when time is limited - and its opportunity cost is higher, SNAP participating households tend to substitute to *FAFH Fastfood* more than other FAFH, whereas other households substitute to *FAFH-Restaurants*. When food prices increase, households spend more time on food P&P. The highest responsiveness of food P&P time allocation is observed for price changes in *Grocery-PreparedF*.

**Table 2.4:** Estimated Marshallian Price Elasticities. Panel (a) SNAP recipient households; Panel (b) SNAP-eligible nonparticipant households; and Panel (c) SNAP-ineligible households.

**(a)** Estimated Marshallian Price Elasticities of SNAP recipient households.

| | SNAP participants | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | With respect to the price of | | | | | | | |
| **Marshallian Elasticity of** | **FAH-NS-LC** | **FAH-S-LC** | **FAH-NS-C** | **FAH-S-C** | **Grocery-PreparedF** | **FAFH Restaurant** | **FAFH Fastfood** | **Food P&P Time** |
| **FAH-NS-LC** | -0.6795 *** | 0.0358 | -0.0535 ** | -0.0323 | -0.0172 | -0.2124 *** | -0.0091 | 0.0006 |
| | (0.0535) | (0.0338) | (0.0247) | (0.0197) | (0.1149) | (0.0703) | (0.0441) | (0.0160) |
| **FAH-S-LC** | 0.0434 | -0.7759 *** | 0.0188 | -0.1060 *** | -0.2333 ** | -0.0161 | 0.0321 | 0.0029 |
| | (0.0367) | (0.0477) | (0.0253) | (0.0201) | (0.1091) | (0.0679) | (0.0441) | (0.0153) |
| **FAH-NS-C** | -0.1166 *** | -0.0138 | -0.9877 *** | -0.0624 *** | -0.0814 | 0.0251 | 0.0866 ** | 0.0532 *** |
| | (0.0378) | (0.0345) | (0.0369) | (0.0201) | (0.1048) | (0.0659) | (0.0422) | (0.0147) |
| **FAH-S-C** | -0.0737 | -0.2276 *** | -0.0387 | -0.9041 *** | -0.3450 ** | 0.1123 | 0.0373 | 0.0592 *** |
| | (0.0468) | (0.0422) | (0.0289) | (0.0308) | (0.1363) | (0.0855) | (0.0523) | (0.0174) |
| **Grocery-PreparedF** | 0.0154 | -0.0758 | 0.0091 | -0.0455 * | -1.0017 *** | -0.1022 | -0.0069 | 0.0904 *** |
| | (0.0532) | (0.0468) | (0.0315) | (0.0257) | (0.2346) | (0.1141) | (0.0613) | (0.0229) |
| **FAFH Restaurant** | -0.2362 *** | -0.0684 | -0.0200 | -0.0158 | -0.2798 | -0.5392 *** | -0.1181 * | 0.0999 *** |
| | (0.0605) | (0.0508) | (0.0357) | (0.0292) | (0.2063) | (0.1629) | (0.0717) | (0.0242) |
| **FAFH Fastfood** | -0.1449 ** | -0.0942 | -0.0151 | -0.1119 *** | -0.2245 | -0.2403 * | -0.6024 *** | 0.0955 *** |
| | (0.0677) | (0.0601) | (0.0410) | (0.0316) | (0.1917) | (0.1243) | (0.1014) | (0.0247) |
| **Food P&P Time** | -0.2162 *** | -0.2177 *** | -0.0474 | -0.1516 *** | 0.1917 | 0.3084 *** | 0.2400 *** | -0.8339 *** |
| | (0.0654) | (0.0549) | (0.0351) | (0.0258) | (0.1741) | (0.0937) | (0.0541) | (0.0139) |

Standard errors in parenthesis. *, **, and *** represent, respectively, estimated elasticities statistically different from zero at the 10%, 5% and 1% significance level.

**(b)** Estimated Marshallian Price Elasticities of SNAP-eligible nonparticipant households.

| | SNAP-eligible nonparticipants | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | With respect to the price of | | | | | | | |
| **Marshallian Elasticity of** | **FAH-NS-LC** | **FAH-S-LC** | **FAH-NS-C** | **FAH-S-C** | **Grocery-PreparedF** | **FAFH Restaurant** | **FAFH Fastfood** | **Food P&P Time** |
| **FAH-NS-LC** | -0.6000 *** | -0.0916 ** | -0.1097 *** | -0.0396 * | -0.4054 *** | -0.0260 | 0.0368 | 0.0209 * |
| | (0.0586) | (0.0405) | (0.0297) | (0.0235) | (0.1546) | (0.0465) | (0.0449) | (0.0117) |
| **FAH-S-LC** | -0.0163 | -0.7945 *** | -0.0584 ** | -0.0532 ** | 0.3309 ** | -0.1307 *** | -0.0104 | 0.0189 |
| | (0.0413) | (0.0585) | (0.0293) | (0.0259) | (0.1673) | (0.0503) | (0.0478) | (0.0122) |
| **FAH-NS-C** | -0.1103 ** | -0.1443 *** | -0.8246 *** | -0.1051 *** | -0.4058 ** | 0.0287 | 0.1105 ** | 0.0342 *** |
| | (0.0431) | (0.0442) | (0.0396) | (0.0252) | (0.1691) | (0.0483) | (0.0468) | (0.0115) |
| **FAH-S-C** | 0.0507 | -0.1307 ** | -0.0900 *** | -0.9362 *** | -1.0473 *** | -0.0251 | 0.2019 *** | 0.0514 *** |
| | (0.0513) | (0.0550) | (0.0342) | (0.0386) | (0.2001) | (0.0594) | (0.0552) | (0.0136) |
| **Grocery-PreparedF** | -0.0718 | 0.1627 *** | -0.0304 | -0.1295 *** | -1.6492 *** | -0.2303 *** | 0.1874 *** | 0.1175 *** |
| | (0.0564) | (0.0547) | (0.0372) | (0.0326) | (0.3128) | (0.0789) | (0.0685) | (0.0208) |
| **FAFH Restaurant** | 0.0079 | -0.2365 *** | 0.0113 | -0.0626 | -1.1422 *** | -0.6062 *** | -0.1540 ** | 0.1049 *** |
| | (0.0679) | (0.0717) | (0.0413) | (0.0391) | (0.3098) | (0.1269) | (0.0775) | (0.0191) |
| **FAFH Fastfood** | 0.0140 | -0.1696 ** | -0.0005 | 0.0073 | 0.4048 | -0.2500 *** | -0.7275 *** | -0.0109 |
| | (0.0715) | (0.0723) | (0.0450) | (0.0405) | (0.2822) | (0.0828) | (0.1060) | (0.0181) |
| **Food P&P Time** | 0.0799 | -0.2629 *** | -0.0968 ** | -0.1786 *** | 0.4573 | 0.1716 ** | 0.0765 | -0.8007 *** |
| | (0.0851) | (0.0824) | (0.0454) | (0.0425) | (0.3379) | (0.0705) | (0.0593) | (0.0121) |

Standard errors in parenthesis. *, **, and *** represent, respectively, estimated elasticities statistically different from zero at the 10%, 5% and 1% significance level.

(**c**) Estimated Marshallian Price Elasticities of SNAP-ineligible households.

| | SNAP-ineligible | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | With respect to the price of | | | | | | | |
| **Marshallian Elasticity of** | **FAH-NS-LC** | **FAH-S-LC** | **FAH-NS-C** | **FAH-S-C** | **Grocery-PreparedF** | **FAFH Restaurant** | **FAFH Fastfood** | **Food P&P Time** |
| **FAH-NS-LC** | -0.6054 *** | -0.0904 *** | -0.0711 *** | -0.0176 | -0.0605 | -0.0946 *** | 0.0013 | 0.0116 * |
| | (0.0497) | (0.0313) | (0.0203) | (0.0170) | (0.1048) | (0.0254) | (0.0329) | (0.0064) |
| **FAH-S-LC** | -0.1008 *** | -0.6942 *** | 0.0101 | -0.0900 *** | -0.2995 *** | -0.0386 | 0.0080 | 0.0230 *** |
| | (0.0335) | (0.0464) | (0.0206) | (0.0171) | (0.1077) | (0.0244) | (0.0332) | (0.0064) |
| **FAH-NS-C** | -0.1530 *** | -0.0163 | -0.8947 *** | -0.0499 *** | -0.0148 | -0.0649 *** | 0.0607 ** | 0.0219 *** |
| | (0.0328) | (0.0320) | (0.0289) | (0.0173) | (0.1027) | (0.0228) | (0.0303) | (0.0058) |
| **FAH-S-C** | -0.0449 | -0.1994 *** | -0.0210 | -1.0010 *** | -0.1834 | 0.0051 | 0.0598 | 0.0350 *** |
| | (0.0411) | (0.0405) | (0.0228) | (0.0280) | (0.1226) | (0.0314) | (0.0404) | (0.0076) |
| **Grocery-PreparedF** | -0.0360 | -0.1283 *** | -0.0041 | -0.0417 ** | -1.3075 *** | 0.0119 | -0.0694 | 0.0663 *** |
| | (0.0432) | (0.0418) | (0.0253) | (0.0212) | (0.1990) | (0.0330) | (0.0442) | (0.0102) |
| **FAFH Restaurant** | -0.2738 *** | -0.1417 *** | -0.1087 *** | -0.0664 ** | 0.0361 | -0.7977 *** | -0.1647 *** | 0.0777 *** |
| | (0.0563) | (0.0523) | (0.0296) | (0.0274) | (0.1752) | (0.0626) | (0.0548) | (0.0099) |
| **FAFH Fastfood** | -0.1223 ** | -0.1070 ** | -0.0261 | -0.0836 *** | -0.3519 ** | -0.1959 *** | -0.5064 *** | 0.0320 *** |
| | (0.0567) | (0.0538) | (0.0305) | (0.0279) | (0.1747) | (0.0430) | (0.0745) | (0.0095) |
| **Food P&P Time** | -0.3786 *** | -0.2796 *** | -0.1924 *** | -0.3540 *** | 0.8818 *** | 0.0681 | 0.2573 *** | -0.7923 *** |
| | (0.0763) | (0.0701) | (0.0428) | (0.0362) | (0.3005) | (0.0416) | (0.0532) | (0.0085) |

Standard errors in parenthesis. *, **, and *** represent, respectively, estimated elasticities statistically different from zero at the 10%, 5% and 1% significance level.

**Table 2.5:** Estimated Hicksian Price Elasticities. Panel (a) SNAP recipient households; Panel (b) SNAP-eligible nonparticipant households; and Panel (c) SNAP-ineligible households.

(**a**) Estimated Hicksian Price Elasticities of SNAP recipient households.

| | SNAP participants | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | With respect to the price of | | | | | | | |
| **Hicksian Elasticity of** | **FAH-NS-LC** | **FAH-S-LC** | **FAH-NS-C** | **FAH-S-C** | **Grocery-PreparedF** | **FAFH Restaurant** | **FAFH Fastfood** | **Food P&P Time** |
| **FAH-NS-LC** | -0.5601 *** | 0.1577 *** | 0.0427 * | 0.0889 *** | 0.1516 | -0.1561 ** | 0.0198 | 0.0457 *** |
| | (0.0512) | (0.0329) | (0.0241) | (0.0189) | (0.1114) | (0.0694) | (0.0439) | (0.0159) |
| **FAH-S-LC** | 0.1789 *** | -0.6376 *** | 0.1280 *** | 0.0315 | -0.0417 | 0.0478 | 0.0648 | 0.0540 *** |
| | (0.0373) | (0.0478) | (0.0253) | (0.0192) | (0.1085) | (0.0672) | (0.0439) | (0.0152) |
| **FAH-NS-C** | 0.0649 * | 0.1715 *** | -0.8415 *** | 0.1218 *** | 0.1752 * | 0.1107 * | 0.1305 *** | 0.1216 *** |
| | (0.0366) | (0.0339) | (0.0352) | (0.0188) | (0.1000) | (0.0632) | (0.0415) | (0.0144) |
| **FAH-S-C** | 0.2150 *** | 0.0671 | 0.1938 *** | -0.6111 *** | 0.0631 | 0.2484 *** | 0.1071 ** | 0.1681 *** |
| | (0.0458) | (0.0410) | (0.0298) | (0.0313) | (0.1289) | (0.0813) | (0.0515) | (0.0170) |
| **Grocery-PreparedF** | 0.0725 | -0.0176 | 0.0551 * | 0.0125 | -0.9210 *** | -0.0753 | 0.0069 | 0.1119 *** |
| | (0.0533) | (0.0457) | (0.0315) | (0.0255) | (0.2345) | (0.1139) | (0.0610) | (0.0229) |
| **FAFH Restaurant** | -0.1338 ** | 0.0362 | 0.0625 * | 0.0881 *** | -0.1350 | -0.4909 *** | -0.0934 | 0.1385 *** |
| | (0.0595) | (0.0508) | (0.0357) | (0.0288) | (0.2044) | (0.1621) | (0.0716) | (0.0241) |
| **FAFH Fastfood** | 0.0288 | 0.0831 | 0.1248 *** | 0.0644 ** | 0.0211 | -0.1584 | -0.5604 *** | 0.1610 *** |
| | (0.0639) | (0.0563) | (0.0397) | (0.0310) | (0.1856) | (0.1214) | (0.1002) | (0.0242) |
| **Food P&P Time** | 0.1340 *** | 0.1397 *** | 0.2346 *** | 0.2039 *** | 0.6868 *** | 0.4736 *** | 0.3247 *** | -0.7018 *** |
| | (0.0465) | (0.0394) | (0.0278) | (0.0206) | (0.1403) | (0.0824) | (0.0489) | (0.0121) |

Standard errors in parenthesis. *, **, and *** represent, respectively, estimated elasticities statistically different from zero at the 10%, 5% and 1% significance level.

**(b)** Estimated Hicksian Price Elasticities of SNAP-eligible nonparticipant households.

| SNAP-eligible nonparticipants | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | With respect to the price of | | | | | | | |
| **Hicksian Elasticity of** | **FAH-NS-LC** | **FAH-S-LC** | **FAH-NS-C** | **FAH-S-C** | **Grocery-PreparedF** | **FAFH Restaurant** | **FAFH Fastfood** | **Food P&P Time** |
| **FAH-NS-LC** | -0.5517 *** | 0.0331 | -0.0200 | 0.0725 *** | -0.1467 | 0.0539 | 0.0577 | 0.0669 *** |
| | (0.0553) | (0.0379) | (0.0275) | (0.0224) | (0.1536) | (0.0457) | (0.0445) | (0.0115) |
| **FAH-S-LC** | 0.0356 | -0.6605 *** | 0.0380 | 0.0672 *** | 0.6088 *** | -0.0448 | 0.0120 | 0.0683 *** |
| | (0.0408) | (0.0566) | (0.0283) | (0.0244) | (0.1607) | (0.0495) | (0.0472) | (0.0121) |
| **FAH-NS-C** | -0.0323 | 0.0570 | -0.6798 *** | 0.0757 *** | 0.0115 | 0.1576 *** | 0.1442 *** | 0.1084 *** |
| | (0.0444) | (0.0424) | (0.0412) | (0.0248) | (0.1630) | (0.0459) | (0.0459) | (0.0113) |
| **FAH-S-C** | 0.1522 *** | 0.1314 *** | 0.0985 *** | -0.7008 *** | -0.5038 *** | 0.1428 ** | 0.2457 *** | 0.1481 *** |
| | (0.0471) | (0.0478) | (0.0323) | (0.0392) | (0.1843) | (0.0564) | (0.0540) | (0.0132) |
| **Grocery-PreparedF** | -0.0540 | 0.2086 *** | 0.0026 | -0.0883 *** | -1.5540 *** | -0.2008 ** | 0.1951 *** | 0.1344 *** |
| | (0.0565) | (0.0551) | (0.0372) | (0.0323) | (0.3114) | (0.0786) | (0.0683) | (0.0208) |
| **FAFH Restaurant** | 0.0765 | -0.0593 | 0.1387 *** | 0.0965 ** | -0.7748 ** | -0.4927 *** | -0.1244 | 0.1702 *** |
| | (0.0648) | (0.0654) | (0.0404) | (0.0381) | (0.3031) | (0.1259) | (0.0771) | (0.0189) |
| **FAFH Fastfood** | 0.0861 | 0.0167 | 0.1334 *** | 0.1745 *** | 0.7908 *** | -0.1307 | -0.6964 *** | 0.0577 *** |
| | (0.0665) | (0.0656) | (0.0425) | (0.0383) | (0.2769) | (0.0811) | (0.1059) | (0.0179) |
| **Food P&P Time** | 0.2875 *** | 0.2729 *** | 0.2886 *** | 0.3026 *** | 1.5681 *** | 0.5148 *** | 0.1661 *** | -0.6032 *** |
| | (0.0495) | (0.0484) | (0.0302) | (0.0270) | (0.2430) | (0.0572) | (0.0514) | (0.0094) |

Standard errors in parenthesis. *, **, and *** represent, respectively, estimated elasticities statistically different from zero at the 10%, 5% and 1% significance level.

**(c)** Estimated Hicksian Price Elasticities of SNAP-ineligible households.

| SNAP-ineligible | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | With respect to the price of | | | | | | | |
| **Hicksian Elasticity of** | **FAH-NS-LC** | **FAH-S-LC** | **FAH-NS-C** | **FAH-S-C** | **Grocery-PreparedF** | **FAFH Restaurant** | **FAFH Fastfood** | **Food P&P Time** |
| **FAH-NS-LC** | -0.5101 *** | 0.0017 | 0.0016 | 0.0771 *** | 0.0118 | -0.0331 | 0.0210 | 0.0456 *** |
| | (0.0475) | (0.0310) | (0.0192) | (0.0162) | (0.1006) | (0.0249) | (0.0325) | (0.0063) |
| **FAH-S-LC** | 0.0018 | -0.5951 *** | 0.0884 *** | 0.0120 | -0.2217 ** | 0.0276 | 0.0291 | 0.0596 *** |
| | (0.0334) | (0.0459) | (0.0205) | (0.0165) | (0.1041) | (0.0241) | (0.0328) | (0.0063) |
| **FAH-NS-C** | 0.0026 | 0.1340 *** | -0.7760 *** | 0.1047 *** | 0.1031 | 0.0355 | 0.0928 *** | 0.0774 *** |
| | (0.0314) | (0.0310) | (0.0271) | (0.0156) | (0.0963) | (0.0217) | (0.0293) | (0.0057) |
| **FAH-S-C** | 0.1899 *** | 0.0275 | 0.1581 *** | -0.7677 *** | -0.0055 | 0.1566 *** | 0.1082 *** | 0.1188 *** |
| | (0.0398) | (0.0377) | (0.0235) | (0.0274) | (0.1211) | (0.0300) | (0.0394) | (0.0075) |
| **Grocery-PreparedF** | 0.0051 | -0.0886 ** | 0.0272 | -0.0010 | -1.2764 *** | 0.0384 | -0.0610 | 0.0810 *** |
| | (0.0433) | (0.0416) | (0.0254) | (0.0212) | (0.1984) | (0.0332) | (0.0441) | (0.0102) |
| **FAFH Restaurant** | -0.0705 | 0.0547 | 0.0464 | 0.1356 *** | 0.1902 | -0.6665 *** | -0.1228 ** | 0.1503 *** |
| | (0.0531) | (0.0477) | (0.0283) | (0.0260) | (0.1645) | (0.0610) | (0.0542) | (0.0097) |
| **FAFH Fastfood** | 0.0345 | 0.0445 | 0.0935 *** | 0.0723 *** | -0.2331 | -0.0947 ** | -0.4741 *** | 0.0879 *** |
| | (0.0534) | (0.0501) | (0.0295) | (0.0263) | (0.1686) | (0.0418) | (0.0740) | (0.0094) |
| **Food P&P Time** | 0.3468 *** | 0.4213 *** | 0.3609 *** | 0.3669 *** | 1.4316 *** | 0.5362 *** | 0.4068 *** | -0.5335 *** |
| | (0.0480) | (0.0448) | (0.0264) | (0.0230) | (0.1803) | (0.0346) | (0.0436) | (0.0060) |

Standard errors in parenthesis. *, **, and *** represent, respectively, estimated elasticities statistically different from zero at the 10%, 5% and 1% significance level.

The resource (or full expenditure) elasticities are reported in Table 2.6. The estimated resource elasticities are all positive and statistically different from zero, indicating that, when resources increase, all household groups' quantity of food demanded and time allocation to food P&P increase. The magnitudes of the resource elasticities for SNAP participants and SNAP-ineligible households indicate that with higher resources, these households' demand for FAH increases more than that for *FAFH Restaurant* and *FAFH Fastfood*. Also, amongst FAH groups, the demand for low-convenience foods increases more than, or with the same magnitude, than the demand for convenience foods with same storability level. For SNAP-eligible nonparticipant household, instead, the resource elasticities indicate that the demand for storable FAH increase more than non-storable FAH when resources increase. For SNAP participant households and SNAP-eligible nonparticipant households, as resources increase, the demand for *Grocery-PreparedF* increases the most compared to other food categories. All household groups show similar patterns of resource elasticities for FAFH, although the relative magnitudes differ. Overall, as resources increase, the relative increase of demand for *FAFH Fastfood* is the lowest compared to that of other food categories. However, while the magnitude of the resources elasticities is similar across household groups for *FAFH Fastfood*, the demand for *FAFH Restaurant* it is about 40% less resource elastic for SNAP participants households compared to other household groups. Resource elasticities for *Food P&P Time* show the second-lowest magnitude for all household groups, however, the magnitude for SNAP recipient households is more than 10% smaller than for other household groups.

The resource Engel curves are reported in Figure 2.2. Interestingly, the resource Engel curves for SNAP households follow similar patterns across all four FAH food groupings considered, and in particular for *FAH-NS-LC*, and *FAH-NS-C*. The resource shares vary in similar fashion with total resource availability, declining at low levels of resources and then increasing, the latter portion of the pattern being more marked for storable products.

The resource Engel curves of *Grocery-PreparedF* and *FAFH-Restaurant* show heterogeneous patterns across household sub-samples, but similar patters for SNAP participants and income non-ineligible households. At both low and high resource availability levels, when the resource availability increases, SNAP participant (SNAP-ineligible) households will increase (decrease) their resource shared of both *Grocery-PreparedF* and *FAFH-Restaurant*.

For all three household groups, the resource Engel curves for *FAFH-Fast Food* show an inverse U-shape: that is, at low resource levels, a resource increase lead to higher shares of *FAFH-Fast Food* whereas, at high resource levels, an increase of resources will lead to lower resource shares allocated to Fast Food. Further, for all household subgroups, the share of time allocated to food P&P decreases when resource availability increases, except for SNAP participant households with very low resources, for which an increase in overall resources results in higher resource share of *Food P&P Time*.

**Table 2.6:** Resource (Full Expenditure) Elasticities

| **Resource Elasticity of** | **SNAP participants** | | **SNAP-eligible nonparticipants** | | **SNAP-ineligible** | |
|---|---|---|---|---|---|---|
| **FAH-NS-LC** | 1.4083<br>(0.1322) | *** | 0.6459<br>(0.1781) | *** | 1.7149<br>(0.1450) | *** |
| **FAH-S-LC** | 1.4375<br>(0.1162) | *** | 1.6674<br>(0.1998) | *** | 1.6570<br>(0.1374) | *** |
| **FAH-NS-C** | 1.1345<br>(0.0618) | *** | 1.1992<br>(0.0917) | *** | 1.3080<br>(0.0745) | *** |
| **FAH-S-C** | 1.4296<br>(0.0531) | *** | 1.4976<br>(0.0881) | *** | 1.7043<br>(0.0720) | *** |
| **Grocery-PreparedF** | 1.9912<br>(0.3193) | *** | 3.4570<br>(0.5948) | *** | 1.2997<br>(0.4959) | *** |
| **FAFH Restaurant** | 0.6644<br>(0.1641) | *** | 1.0681<br>(0.1357) | *** | 1.1068<br>(0.0725) | *** |
| **FAFH Fastfood** | 0.3405<br>(0.0799) | *** | 0.2789<br>(0.0838) | *** | 0.3534<br>(0.0787) | *** |
| **Food P&P Time** | 0.5313<br>(0.0245) | *** | 0.6147<br>(0.0222) | *** | 0.6119<br>(0.0145) | *** |

### 2.4.3 Discussion and Policy Implications

Overall, our results suggest that SNAP participant, SNAP-eligible nonparticipant, and SNAP-ineligible households respond differently to limited time availability for food P&P. Our results suggest that SNAP participants' time allocation for food P&P is more responsive to the opportunity cost of time, compared to the other two types of households. Furthermore, SNAP participating

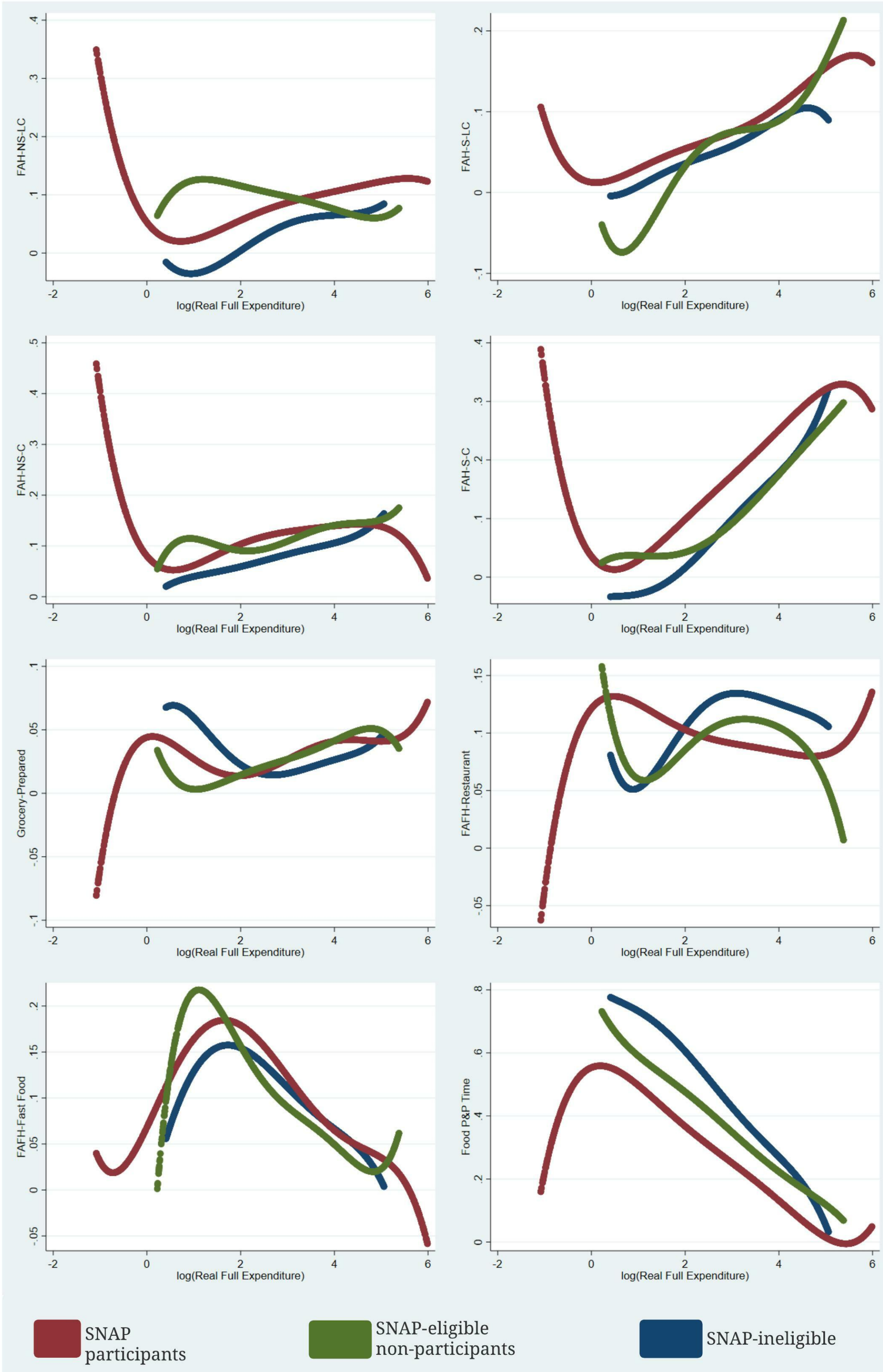



**Figure 2.2:** Real Full Expenditure Engel Curves

households are identified as vulnerable families-nearly 90% of those households contain a child (<age 18), an elderly person (>60 yeas), or an individual with disabilities (CBPP 2019).

Further, they tend to acquire more food with time saving feature -i.e. convenience FAH, *Grocery-PreparedF*, and FAFH)- when time is more limited. Even though a higher opportunity cost of time implies higher wage rates, our results suggests that SNAP participants'demand for low-convenience FAH (including fresh fruits and vegetables) does not increase significantly with time cost. According to the TFP, which aims to design healthful and minimal cost meal plans satisfying the recommendations of the Dietary Guidelines for Americans, and which SNAP allotments are based on, the average lowest cost of a meal per person is about \$1.39 (CNPP 2020). However, the TFP has not been updated since 2006 (USDA 2006), and does not account for the time cost of food. Our results suggest that accounting for households' time cost and foods' time-saving features is vital when designing tools to help households achieving nutritious diet with limited resource.

Recently proposed changes to SNAP include a 20.3% increase in total monthly SNAP benefits (C-FARE 2021). That amount corresponds to about \$36.24 per person each month (CAP 2021). Our results suggest that SNAP participants should be given about 44\$ per week in order for them to spend an additional hour per week on food P&P. If we assume SNAP recipients can purchase enough food using the current amount of SNAP benefits they receive, the proposed change for SNAP may lead a two-person household to allocate nearly 25 minutes per week additionally on food P&P.

Further, our results in Table 2.4 shows that when SNAP participants' cost of time increases, *FAFH-Fastfood* quantity demanded increases more compared to *Grocery-PreparedF*. *Grocery-PreparedF* could be a better or healthier time-saving option compared to *FAFH-Fastfood*. Our results also indicate that with more resource availability, both SNAP participant households' and SNAP-eligible nonparticipant households' percentage of *Grocery-PreparedF* purchase increase more compared to the increase of other food categories. As SNAP benefits cannot be used to purchase some types of *Grocery-PreparedF* including foods that will be eaten in the store and hot foods (FNS 2019), SNAP participants pay out of pocket when purchasing *Grocery-PreparedF*. Allowing SNAP benefits to be used for purchasing *Grocery-PreparedF* may be beneficial in terms of providing incentives to increase the quantity demanded of *Grocery-PreparedF* instead of *FAFH-Fastfood*, which may result in healthier choices.

## 2.5 Conclusions, Limitations, and Future Research

In this study, we estimate the substitution between different FAH categories (classified according to their storability and time saving / convenience features), FAFH (classified based upon where it was purchased), and the time allocated to food P&P related activities, using an extension of Lewbel & Pendakur (2009)'s EASI demand system. Our Time Use EASI (TU-EASI) incorporates both demand for time and goods. Since the TU-EASI accounts for households' time allocation we argue that our approach provides more information on demand for and substitution between food categories, compared to traditional demand systems, as it provides more insights on households' economizing strategies.

Using this modeling framework, and a data set obtained merging the ATUS time records for food P&P to FoodAPS' food expenditure data, we obtain resource Engel curves, own- and cross-price elasticities of demand for food and time for food P&P activities with respect to food prices and time costs. The results suggest that the relationship between resource shares and resource availability is highly non-linear. When opportunity cost of time increases, or, in other words, when time becomes more limited, the majority of convenience FAH and FAFH quantities demanded increases across three types of households segmented by their SNAP eligibility and recipient status. Convenience FAH and FAFH act as gross substitutes for *Food P&P Time*. Also, SNAP participants' FAH and *Grocery-PreparedF* purchases increase more with higher resource availability. Our findings suggest the importance of accounting for time cost when designing tools to help households achieving nutritious diet with limited resource (e.g. TFP).

*Food P&P Time* includes both time spent on FAH and FAFH; however, time spent on food preparation represents more than 78% of the total time allocated to food P&P. In the future, we may consider including time spent on FAH and FAFH categories separately in our demand system, because disentangling the effect of time for FAH and FAFH may provide more information about the association between time and food quantities demanded.

A major limitation of this study stems from the unavailability of one single database including both food P&P time allocation and food expenditure data by food categories. Because of it, we had to impute food P&P time allocation of households in FoodAPS using observed time use of similar households from the ATUS. As such, the imputed food P&P time use variables may embed some measurement error. We will address this issue in the future by determining the impact of any measurement error in the imputed food P&P time use variables on our estimates. Another future research avenue is that of modeling monetary expenditure (budget constraint) and time allocation (time constraint) separately, which would allow inferring directly on households purchasing behavior under separate conditions of money and time scarcity.

# Chapter 3

# Spending More Time for Food Means Acquiring Better Food? Quality of Food Acquisition and Time Use

## 3.1 Introduction

Most Americans suffer from one or more diet-related health conditions, including overweight, obesity, type 2 diabetes, certain types of cancer, heart diseases, strokes, hypertension, liver diseases, dental caries, and/or metabolic syndromes (United Stated Department of Agriculture, 2020a). In fact, 19% of children and teens (aged 2 to 19 years) and 40% of U.S. adults are obese. [29] In addition, more than one third (88 million) of U.S. adults have pre-diabetes (Centers for Disease Control and Prevention, 2021). The healthfulness of an individual's diet is believed to play an important role in preventing many non-communicable diseases (Bruins et al. 2019; Di Daniele 2019).

Given the importance of a healthy diet, several programs in the U.S. are designed to promote healthier diets. The U.S. Department of Agriculture (USDA) and the U.S. Department of Health and Human Services (HHS) provide science-based advice on the consumption of foods and drinks promoting health, reducing the risk of chronic diseases while meeting nutritional needs, through the Dietary Guidelines for Americans (DGA) (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020). Further, numerous assistance programs exist helping Americans to meet their nutritional needs. [30] Despite the availability of the DGA

[29] Adults are classified as obese when their Body Mass Index (BMI) - calculated as weight in Kg divided by height (in meters) squared - equals or exceeds 30

[30] An incomplete list of programs include: the Supplemental Nutrition Assistance Program (SNAP), Women, Infants, and Children Program (WIC), Child and Adult Care Food Program (CACFP), National School Lunch Program (NSLP), and The Emergency Food Assistance Program (TEFAP) (United Stated Department of Agriculture, 2020b).

and food assistance programs, Americans' diet has not changed significantly over time (United Stated Department of Agriculture, 2020a). When trying to explain the variation in diet-quality, the three contributing factors investigated the most are income, education, and the food environment, whereas other factors are disregarded. Scharadin & Jaenicke (2020) argues that the time used in activities that can affect diet quality could also be a strong determinant of dietary quality. In this chapter, we study the association between time allocation to different food related activities and a household's dietary quality.

To the best of our knowledge, only four studies have examined the relationship between time spent for food related activities and diet quality: Mancino & Gregory 2012; Monsivais et al. 2014; Wolfson & Bleich 2015; Rogus (2018), with mixed results. Mancino & Gregory (2012) and Rogus (2018) used, respectively, daily and weekly Healthy Eating Index (HEI) to measure diet quality. The HEI is a direct measure of diet quality, capturing how well the diet is aligned with DGA's key recommendations (Food and Nutrition Service, 2020). [31] While Mancino & Gregory (2012) found no evidence of an association between diet quality and time spent cooking, Rogus (2018) found a negative association for high-income households, and no association for low-income households. The other two studies (Monsivais et al. 2014; Wolfson & Bleich 2015) used other indicators of diet quality: 1) frequency of consuming fast-food or pizza, 2) ready-to-eat meals and frozen meals, and 3) dollars spent on eating out and food-at-home (FAH). Their findings indicate the existence of positive associations between those indicators and time spent cooking. Assessing the relationship between time spent cooking (or it's proxies) and average dietary quality, instead of taking into account the diverse behavior of households across the distribution of HEI, could drive these mixed results. Also, a major limitation in these four studies is data availability, leading the authors to have used proxies for food-related time use, which means that the four studies used different measurements of, and proxies for, food-related time use, which may have contributed to the mixed results (Rogus, 2018). Monsivais et al. (2014)'s approach was to stratify the sample into 3 groups

[31] In addition to HEI, Mancino & Gregory (2012) used other indicators of diet quality such as daily energy density, and consumption of fruits, whole grain, vegetables, saturated fat, and sodium.

based on time spent on food preparation and cleanup (less than 1 hour per day, 1–2 hours per day, and greater than 2 hours per day) and compare indicators of diet quality across those groups. Mancino & Gregory (2012) used minutes spent in primary food preparation per day as the time-use variable, while Wolfson & Bleich (2015) used the frequency of cooking dinner per week (low (0–1), medium (2–5) and high (6–7)) as a proxy for time spent on food preparation. Further, Rogus (2018) exploited three variables to represent time constraint: two of them are direct measures of food-related time use - an indicator variable equals one if the respondent stated they were too busy to prepare healthy food, and minutes spent traveling to and from food acquisitions - and the third is an indirect measure - minutes spent traveling to and from work.

The objective of this chapter is to study the association between households' diet quality (HEI) of food acquisitions, and time allocated to different food related activities - eating and drinking, food preparation, presentation, kitchen clean-up, grocery shopping, purchasing food-away-from-home (FAFH), and aggregated variables which combine them. We analyze this association for three sub-samples of households - 1) households participating in the SNAP program, 2) SNAP-eligible households that do not participate in the program, and 3) SNAP-ineligible households. Our rationale behind sub-sampling households by SNAP participation/eligibility is that these households may act differently in acquiring meals due to their dissimilar income and time constraints (Mancino & Newman, 2007).

Our main contribution to the literature investigating the association between food related time use and diet quality is that, instead of focusing on the association between the (conditional) mean diet quality (HEI) and time spent on food activities, we assess how this relationship varies across the distribution of HEI. To achieve this goal, we apply the Unconditional Quantile Regression (UQR) estimator proposed by Firpo et al. (2009) to a unique data set created by merging the 2012 American Time Use Survey (ATUS) with the National Household Food Acquisition and Purchase Survey (FoodAPS) data. The data were combined using the method developed by You & Davis (2019). This method consists of predicting the amount of time allocated to food related activities in a given day of the week, aggregated at the weekly level. Then, following Hamermesh (2008) and You & Davis (2019), we match individuals in ATUS and FoodAPS using propensity scores assigned based on the characteristics of the individuals, households, and location.

This chapter proceeds as follows: first, we illustrate our empirical approach to assess the association between diet quality and food-related time use, followed by description of the data, the variables used in the estimation, with a focus on the categories of food-related activities. Then we discuss the empirical results and their policy implications. Finally, concluding remarks, limitations and future research avenues are discussed.

## 3.2 Empirical Methods

The objective of this chapter is to study the association between households' diet quality measured by their food acquisitions HEI, and time allocated to different food related activities. Apart from time, other factors are known to affect households' eating behavior and therefore HEI (Mancino & Gregory 2012; Rogus 2018; Cleary et al. 2020). Thus, we assume HEI to be a function of a series of covariates as in the equations below:

$$HEI_i = f(TimeF_i, Exercise_i, HH_i, Month_i, State_i|\beta) + \varepsilon_i \tag{3.1}$$

where, $HEI_i$ is the HEI of the $i^th$ household, $TimeF_i$ is a vector of variables capturing time allocated to food-related activities by household $i$; $Exercise_i$ is a measure of time allocated to exercise, sports, and recreational activities; $HH_i$ is a vector of demographic and other characteristics of the household $i$; $Month_i$ is a vector of indicator variables representing the month the FoodAPS survey was conducted for the $i^th$ household; $State$ is a vector of indicator variables representing the state household $i$ is located in; $\beta$ is a vector of coefficients to be estimated, and $\varepsilon_i$ represents a vector of unexplained variation in $HEI$.

### 3.2.1 Model specifications and time use measures

Since the relationship between food-related activities and HEI can differ in magnitude and direction, in the first specification (Specification 1) the vector $TimeF$ includes nine food-related activities ($Act\ Time_a$)[32].

$$HEI_i = \sum_{a=1}^{9} \beta_a^{time} (Act\ Time)_{ai} + \beta^{exer} Exercise_i + \sum_{h=1}^{H} \beta_h^{HH} HH_{hi} + \beta^m Month_i + \beta^s State_i + \varepsilon_i \tag{3.2}$$

A household's amount of time allocated to one specific food-related activity is likely correlated to the time spent in others [33]. For instance, if households spend more time in cooking food at home, they may need to spend more time in cleaning the kitchen as well. To account for the joint variability of the food related activities variables, we aggregate them in fewer covariates by using principal component analysis (PCAs), as discussed in more detail in section 3.3.1. Thus, Specification 2 is.

$$HEI_i = \sum_{p=1}^{3} \beta_p^{time} (PC\ Time)_{pi} + \beta^{exer} Exercise_i + \sum_{h=1}^{H} \beta_h^{HH} HH_{hi} + \beta^m Month_i + \beta^s State_i + \varepsilon_i \tag{3.3}$$

$PC\ Time_p$ are standardized Principal Components (PCs) varying from 0 to 100. Even though, $PC\ Time_p$ account for the correlation between different activities, the resulting activity-combinations could be more statistics driven. Thus, $\beta_p^{time}$ reflects the association between HEI and time allocated to different combinations of food related activities, when the $PC\ Time_{pi}$ moves from 0 - the "worst" combination - to 100 - the "best" combination, hence, its interpretation from a policy perspective may be unclear. Following the same aggregation suggested by the PCA results, we combine time allocation variables showing common variance to represent broader categories

[32] Because we test multiple hypotheses related to single estimated parameters here, we will conduct relevant statistical corrrects/ tests such Bonferroni correction and Wolf test in latter versions of this study

[33] See Table A.1. in the appendix for correlations between 9 food-related activities.

of food-related activities, which is both more intuitive, and leads to estimates more conducive to policy recommendations. Thus, in Specification 3, we use 4 aggregates of food-related activities ($Aggr\ Time_g$) along with $Exercise$, based on PCA results, as discussed in section 3.3.1. Specification 3 is,

$$HEI_i = \sum_{g=1}^{4} \beta_g^{time} (Aggr\ Time)_{gi} + \beta^{exer} Exercise_i + \sum_{h=1}^{H} \beta_h^{HH} HH_{hi} + \beta^m Month_i + \beta^s State_i + \varepsilon_i. \tag{3.4}$$

### 3.2.2 Estimation

The relationship between time use, other covariates, and HEI can be heterogeneous across the distribution of HEI (Asirvatham 2009; Cleary et al. 2020; Smith 2017; Vidoni et al. 2019). Our goal is to investigate how the relationship between a household's diet quality and time allocated to different food related activities vary across the spectrum of diet quality, captured by their food acquisition HEI.

Both Conditional and Unconditional Quantile Regressions allow for assessing the impact of a covariate on an outcome variable across its distribution (or at different quantiles). However, a major limitation of using Conditional Quantile Regression is that the estimated effect of a covariate of interest on the outcome variable at a given quantile is measured conditionally on a specific level of the covariate, while keeping other covariates at their mean levels (Borah & Basu, 2013). Hence, any estimated effects will vary with both the levels of the covariates, and with alternative sets of covariates included in the model. The Unconditional Quantile Regression (UQR) estimator, instead, allows calculating the ceteris paribus unconditional effect of a covariate on the outcome variable at given quantiles; in other words, the estimated effects do not vary depending upon the value (and selection) of the covariates included in the model (Firpo et al., 2009). Further, using UQR, the estimated coefficients can be interpreted directly as the effect of a unit change in an explanatory variable on the unconditional distribution of the outcome variable (Firpo et al., 2009), that is its marginal effect.

Thus, we opt for using the UQR estimator proposed by (Firpo et al., 2009), based on the concepts of influence function and re-centered influence function. We estimate the parameters in Equations 3.2, 3.3, and 3.4 using the rifreg STATA package developed by (Firpo et al., 2009). Since correct analytical standard errors of the UQR are complex, we use 200 bootstrap replications to approximate them.

We study the relationship between diet quality and food-related time use for 3 sub-samples of households separately. The three sub-samples are - 1) households participating in the SNAP program - henceforth SNAP participants, 2) households which are eligible to participate in SNAP but do not participate - henceforth SNAP-eligible nonparticipants, and 3) households which are not eligible to participate in the SNAP program - henceforth SNAP ineligible households. Our rationale behind sub-sampling households by SNAP participation/eligibility is that these households may act differently in acquiring meals due to their dissimilar income and time limitations (Mancino & Newman, 2007). Further, analyzing these sub-samples shed light on the effectiveness of potential interventions or policy designs to improve diet quality of household members belong to each household group separately.

## 3.3 Data

The data used in this analysis come mainly from two sources: FoodAPS and ATUS. Specifically, we use food-at-home (FAH) HEI scores[34] and other covariates (i.e. household characteristics) from FoodAPS. Households' time allocated to food-related activities and exercise are obtained from ATUS via a two-part model similar to section 2.3.1 in Chapter 2.

[34]We use the methods used by Cleary et al. (2020) to estimate FAH HEI. See Section 3.3.2 for more details.

### 3.3.1 Time Allocation Variables

We use data from the 2012 ATUS time diaries to measure time spent on different food-related activities and exercise. In our analysis we consider the following nine food-related time categories:

- food and drink preparation (ATUS Code 020201),
- food presentation (ATUS Code 020202),
- kitchen and food clean-up (ATUS Code 020203),
- grocery shopping (ATUS Code 070101),
- travel for grocery shopping (ATUS Code 180701),
- purchasing food -not groceries- (ATUS Code 070103),
- waiting associated with eating and drinking (ATUS Code 110201),
- travel related to purchasing food -not groceries- (ATUS Code 180703), and
- eating and drinking (ATUS Code 110100).

For time allocated to exercise, we use the time category "sports, exercise, and recreation" (ATUS Code 130000).

Similar to the analysis performed in Chapter 2, we follow You & Davis (2019) to estimate weekly time allocation for each activity using a two-part model. Then we match individuals in ATUS with FoodAPS household heads and their spouses or partners, using propensity score matching (nearest neighbor matching) similar to Hamermesh (2008). Out of the 4,826 households included in FoodAPS (ERS 2019a), 4,206 were retained in the data after matching.

In model specification 1 ($Act\ Time_a$), we include the above-mentioned nine food-related activities, along with time allocated to exercise ($Exercise$). The nine activities are $food\ preparation$, $food\ presentation$, $kitchen\ clean-up$, $grocery\ shopping$, $grocery\ travel$, $FAFH\ purchase$, $FAFH\ waiting$, $FAFH\ travel$, and $eat\ drink$. All time use variables are measured in hours/week per household.

For the second specification, we calculate the principal components (PCs) of time allocations ($PC\ Time_p$) for each sub-sample of household using Principal Component Analysis (PCA). We retain the factors with eigenvalues greater than 1 (Kaiser's rule) and use the "promax" rotation to the matrix of factor loadings. We then calculate standardized PCs by dividing the difference between a factor and its minimum value, by the factor's range of values (maximum value - minimum value), then multiplied by 100. The PC factor loadings of SNAP participants, SNAP eligibles, and SNAP non-eligibles are reported in Table 3.1.

For SNAP participants, the food-preparation activity variables showing the highest loadings on factor 1 are related to FAH acquisition and preparation ($food\ preparation$, $food\ presentation$, $kitchen\ clean-up$, $grocery\ shopping$, and $grocery\ travel$). Factors 2's highest loadings are on time spent on FAFH acquisition ($FAFH\ purchase$, $FAFH\ waiting$, $FAFH\ travel$) and eating in general ($eat\ drink$). Hence, SNAP participants' standardized PC based on factor 1 is $FAH_{PC}^{SP}$, and based on factor 2 is $FAFH\_eat_{PC}^{SP}$. For SNAP-eligible nonparticipants, food-related activities with the highest loadings on factors 1 are those related to eating in addition to FAH acquisition and preparation. Factors 2's highest loadings are for FAFH related activities. Thus, SNAP-eligible nonparticipants' standardized PCs generated using factor 1 and 2, respectively, are $FAH\_eat_{PC}^{IE}$, and $FAFH_{PC}^{IE}$. Following Kaiser's rule, while only 2 factors were retained for SNAP participants and SNAP-eligible nonparticipants, for the SNAP-ineligible sub-sample, 3 factors presented eigenvalues greater than 1. The Highest loadings on the first factors of SNAP-ineligibles are related to FAH acquisition, and eating ($grocery\ shopping$, $grocery\ travel$, and $eat\ drink$). The second factor is more related to FAH preparation and waiting for FAFH ($food\ preparation$, $food\ presentation$, $kitchen\ clean-up$, and $FAFH\ waiting$). The third factor's highest loadings are on time to travel and purchase FAFH ($FAFH\ travel$ and $FAFH\ purchase$). Hence, SNAP-ineligible households' PCs based on factor 1, 2, and 3, are $FAHshop\_eat_{PC}^{II}$, $FAHprepFAFHwait_{PC}^{II}$, and $FAFHpurch\_trvl_{PC}^{II}$, respectively. For all subgroups, we include $exercise$ (measured in hours/ week per household) as a separate time category in addition to the PCA based time categories.

**Table 3.1:** Principal component analysis; Variable loadings on the rotated retained factors. Panel (a) SNAP participant households; Panel (b) SNAP-eligible nonparticipant households; and Panel (c) SNAP-ineligible households.

**(a)** Variable loadings: SNAP participant households sub-sample.

| Variable | Factor 1 | Factor 2 |
|---|---|---|
| food preparation | 0.8305 | -0.1908 |
| food presentation | 0.7170 | -0.1075 |
| kitchen clean-up | 0.8258 | -0.1040 |
| grocery shopping | 0.5585 | 0.1956 |
| grocery travel | 0.5522 | 0.2465 |
| FAFH purchase | -0.1634 | 0.9580 |
| FAFH waiting | 0.2278 | 0.3897 |
| FAFH travel | -0.0683 | 0.9419 |
| eat drink | 0.2652 | 0.3395 |

**(b)** Variable loadings: SNAP-eligible nonparticipant households sub-sample.

| Variable | Factor 1 | Factor 2 |
|---|---|---|
| food preparation | 0.8012 | -0.1138 |
| food presentation | 0.7129 | -0.1578 |
| kitchen clean-up | 0.8673 | -0.1942 |
| grocery shopping | 0.5196 | 0.2687 |
| grocery travel | 0.5187 | 0.3245 |
| FAFH purchase | -0.1764 | 0.9560 |
| FAFH waiting | 0.2883 | 0.3128 |
| FAFH travel | -0.0930 | 0.9466 |
| eat drink | 0.3160 | 0.2905 |

**(c)** Variable loadings: SNAP-ineligible households sub-sample.

| Variable | Factor 1 | Factor 2 | Factor 3 |
|---|---|---|---|
| food preparation | 0.1849 | 0.6863 | -0.1153 |
| food presentation | -0.2026 | 0.8869 | 0.1004 |
| kitchen clean-up | 0.0713 | 0.8178 | -0.0592 |
| grocery shopping | 0.8763 | -0.0234 | -0.0632 |
| grocery travel | 0.8572 | -0.0257 | 0.0513 |
| FAFH purchase | -0.0500 | -0.0193 | 0.9255 |
| FAFH waiting | 0.2449 | 0.2756 | 0.1919 |
| FAFH travel | 0.0494 | 0.0003 | 0.8848 |
| eat drink | 0.5843 | -0.0562 | 0.0380 |

For specification 3, we aggregate food-related activities ($Aggr\ Time_g$) based on loadings reported in 3.1. $food\ preparation$, $food\ presentation$, and $kitchen\ clean-up$ are grouped together for all sub-samples. Thus, the first aggregated time category is the total time allocated to FAH preparation - $Total\ FAHprep$ - that was generated by combining time allocated to $food\ preparation$, $food\ presentation$, and $kitchen\ clean-up$ . $grocery\ shopping$ and $grocery\ travel$ are aggregated to generate total time allocated to purchasing FAH - $Total\ FAHshop$. Total time allocated to purchasing FAFH is the third aggregated time category- $Total\ FAFHpurch$ - which is created by combining $FAFH\ purchase$, $FAFH\ waiting$, $FAFH\ travel$. Since, $eat\ drink$ does not show a clear correlation pattern with other activities across the sub-samples, we keep $eat\ drink$ as a separate time variable in specification 3. Further, similar to specification 1 and 2, we use $exercise$ as separate category. Hence, 5 time categories are used in specification 3.

The summary statistics of the time-use variables are reported in Table 3.2. Note that time-use variables based on PCA in Specification 2 ($FAH_{PC}^{SP}$, $FAFH\_eat_{PC}^{SP}$, $FAH\_eat_{PC}^{IE}$, $FAFH_{PC}^{IE}$, $FAHshop\_eat_{PC}^{II}$, $FAHprepFAFHwait_{PC}^{II}$, and $FAFHpurch\_trvl_{PC}^{II}$) vary on a 0 to 100 scale. Other time allocation variables are in hours / week per household.

### 3.3.2 Dependent Variable - HEI

The nationally representative FoodAPS dataset records households' total food purchases and acquisitions. We use FAH scores calculated for households in FoodAPS as the dependent variable. Because FoodAPS data were collected between April 2012 and January 2013, we use the HEI-2010 - measuring diet quality relative to the adherence to the 2010 DGA (Vadiveloo et al., 2020) - to measure a household's dietary quality. Specifically, the HEI-2010 is a measure of adherence to nine adequacy components [35] (which includes total fruit, whole fruit, total vegetables, greens and beans, whole grains, dairy, seafood and plant proteins, total protein foods, and fatty acids) and three moderation components (i.e. refined grains, sodium, and empty calories) Guenther et al.

[35] First, we measured the quantity of acquired food related to each component in kilo carolies, and then we assigned a score for each component based on every 1000 kcal acquired. See National Cancer Institute (2022) for more details.

**Table 3.2:** Summary statistics: household time allocation variables.

| Variable | SNAP participants[a] | | SNAP-eligible nonparticipants[b] | | SNAP-ineligibles[c] | |
|---|---|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. | Mean | S.D. |
| food preparation | 2.954 | 2.958 | 2.840 | 2.868 | 3.001 | 2.854 |
| food presentation | 0.019 | 0.022 | 0.016 | 0.019 | 0.017 | 0.019 |
| kitchen clean-up | 0.638 | 0.652 | 0.631 | 0.613 | 0.665 | 0.587 |
| grocery shopping | 0.389 | 0.320 | 0.388 | 0.316 | 0.457 | 0.357 |
| grocery travel | 0.208 | 0.131 | 0.215 | 0.136 | 0.252 | 0.159 |
| FAFH purchase | 0.075 | 0.051 | 0.074 | 0.052 | 0.095 | 0.068 |
| FAFH waiting | 0.008 | 0.007 | 0.008 | 0.007 | 0.009 | 0.006 |
| FAFH travel | 0.168 | 0.091 | 0.166 | 0.094 | 0.201 | 0.107 |
| eat drink | 9.306 | 6.692 | 10.002 | 7.578 | 11.745 | 8.280 |
| exercise | 1.083 | 0.967 | 1.202 | 1.228 | 1.498 | 1.319 |
| $\text{FAH}_{PC}^{SP}$ | 21.543 | 14.956 | | | | |
| $\text{FAFH\_eat}_{PC}^{SP}$ | 18.012 | 11.703 | | | | |
| $\text{FAH\_eat}_{PC}^{IE}$ | | | 17.800 | 12.677 | | |
| $\text{FAFH}_{PC}^{IE}$ | | | 20.134 | 12.726 | | |
| $\text{FAHshop\_eat}_{PC}^{II}$ | | | | | 13.550 | 8.520 |
| $\text{FAHprepFAFHwait}_{PC}^{II}$ | | | | | 18.176 | 14.253 |
| $\text{FAFHpurch\_trvl}_{PC}^{II}$ | | | | | 15.841 | 8.797 |
| Total FAHprep | 3.796 | 4.353 | 3.878 | 4.298 | 3.874 | 3.892 |
| Total FAHshop | 0.610 | 0.411 | 0.617 | 0.411 | 0.721 | 0.441 |
| Total FAFHpurch | 0.278 | 0.171 | 0.277 | 0.182 | 0.336 | 0.187 |

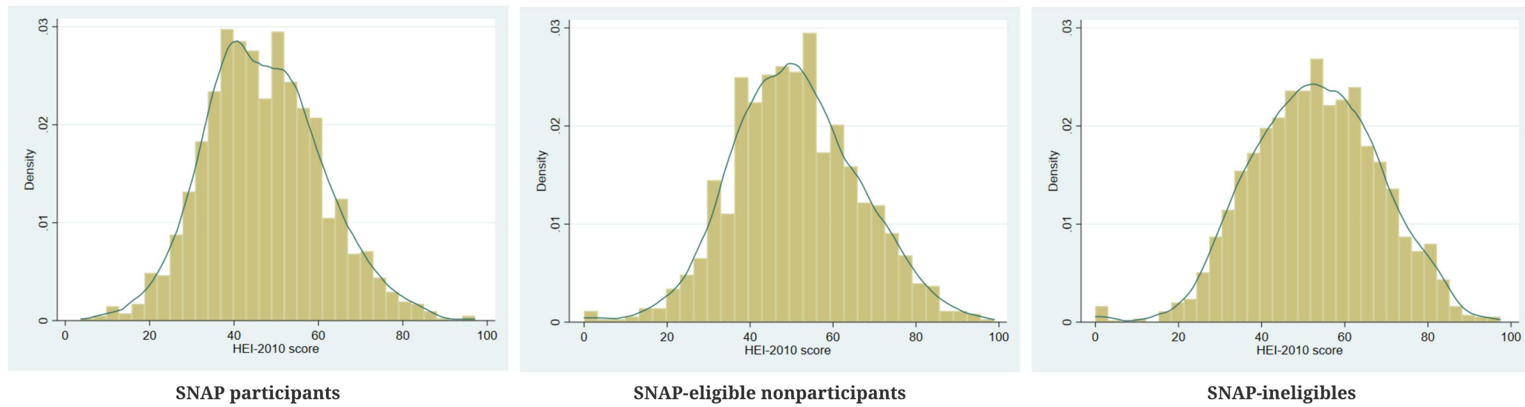
Source: Authors' elaboration on ATUS data. [a]N=1348; [b]N=1057; [c]N=1801.
$\text{FAH}_{PC}^{SP}$, $\text{FAFH\_eat}_{PC}^{SP}$, $\text{FAH\_eat}_{PC}^{IE}$, $\text{FAFH}_{PC}^{IE}$, $\text{FAHshop\_eat}_{PC}^{II}$, $\text{FAHprepFAFHwait}_{PC}^{II}$,$\text{FAFHpurch\_trvl}_{PC}^{II}$ vary on a scale of 0-100. Other variables are in hours/week per household.

(2014).The maximum achievable HEI score is 100, and higher scores indicate closer adherence to the DGA, hence, better diet quality.

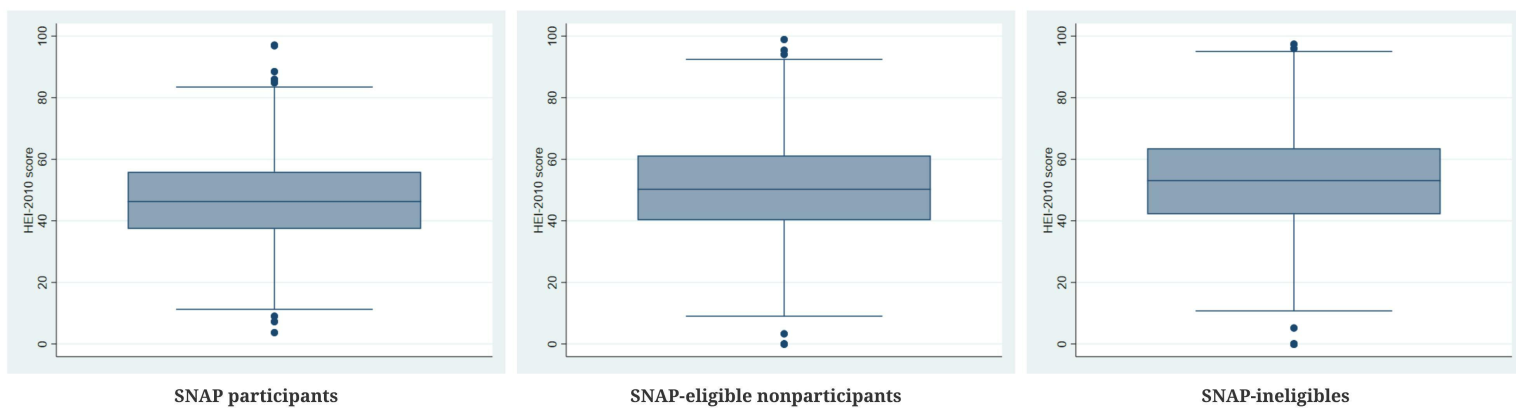
Figure 3.1a shows the frequency distribution of HEI scores for SNAP participant, SNAP-eligible nonparticipant, and SNAP-ineligible households, and 3.1b shows the descriptive statistics of those household subgroups. The histogram of SNAP participant households seems skewed to left-side compared to other two subgroups of households, suggesting on average, SNAP participant households' dietary quality is lower than the SNAP-eligible nonparticipant and SNAP-ineligible households.

The mean HEI scores of SNAP participant households is 47.03; for SNAP-eligible nonparticipants it is 50.98, and 52.96 for SNAP-ineligible households. The descriptive statistics in the box plot also provides evidence for this pattern. In addition, figure 3.1a clearly shows that the three subgroups of households' distributions of HEI scores are different[36], supporting our decision to 1)sub-sample households by SNAP recipients/eligibility, and 2) use UQR for the analysis.

[36]We test the difference between the distributions of HEI scores of the three household sub-samples by applying the Kolmogorov-Smirnov test, and found that the three distributions are statistically significantly different from each other (with P-value <0.001).




**(a)** Frequency distribution and kernel density estimation of HEI scores for SNAP participant, SNAP-eligible nonparticipant, and SNAP-ineligible households




**(b)** Box-plots of HEI scores for SNAP participant, SNAP-eligible nonparticipant, and SNAP-ineligible households

**Figure 3.1:** Frequency distribution and kernel density estimation (top panel), and Box-plots (bottom panel) of HEI scores for SNAP participant, SNAP-eligible nonparticipant, and SNAP-ineligible households.

Source: Authors' elaborations on FoodAPS data

### 3.3.3 Control Variables

Following previous studies on household diet quality and time use, we use a set of household characteristics as controls in our model (Mancino & Gregory 2012; Rogus 2018; Cleary et al. 2020): household size ($HH\ Size$); an indicator variable capturing the presence of children in the household below 18 years of age ($Children$); A set of indicator variables representing the racial/ethnic group household members' belong to (Hispanic - $Hisp\ HH$; Black/African American - $Black\ HH$ ; Asian - $Asian\ HH$; "other" including multiple races- $Others\ HH$; excluded group is White - $White\ \ HH$); indicator variables capturing the education level of the highest educated household member (high school grad - $High\ School$, college education - $College$, bachelor's degree - $Bachelors$, and master's degree or higher $Postgraguate$; excluded group is less than high school $Less\ HS$); number of household members who are working ($Working$); indicator variables capturing homeownership ($Own\ \ Home$); or if a household living situation involves arrangements other than ownership or renting which does not require payments ($Oth\ HomeOwn$) - renting is the excluded category ($Rent\ \ Home$); an indicator variable capturing having vehicles in the household ($Vehicle$); and an indicator variable representing household being located in a non-metro area ($Nonmetro$). Summary statistics of the household characteristics are in Table 3.3.

The FoodAPS survey was conducted between April 2012 and January 2013 and each household participated in the data collection activities for one week during the time period the survey was conducted. Thus, households' food acquisition response may depend on the time they faced the survey. For instance, a household's food acquisition decision in December may differ from the same household's decisions in May. Further, these decisions may depend on other geographic factors that are time invariant. To control for those time-variant and invariant factors that may affect households' food acquisition decisions, we include, respectively, a set of indicator variables for each calendar month during which the FoodAPS data were collected, and state-level fixed effects.

**Table 3.3:** Weighted summary statistics of the control variables.

| Variable | SNAP participants | | SNAP-eligible non-participants | | SNAP-ineligibles | |
|---|---|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. | Mean | S.D. |
| HH Size | 2.943 | 1.873 | 2.233 | 1.599 | 2.431 | 1.358 |
| Children | 0.491 | 0.500 | 0.261 | 0.439 | 0.314 | 0.464 |
| Hisp HH | 0.271 | 0.444 | 0.211 | 0.408 | 0.099 | 0.299 |
| White HH | 0.640 | 0.480 | 0.691 | 0.462 | 0.772 | 0.418 |
| Black HH | 0.250 | 0.433 | 0.122 | 0.328 | 0.077 | 0.266 |
| Asian HH | 0.008 | 0.088 | 0.037 | 0.190 | 0.038 | 0.191 |
| Others HH | 0.161 | 0.367 | 0.093 | 0.290 | 0.081 | 0.273 |
| Less HS | 0.184 | 0.388 | 0.107 | 0.309 | 0.022 | 0.147 |
| High School | 0.356 | 0.479 | 0.253 | 0.435 | 0.154 | 0.361 |
| College | 0.334 | 0.472 | 0.338 | 0.473 | 0.326 | 0.469 |
| Bachelors | 0.097 | 0.296 | 0.167 | 0.373 | 0.272 | 0.445 |
| Postgraguate | 0.028 | 0.166 | 0.134 | 0.341 | 0.225 | 0.418 |
| Working | 0.736 | 0.868 | 0.846 | 0.926 | 1.239 | 0.935 |
| Own Home | 0.620 | 0.486 | 0.394 | 0.489 | 0.272 | 0.445 |
| Rent Home | 0.323 | 0.468 | 0.577 | 0.494 | 0.712 | 0.453 |
| Oth HomeOwn | 0.057 | 0.232 | 0.029 | 0.168 | 0.016 | 0.127 |
| Vehicle | 0.731 | 0.444 | 0.829 | 0.377 | 0.949 | 0.219 |
| Nonmetro | 0.142 | 0.349 | 0.135 | 0.342 | 0.136 | 0.343 |

Source: Authors' elaboration on FoodAPS data.

## 3.4 Results

In this section, we present and discuss results focusing on the association between HEI and time variables. For brevity, we only report the estimated OLS and UQR coefficients of the time-use variables for all the specifications, while estimated coefficients of the control variables specifications are reported in the Appendix[37]. Estimated time use coefficients of the time-use variables for Specification 1 are reported in Figure 3.2, and Table 3.4; those for Specification 2 in Figure 3.3, and Table 3.5; and Specification 3's in Figure 3.4, and Table 3.6. In all figures, OLS coefficients are shown as solid green lines; solid red lines are the estimated UQR coefficients; and shaded gray areas represent the 95$\%$ confidence intervals of the UQR coefficients. In all tables, OLS coefficients along with UQR coefficients for selected quantiles ($5^th$, $15^th$, $25^th$, $50^th$, $75^th$, $85^th$ and $95^th$) are reported.

[37]Please see Appendix Tables A.2., A.3., and A.4. for the full set of estimated parameters.

### 3.4.1 Empirical Results: Specification 1

OLS and UQR coefficients for SNAP participant, SNAP-eligible nonparticipant, and SNAP-ineligible households are depicted, respectively, in the left, middle, and right column of Figure 3.2. While FAH preparation and acquisition related activities' ($food\ preparation$, $food\ presentation$, $kitchen\ clean-up$, $grocery\ shopping$, and $grocery\ travel$) coefficients are in Figure 3.2.a, FAFH related activities' ($FAFH\ purchase$, $FAFH\ waiting$, $FAFH\ travel$) coefficients and those of $eat\ drink$, and $exercise$ are reported in Figure 3.2.b. OLS and UQR coefficients for selected quantiles are further reported in Table 3.4 for SNAP participant (top panel), SNAP-eligible nonparticipant (middle panel), and SNAP-ineligible (bottom panel) households.

Specification 1's UQR results for SNAP participants do not show any statistically significant relationship between HEI and the nine food-related time-use variables or time spent exercising. While most of the estimated time coefficients do not depict a clear pattern in their association with HEI, $food\ preparation$ shows a positive association with HEI at the lower HEI quantiles (except the $15^{th}$) and a negative association at the higher HEI quantiles. Instead, the UQR coefficients of $exercise$ are only positive at the $25^{th}$ and $50^{th}$ HEI quantiles.

Differently from SNAP participants, for SNAP-eligible nonparticipants, $food\ preparation$ show a negative association with HEI at the lower HEI quantiles and a positive association at higher HEI quantiles. However, those associations are not statistically significant. $kitchen\ clean-up$ has a positive and a statistically significant association (an estimated coefficient of 3.37) at the $5^{th}$ HEI quantile, but the coefficients become negative (and not statistically significant) at higher quantiles. Although the OLS coefficient for time spent grocery shopping is positive but not statistically significant, UQR's results show evidence of a positive association between grocery shopping time and HEI up until the $50^{th}$ HEI quantile (statistically significant at the $25^{th}$ HEI quantile with a magnitude of 3.96), then becomes negative (and statistically significant in $95^{th}$ HEI quantile). Time allocated to $exercise$ show a negative relationship with HEI at lower HEI quantiles (statistically significant in the $5^{th}$ HEI quantile with a value of -2.47), but the relationship becomes positive from the $75^{th}$ HEI quantile onward. Similar to SNAP participants, the estimated OLS coefficients are not statistically significant for SNAP-eligible nonparticipant households. It should be noted that the OLS point estimates fall within the 95% confidence interval of the estimated UQR coefficient.

For SNAP-ineligible households, the estimated coefficients of $grocery\ travel$, $FAFH\ travel$ and $exercise$ show clear increasing patterns, and $food\ presentation$, and $FAFH\ purchase$ show decreasing patterns along the HEI distribution, although statistically significant only at limited HEI quantiles. The coefficients of $grocery\ shopping$ are positive at most quantiles and statistically significant in the $15^{th}$ HEI quantile with a value of 2.90. The association between $food\ preparation$ and HEI is not statistically different from zero, but shows an increasing pattern in magnitude along the HEI distribution. Although we find no evidence of a statistically significant association between time spent eating and HEI for SNAP participant and SNAP-eligible non-participant households, we do find positive and statistically significant relationships with SNAP-ineligible households' HEI (except the association is negative but not statistically significant in the $95^{th}$ HEI quantile) ranging from 0.11 to 0.18.

### 3.4.2 Empirical Results: Specification 2

Specification 2's estimated coefficients for SNAP participant, SNAP-eligible nonparticipant, and SNAP-ineligible households are presented in Figure 3.3's left, middle, and right column, respectively. OLS and UQR coefficients for selected quantiles are reported in Table 3.5 for SNAP participants (top panel), SNAP-eligible nonparticipants (middle panel), and SNAP-ineligible households (bottom panel).

For SNAP participating households, we do not find a statistically significant relationship between time allocated to FAH-related activities ($FAH_{PC}^{SP}$) and HEI. However, we note that the estimated coefficients are mostly negative, except for the highest ($85^{th}$ and $95^{th}$) HEI quantiles. For this group of households, we find that time spent eating is more correlated with activities related to FAFH. The UQR results suggest that time spent eating and for FAFH-related activities related ($FAFH\_eat_{PC}^{SP}$) has a positive and statistically significant association with HEI at the lower HEI quantiles, reaching values as large as 0.13.

For SNAP-eligible non-participants, the first standardized principal component which mainly consist of time spent eating and for FAH-related activities, does not show a statistically significant association with HEI, although the estimated OLS and UQR coefficients are mostly negative except at higher HEI quantiles. The estimated coefficients of $FAFH^{IE}_{PC}$ are negative, and statistically significant at the 75$^{th}$ and 85$^{th}$ HEI quantiles with magnitudes reaching -0.14. Consistent with Specification 1's results, $exercise$ is negatively related to HEI at lower HEI quantiles (statistically significant in the 5$^{th}$ HEI quantile), and positively related to HEI at higher quantiles, ranging from -2.45 to 0.92.

SNAP-ineligible households' $FAHshop\_eat^{II}_{PC}$ which comprises time spent acquiring FAH and eating, is positively associated with HEI in a statistically significant way at most quantiles, for coefficients ranging from 0.1 to 0.2. We do not find evidence of statistically significant relationships between HEI and $FAHprepFAFHwait^{II}_{PC}$ or $FAFHpurch\_trvl^{II}_{PC}$. However, $exercise$ shows a negative association with HEI at lower HEI quantiles, while turning to positive from the 25$^{th}$ HEI quantile onwards, although becoming statistically significant only at the 95$^{th}$ HEI quantile with a magnitude of 1.57.

### 3.4.3 Empirical Results: Specification 3

Estimated OLS and UQR food-related time activities coefficients for Specification 3 are illustrated in Figure 3.4, for SNAP participant (left column), SNAP-eligible nonparticipant (middle column), and SNAP-ineligible households (right column). Table 3.6 presents the OLS and UQR coefficients estimated at selected HEI quantiles for SNAP participants (top panel), SNAP-eligible nonparticipants (middle panel), and SNAP-ineligibles (bottom panel).

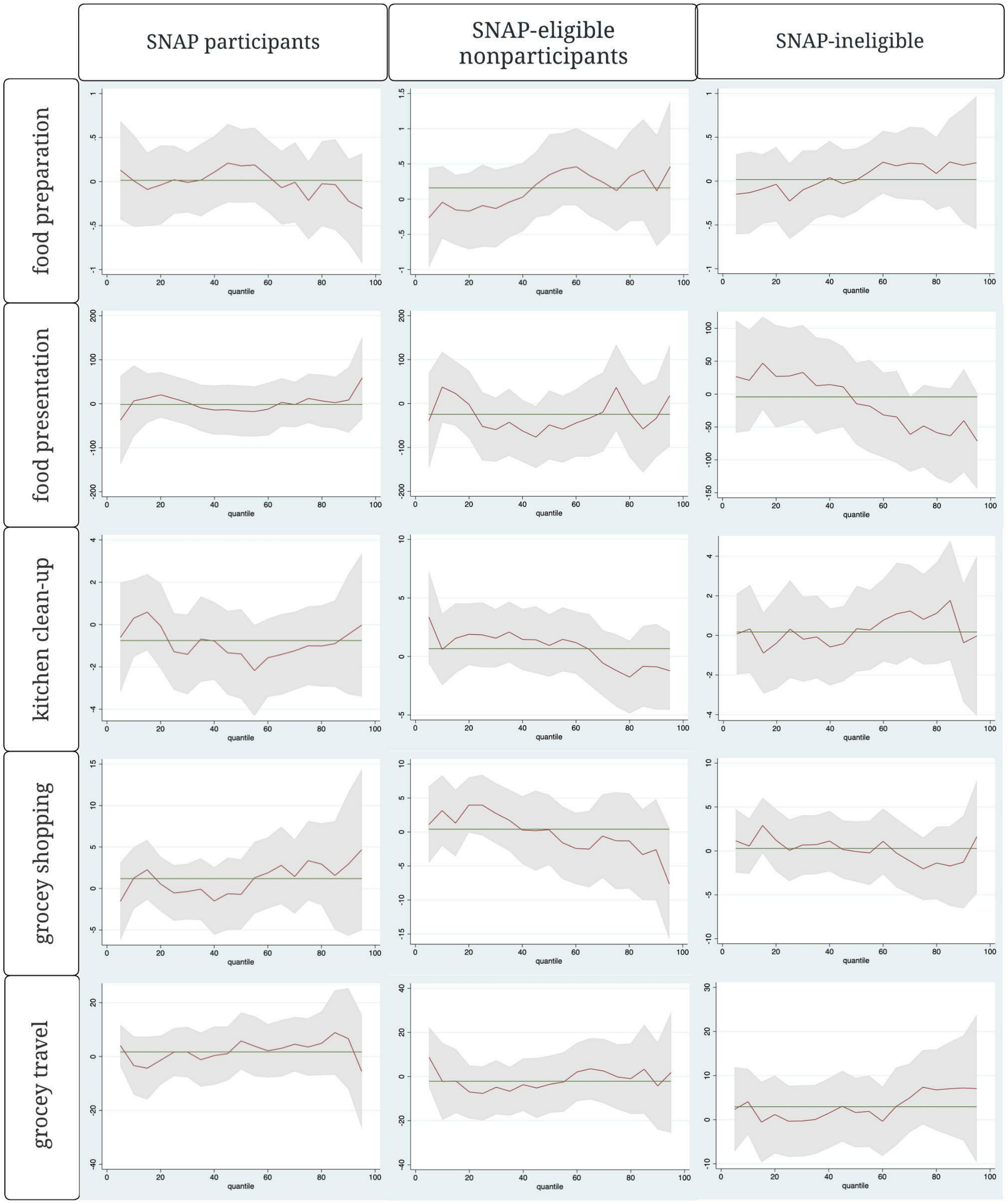
Consistent with the results of Specifications 1 and 2, Specification 3's estimated coefficients for SNAP-participants are also, for the most part, not statistically different from zero. Time spent food preparing ($Total\ FAHprep$) shows a negative relationship with HEI of SNAP-participants raging between -0.10 to -0.27, and this relationship is statistically significant at 25$^{th}$ and 75$^{th}$ HEI quantiles. We do not find a statistical significant association between $Total\ FAFHpurch$ and

HEI, however, its estimated coefficients are positive at the lower quantiles with values as large as 6.60. While the pattern of the relationship between $Total\ FAFHpurch$ and HEI seems to be decreasing in magnitude along the distribution of HEI, the relationship between $Total\ FAHshop$ and HEI shows somewhat an increasing pattern with higher HEI.

For SNAP-eligible non-participant households, estimated OLS and UQR coefficients of time spent preparing FAH ($Total\ FAHprep$) and eating ($eat\ drink$) are not statistically different from zero. The association between FAH acquisition ($Total\ FAHshop$) and HEI is positive at lower HEI quantiles - statistically significant at the $5^{th}$ quantile - and negative at higher HEI quantiles (with a statistically significant coefficient at the $95^{th}$ quantile), ranging from 4.48 to -5.32. Time spent acquiring FAFH has a negative relationship with HEI, ranging between -0.62 to -9.43; the OLS and UQR coefficients at the $25^{th}$, $75^{th}$, and $85^{th}$ HEI quantiles are statistically different from zero. For this sub-sample, $exercise$, again, resulted in estimates consistent with the other two model Specifications.

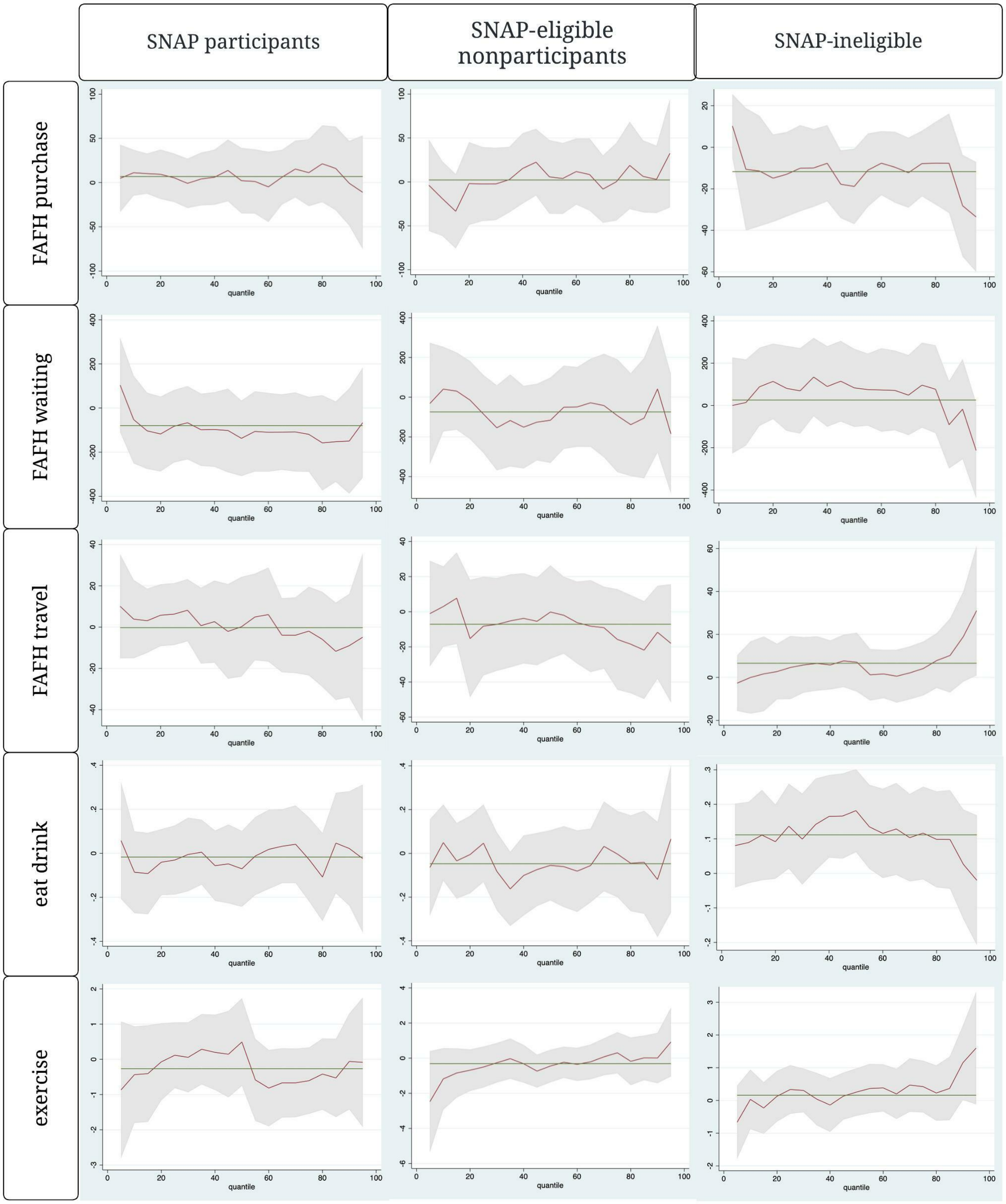
The estimated OLS coefficients of $Total\ FAHshop$ and $eat\ drink$ for SNAP-ineligible households are positive and statistically significant, and fall within the 95% confidence intervals of UQR estimates. Consistent with the OLS estimates, the UQR coefficients for $Total\ FAHshop$ and $eat\ drink$ are also positive and statistically significant in some quantiles. Although coefficients of time spent preparing FAH and acquiring FAH are negative for the most part, they are not statistically different from zero. The pattern of the association between $exercise$ and HEI obtained in specifications 1 and 2, persists in specification 3's results as well.

Our choice of utilizing UQR helped to measure the association between food-related time categories and HEI across the distribution of the latter. Mostly consistent with Rogus (2018), we do not find a relationship between food-related time categories and HEI for low-income (SNAP-participant and SNAP-eligible non-participant) households, looking at OLS results (except $Total\ FAFHpurch$ for SNAP-eligible non-participants). However, using UQR we find, for those two groups of households, some statistically significant associations between time-use and HEI at some HEI quantiles. It should be noted that, for SNAP-ineligible (or high-income) households, OLS coefficients fall between the 95% confidence intervals of UQR coefficients, and also show the statistically significant patterns of UQR estimates. This suggests that for SNAP-ineligible households, OLS coefficients represent a good approximation of the association between food-related time categories and HEI across its entire distribution.




**(a)**

**Figure 3.2:** Specification 1: Relationship between time variables related to FAH preparation and acquisition, and HEI. SNAP participants households, SNAP-eligible nonparticipant households and SNAP-ineligible households.




**(b)**

**Figure 3.2:** Specification 1: Relationship between time variables related to FAFH acquisition, eating and drinking, and exercise, and HEI. SNAP participants households, SNAP-eligible nonparticipant households and SNAP-ineligible households.

**Table 3.4:** Model Specification 1: Estimated OLS and UQR coefficients - time variables only. Panel (a) SNAP participant households; Panel (b) SNAP-eligible nonparticipant households; and Panel (c) SNAP-ineligible households.

**(a)** Estimated OLS and UQR coefficients of time variables of SNAP participant households.

| | **OLS** | **RIF Regressions** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **5** | **15** | **25** | **50** | **75** | **85** | **95** |
| food preparation | 0.014 | 0.129 | -0.089 | 0.021 | 0.179 | -0.215 | -0.035 | -0.305 |
| | (0.154) | (0.284) | (0.213) | (0.197) | (0.213) | (0.226) | (0.263) | (0.318) |
| food presentation | -1.584 | -37.450 | 13.018 | 11.570 | -16.347 | 12.067 | 2.633 | 58.606 |
| | (20.220) | (51.222) | (28.530) | (26.130) | (29.443) | (28.381) | (29.884) | (47.534) |
| kitchen clean-up | -0.756 | -0.607 | 0.587 | -1.281 | -1.389 | -1.004 | -0.902 | -0.027 |
| | (0.726) | (1.323) | (0.917) | (0.923) | (1.080) | (0.948) | (1.039) | (1.721) |
| grocery shopping | 1.185 | -1.550 | 2.256 | -0.536 | -0.705 | 3.354 | 1.569 | 4.673 |
| | (1.538) | (2.389) | (1.834) | (1.706) | (2.153) | (2.434) | (3.335) | (4.942) |
| grocery travel | 1.703 | 4.100 | -4.318 | 1.648 | 5.792 | 3.549 | 8.890 | -5.512 |
| | (3.867) | (3.924) | (5.939) | (4.513) | (5.382) | (5.431) | (7.981) | (10.719) |
| FAFH purchase | 6.902 | 4.770 | 10.106 | 5.442 | 2.179 | 11.229 | 15.975 | -11.011 |
| | (11.973) | (19.387) | (11.563) | (13.955) | (18.846) | (19.276) | (24.128) | (32.730) |
| FAFH waiting | -79.776 | 103.885 | -103.211 | -82.464 | -137.341 | -119.094 | -152.506 | -66.414 |
| | (65.055) | (109.036) | (88.083) | (83.834) | (87.068) | (86.418) | (92.896) | (127.330) |
| FAFH travel | -0.263 | 10.060 | 3.064 | 6.278 | 0.159 | -1.947 | -11.718 | -4.900 |
| | (7.157) | (12.848) | (7.921) | (7.641) | (12.314) | (10.935) | (12.023) | (20.703) |
| eat drink | -0.017 | 0.058 | -0.092 | -0.031 | -0.071 | -0.028 | 0.046 | -0.024 |
| | (0.063) | (0.135) | (0.094) | (0.080) | (0.088) | (0.097) | (0.116) | (0.172) |
| exercise | -0.264 | -0.868 | -0.405 | 0.116 | 0.492 | -0.605 | -0.528 | -0.085 |
| | (0.419) | (0.990) | (0.700) | (0.475) | (0.635) | (0.480) | (0.566) | (0.939) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively.

**(b)** Estimated OLS and UQR coefficients of time variables of SNAP-eligible nonparticipant households.

| | **OLS** | **RIF Regressions** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **5** | **15** | **25** | **50** | **75** | **85** | **95** |
| food preparation | 0.160 | -0.265 | -0.152 | -0.091 | 0.348 | 0.122 | 0.414 | 0.462 |
| | (0.201) | (0.360) | (0.254) | (0.297) | (0.292) | (0.295) | (0.367) | (0.474) |
| food presentation | -24.413 | -39.419 | 22.819 | -51.934 | -48.705 | 36.578 | -57.834 | 18.026 |
| | (30.883) | (55.719) | (37.444) | (39.734) | (40.032) | (50.088) | (50.732) | (58.923) |
| kitchen clean-up | 0.673 | 3.367 * | 1.557 | 1.850 | 0.944 | -1.195 | -0.841 | -1.218 |
| | (1.018) | (2.014) | (1.518) | (1.412) | (1.356) | (1.574) | (1.757) | (1.690) |
| grocery shopping | 0.410 | 1.076 | 1.308 | 3.960 * | 0.334 | -1.284 | -3.330 | -7.627 * |
| | (1.960) | (2.872) | (2.499) | (2.273) | (2.624) | (3.634) | (3.404) | (4.167) |
| grocery travel | -2.131 | 8.781 | -2.041 | -7.651 | -3.464 | -0.157 | 3.340 | 1.850 |
| | (4.840) | (6.923) | (7.377) | (6.248) | (6.591) | (7.497) | (10.325) | (13.957) |
| FAFH purchase | 2.141 | -3.848 | -33.390 | -2.381 | 5.726 | 0.188 | 6.238 | 32.473 |
| | (14.436) | (26.514) | (21.576) | (21.445) | (21.367) | (22.524) | (20.888) | (31.390) |
| FAFH waiting | -74.174 | -31.549 | 30.540 | -85.170 | -116.257 | -93.159 | -105.310 | -184.836 |
| | (80.803) | (155.656) | (99.114) | (100.173) | (109.656) | (144.886) | (154.685) | (153.126) |
| FAFH travel | -7.139 | -1.050 | 7.709 | -8.170 | -0.169 | -15.752 | -21.822 | -17.970 |
| | (8.664) | (15.323) | (13.289) | (14.318) | (13.552) | (14.589) | (14.182) | (17.147) |
| eat drink | -0.047 | -0.064 | -0.034 | 0.046 | -0.055 | -0.003 | -0.041 | 0.066 |
| | (0.069) | (0.112) | (0.088) | (0.090) | (0.082) | (0.100) | (0.120) | (0.172) |
| exercise | -0.313 | -2.474 * | -0.844 | -0.506 | -0.448 | 0.306 | 0.017 | 0.918 |
| | (0.399) | (1.466) | (0.714) | (0.593) | (0.473) | (0.597) | (0.645) | (0.998) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively.

**(c)** Estimated OLS and UQR coefficients of time variables of SNAP-ineligible households.

| | OLS | RIF Regressions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 15 | 25 | 50 | 75 | 85 | 95 |
| food preparation | 0.019 | -0.149 | -0.088 | -0.228 | 0.011 | 0.196 | 0.218 | 0.209 |
| | (0.146) | (0.234) | (0.201) | (0.220) | (0.185) | (0.211) | (0.254) | (0.387) |
| food presentation | -4.219 | 26.629 | 47.002 | 27.525 | -14.686 | -48.431 | -63.373 * | -71.403 * |
| | (23.694) | (43.429) | (36.040) | (37.301) | (31.715) | (31.817) | (36.816) | (37.140) |
| kitchen clean-up | 0.174 | 0.071 | -0.893 | 0.317 | 0.341 | 0.813 | 1.766 | -0.028 |
| | (0.777) | (1.034) | (1.041) | (1.257) | (1.104) | (1.164) | (1.536) | (2.056) |
| grocery shopping | 0.283 | 1.144 | 2.897 * | 0.071 | -0.072 | -2.043 | -1.718 | 1.602 |
| | (1.317) | (1.838) | (1.615) | (1.793) | (1.748) | (1.809) | (2.312) | (3.275) |
| grocery travel | 2.935 | 2.322 | -0.552 | -0.352 | 1.617 | 7.363 * | 7.022 | 7.045 |
| | (3.063) | (4.873) | (4.656) | (4.111) | (4.016) | (4.289) | (5.394) | (8.520) |
| FAFH purchase | -11.691 * | 10.248 | -11.441 | -13.021 | -18.851 ** | -7.837 | -7.709 | -33.554 ** |
| | (6.928) | (7.816) | (13.557) | (10.369) | (9.230) | (8.048) | (12.192) | (13.488) |
| FAFH waiting | 25.412 | 0.082 | 88.416 | 80.805 | 83.105 | 96.194 | -91.003 | -212.433 * |
| | (66.078) | (115.789) | (94.172) | (102.344) | (94.061) | (102.392) | (105.356) | (115.096) |
| FAFH travel | 6.568 | -2.655 | 1.648 | 4.620 | 7.085 | 4.167 | 10.195 | 31.085 ** |
| | (4.577) | (6.605) | (8.859) | (7.496) | (6.984) | (6.391) | (8.770) | (15.377) |
| eat drink | 0.112 ** | 0.081 | 0.111 * | 0.137 ** | 0.182 *** | 0.117 * | 0.098 | -0.020 |
| | (0.046) | (0.062) | (0.067) | (0.063) | (0.061) | (0.069) | (0.073) | (0.096) |
| exercise | 0.158 | -0.668 | -0.230 | 0.334 | 0.257 | 0.423 | 0.367 | 1.601 * |
| | (0.285) | (0.569) | (0.402) | (0.378) | (0.370) | (0.403) | (0.494) | (0.877) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively.

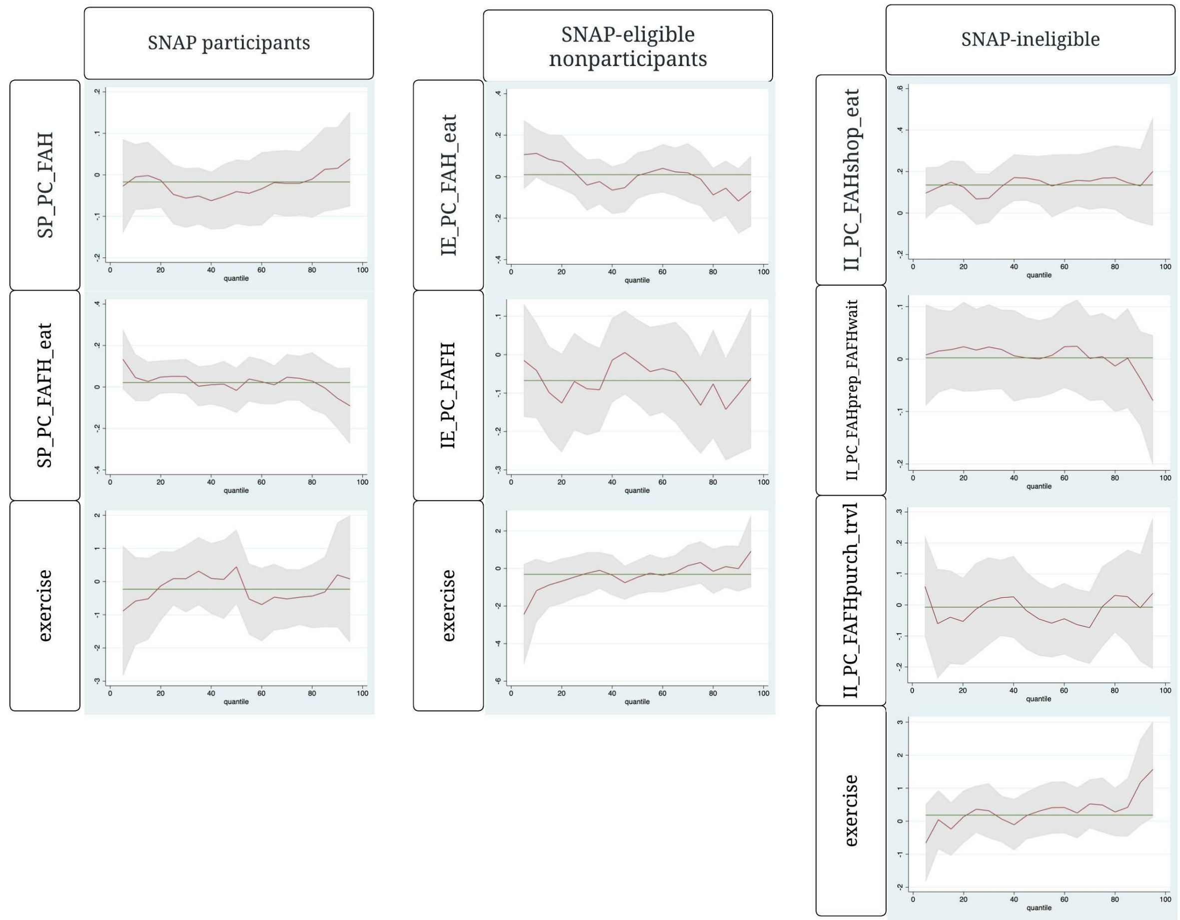



**Figure 3.3:** Specification 2: Relationship between time variables and HEI. SNAP participants households, SNAP-eligible nonparticipant households and SNAP-ineligible households.

**Table 3.5:** Model Specification 2: Estimated OLS and UQR coefficients - time variables only. Panel (a) SNAP participant households; Panel (b) SNAP-eligible nonparticipant households; and Panel (c) SNAP-ineligible households.

**(a)** Estimated OLS and UQR coefficients of time variables of SNAP participant households.

| | OLS | RIF Regressions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 15 | 25 | 50 | 75 | 85 | 95 |
| FAH$_{PC}^{SP}$ | -0.017 | -0.027 | -0.002 | -0.047 | -0.041 | -0.021 | 0.013 | 0.038 |
| | (0.029) | (0.058) | (0.041) | (0.037) | (0.039) | (0.039) | (0.052) | (0.058) |
| FAFH_eat$_{PC}^{SP}$ | 0.022 | 0.133 * | 0.027 | 0.051 | -0.017 | 0.042 | -0.005 | -0.091 |
| | (0.038) | (0.073) | (0.048) | (0.041) | (0.055) | (0.055) | (0.065) | (0.094) |
| exercise | -0.233 | -0.889 | -0.519 | 0.090 | 0.446 | -0.472 | -0.315 | 0.080 |
| | (0.405) | (1.003) | (0.627) | (0.412) | (0.571) | (0.424) | (0.541) | (0.978) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively.

**(b)** Estimated OLS and UQR coefficients of time variables of SNAP-eligible nonparticipant households.

| | OLS | RIF Regressions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 15 | 25 | 50 | 75 | 85 | 95 |
| FAH_eat$_{PC}^{IE}$ | 0.010 | 0.106 | 0.083 | 0.022 | 0.005 | -0.011 | -0.056 | -0.070 |
| | (0.043) | (0.085) | (0.061) | (0.057) | (0.057) | (0.066) | (0.067) | (0.087) |
| FAFH$_{PC}^{IE}$ | -0.067 | -0.015 | -0.099 | -0.070 | -0.018 | -0.132 ** | -0.142 ** | -0.061 |
| | (0.045) | (0.075) | (0.061) | (0.065) | (0.056) | (0.064) | (0.068) | (0.093) |
| exercise | -0.316 | -2.453 * | -0.880 | -0.459 | -0.468 | 0.316 | 0.096 | 0.916 |
| | (0.395) | (1.371) | (0.603) | (0.570) | (0.465) | (0.574) | (0.572) | (0.979) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively.

**(c)** Estimated OLS and UQR coefficients of time variables of SNAP-ineligible households.

| | OLS | RIF Regressions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 15 | 25 | 50 | 75 | 85 | 95 |
| FAHshop_eat$_{PC}^{II}$ | 0.135 *** | 0.096 | 0.148 *** | 0.068 | 0.157 *** | 0.168 ** | 0.147 * | 0.201 |
| | (0.049) | (0.063) | (0.054) | (0.063) | (0.060) | (0.073) | (0.088) | (0.134) |
| FAHprepFAFHwait$_{PC}^{II}$ | 0.003 | 0.008 | 0.018 | 0.017 | 0.000 | 0.005 | 0.002 | -0.079 |
| | (0.029) | (0.049) | (0.038) | (0.040) | (0.037) | (0.042) | (0.049) | (0.063) |
| FAFHpurch_trvl$_{PC}^{II}$ | -0.007 | 0.060 | -0.039 | -0.015 | -0.045 | -0.005 | 0.027 | 0.038 |
| | (0.046) | (0.083) | (0.077) | (0.076) | (0.060) | (0.066) | (0.077) | (0.125) |
| exercise | 0.184 | -0.661 | -0.239 | 0.362 | 0.307 | 0.490 | 0.419 | 1.569 ** |
| | (0.285) | (0.599) | (0.410) | (0.363) | (0.390) | (0.422) | (0.451) | (0.743) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively.

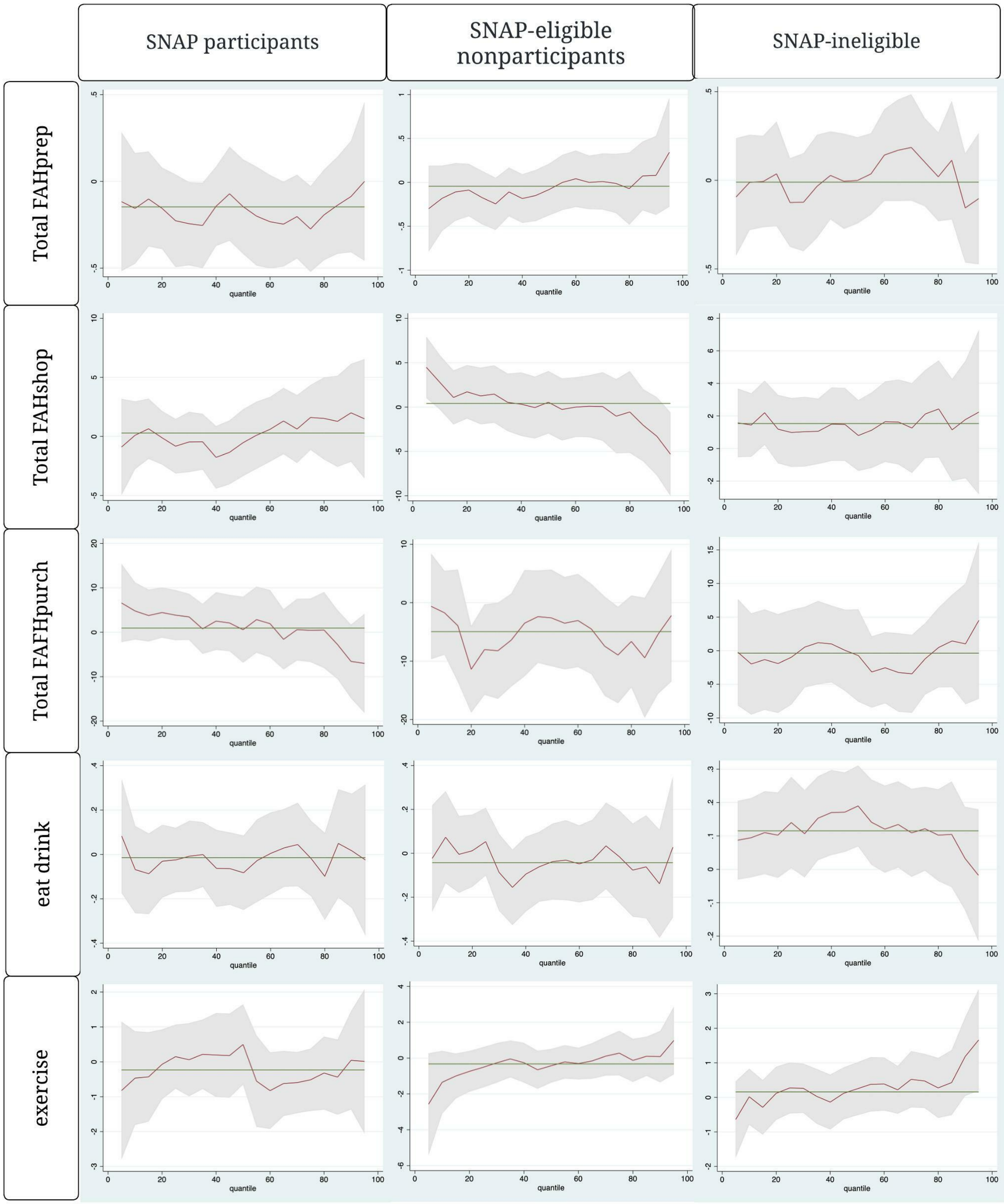



**Figure 3.4:** Specification 3: Relationship between time variables and HEI. SNAP participants households, SNAP-eligible nonparticipant households and SNAP-ineligible households.

**Table 3.6:** Model Specification 3: Estimated OLS and UQR coefficients - time variables only. Panel (a) SNAP participant households; Panel (b) SNAP-eligible nonparticipant households; and Panel (c) SNAP-ineligible households.

**(a)** Estimated OLS and UQR coefficients of time variables of SNAP participant households.

| | **OLS** | **RIF Regressions** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **5** | **15** | **25** | **50** | **75** | **85** | **95** |
| Total FAHprep | -0.147 | -0.117 | -0.101 | -0.227 * | -0.145 | -0.274 ** | -0.137 | 0.000 |
| | (0.090) | (0.204) | (0.140) | (0.136) | (0.139) | (0.126) | (0.143) | (0.233) |
| Total FAHshop | 0.284 | -0.894 | 0.651 | -0.827 | -0.530 | 1.607 | 1.278 | 1.492 |
| | (1.012) | (2.078) | (1.298) | (1.175) | (1.440) | (1.400) | (1.966) | (2.578) |
| Total FAFHpurch | 0.933 | 6.590 | 3.765 | 3.848 | 0.575 | 0.439 | -2.763 | -7.004 |
| | (2.433) | (4.491) | (2.976) | (2.875) | (3.787) | (3.638) | (3.967) | (5.689) |
| eat drink | -0.014 | 0.083 | -0.087 | -0.025 | -0.082 | -0.019 | 0.049 | -0.025 |
| | (0.062) | (0.131) | (0.093) | (0.074) | (0.085) | (0.087) | (0.124) | (0.174) |
| exercise | -0.232 | -0.822 | -0.431 | 0.149 | 0.498 | -0.515 | -0.438 | 0.013 |
| | (0.418) | (1.007) | (0.653) | (0.468) | (0.587) | (0.455) | (0.548) | (1.055) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively.

**(b)** Estimated OLS and UQR coefficients of time variables of SNAP-eligible nonparticipant households.

| | **OLS** | **RIF Regressions** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **5** | **15** | **25** | **50** | **75** | **85** | **95** |
| Total FAHprep | -0.045 | -0.299 | -0.109 | -0.175 | -0.082 | -0.012 | 0.073 | 0.343 |
| | (0.118) | (0.250) | (0.167) | (0.155) | (0.150) | (0.172) | (0.200) | (0.317) |
| Total FAHshop | 0.404 | 4.475 ** | 1.081 | 1.250 | 0.539 | -1.030 | -2.066 | -5.315 ** |
| | (1.258) | (1.773) | (1.552) | (1.627) | (1.793) | (2.130) | (2.076) | (2.400) |
| Total FAFHpurch | -4.939 * | -0.623 | -3.941 | -8.013 ** | -2.596 | -8.952 ** | -9.427 * | -2.196 |
| | (2.946) | (4.604) | (4.904) | (3.949) | (4.212) | (4.206) | (5.238) | (5.762) |
| eat drink | -0.043 | -0.023 | -0.005 | 0.053 | -0.038 | -0.016 | -0.062 | 0.028 |
| | (0.067) | (0.124) | (0.089) | (0.079) | (0.088) | (0.107) | (0.120) | (0.164) |
| exercise | -0.325 | -2.572 * | -1.001 | -0.517 | -0.429 | 0.276 | 0.101 | 0.981 |
| | (0.394) | (1.449) | (0.641) | (0.572) | (0.478) | (0.634) | (0.558) | (0.963) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively.

**(c)** Estimated OLS and UQR coefficients of time variables of SNAP-ineligible households.

| | **OLS** | **RIF Regressions** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **5** | **15** | **25** | **50** | **75** | **85** | **95** |
| Total FAHprep | -0.011 | -0.094 | -0.007 | -0.126 | -0.001 | 0.102 | 0.113 | -0.104 |
| | (0.096) | (0.169) | (0.132) | (0.128) | (0.124) | (0.127) | (0.171) | (0.189) |
| Total FAHshop | 1.536 * | 1.576 | 2.198 ** | 0.986 | 0.801 | 2.124 | 1.146 | 2.238 |
| | (0.895) | (1.076) | (1.005) | (1.077) | (1.108) | (1.379) | (1.597) | (2.573) |
| Total FAFHpurch | -0.373 | -0.231 | -1.325 | -0.963 | -0.722 | -1.183 | 1.455 | 4.518 |
| | (2.123) | (4.044) | (3.813) | (3.593) | (3.508) | (2.715) | (3.510) | (5.958) |
| eat drink | 0.115 ** | 0.087 | 0.110 * | 0.140 ** | 0.190 *** | 0.122 * | 0.105 | -0.018 |
| | (0.046) | (0.060) | (0.063) | (0.070) | (0.062) | (0.064) | (0.081) | (0.101) |
| exercise | 0.159 | -0.639 | -0.289 | 0.273 | 0.247 | 0.474 | 0.429 | 1.661 ** |
| | (0.284) | (0.564) | (0.403) | (0.376) | (0.390) | (0.400) | (0.480) | (0.749) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively.

## 3.5 Conclusions, Policy Implications, and Limitations

In this chapter, we study the association between households' diet quality (measured in HEI) of FAH acquisitions, and time allocated to different food related activities. Our results indicate that the association between time allocated to food-related activities and diet quality depends on the activity considered, as well as SNAP participation and eligibility. Overall, our results suggest that this association is more pronounced in SNAP-ineligible households compared to SNAP-participant and eligible households. For SNAP-participants, we find that the time allocated to FAFH-related activities and eating is positively associated with HEI at lower HEI quantiles, and that time allocated to FAH preparation is negatively associated with diet quality along the distribution of HEI. On the contrary, time spent acquiring FAFH is negatively associated with the HEI of SNAP-eligible non-participants', but time spent acquiring FAH is positively associated with diet quality at lower HEI quantiles. For SNAP-ineligible households, time spent consuming food has a positive and strong association with diet quality. In addition, in this sub-sample of households, time spent acquiring FAH and time spend travelling to purchase FAFH are positively associated with diet quality.

From a policy perspective, our results suggest that SNAP-participants could benefit from accessing diets that are high quality and less time-consuming to them. For SNAP-eligible non-participants as well, results suggest that a more nutritious replacement to FAFH could improve their diet quality. For SNAP-ineligible or more affluent households, we find evidence that spending more time searching, acquiring, and eating food, or making food consumption an experience, rather than a quick task, is related to higher diet quality.

This analysis shows three main limitations. First, the FoodAPS dataset contains data on households' food acquisition, not food consumption. Thus, we can only analyze the association between household' diet quality of FAH acquisitions, and time allocated to different food related activities, and, although informative, it may not necessarily speak to the relationship between households' food consumption and time-use. Second, although the FoodAPS dataset is nationally representative and comes with household weights, the use of bootstrapping to approximate the standard errors, which is required when estimating the UQR coefficients, prevented us from using such weights, which imply that our results should not be considered as obtained from a "truly" national representative sample. Third, given that the data used in this analysis are the same as those used in chapter 1, the concerns regarding measurement errors of the imputed food P&P time use variables persists here.

# Chapter 4

# Farm to School Programming Spillovers and Households' Fruits and Vegetables Purchases

## 4.1 Introduction

More than three fourths of the U.S. population did not meet the recommended intakes of fruits, and 87.3% did not meet the recommended intake of vegetables during the 2007-2010 period (Moore & Thompson 2015; National Cancer Institute 2014)[38]. Thus, health institutions such as the Centers for Disease Control and Prevention (CDC), and the World Health Organization (WHO) provide guidance on strategies to increase fruits and vegetables (FV) consumption (Centers for Disease Control and Prevention 2017; World Health Organization 2002), which include promoting FV consumption at an early age. Given the importance of this strategy (Thompson & Amoroso, 2011), several programs in the U.S. target school children [39].

One such program is the Farm to School Program (FTSP)[40], which is an expansion of the Farm to Institution program and a part of the Healthy Hunger-Free Kids Act of 2010 (Food and Nutrition Service, 2017). The FTSP has two major purposes, 1) to promote local food systems and 2) to provide children access to nutritious food (Allen & Guthman, 2006). FTSPs emphasize fresh

[38]The U.S. Departments of Agriculture and the Department of Health and Human Services jointly publish the Dietary Guidelines for Americans (DGA) which provide science-based advice on food-group specific amounts to be consumed in order to promote health, reduce risk of chronic disease, and meet nutrient needs (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020). Depending on age and gender, federal guidelines recommend different fruits and vegetable intakes as part of a healthy eating pattern. Those recommendations can be found at, respectively, https://www.myplate.gov/eat-healthy/fruits and https://www.myplate.gov/eat-healthy/vegetables

[39]Examples of school interventions are: setting nutritional standards for all foods regularly sold in schools (including vending machines, à la carte lunch lines, and school stores), providing funds for subsidized lunches that meet nutritional standards, increasing monitoring of school districts' maintenance of nutritional standards by means of audits, and providing information to parents (USDA 2013; The White House 2010).

[40]From 2013 to 2018, the USDA provided grants worth approximately $5 million annually; the monetary amounts of the grants awarded in 2019 and 2020, grew to $9 million and $12.1 million, respectively (National Farm to School Network, 2020a).

FV over processed foods, small over large farmers, and local over national vendors, promoting the procurement (and consumption) of locally or regionally sourced food in schools (Allen & Guthman, 2006). According to the 2015 Farm to School Census (FTSC) survey[41], nearly 42,587 schools with 23.6 million students (42% of the 12,585 school districts participated in the survey) had implemented some form of FTSP activities either during the 2013/14 or the 2014/15 school year, or during both school years. One of the expected outcomes of FTSPs is the empowerment of children and their families to make informed food choices (National Farm to School Network, 2020b). Existing studies consider the benefits of FTSPs in terms of increasing students' knowledge and acceptance of FV (Holland et al. 2015; Joshi et al. 2008; Moss et al. 2013). However, studies evaluating the spillover effects of FTSP on household behavior are qualitative in nature and limited in scope (e.g. Moss et al. 2013). Our goal is to assess whether children's exposure to FTSP can influence households' FV purchasing patterns.

FTSP can potentially improve children's diets by facilitating multiple exposures to a variety of FV during the school day, and through activities such as taste tests, food coaches, and school orchards/gardens (Taylor & Johnson, 2013), which can increase students' knowledge and acceptance of FV (e.g. Joshi et al. 2008; Holland et al. 2015; Somerset & Markwell 2009). Also, repeated exposure to FTSP over time may improve the effectiveness of the program [42]. By familiarizing school children with FV, FTSP may facilitate an overall adoption of healthy diets for the entire household (Joshi et al., 2008): in a case study in Los Angeles, 90% of interviewed parents whose children engaged in FTSPs, self-reported positive changes in grocery shopping patterns and at-home cooking (Joshi et al., 2006); another case study in Burlington, VT revealed that 32% of respondent parents believed that their family diet had improved due to their children's participation in FTSP (Schmidt et al., 2006).

[41] To gather information related to school districts' local sourcing and farm to school activities, the USDA conducted the FTSC Survey in 2013, 2015, and 2019.

[42] Several studies show that to foster long-term acceptance of FV by children, multiple and repeated interventions are needed (e.g. Blom-Hoffman et al. 2004; Lakkakula et al. 2010; Wardle et al. 2003)

In this study, we assess whether households whose children are exposed to FTSP show different FV purchasing patterns than those that are not. We use two years of the USDA Farm to School Census, matched with Information Resource Incorporated Consumer Network Panel household-level data on purchases of Food-at-Home, to study the relationship between exposure to FTSP, captured by different measures of exposure duration and programming intensity, and FV expenditure and expenditure shares. We perform our analysis focusing on sub-samples of households residing in metro (where the majority of school districts implementing FTSP are located - Botkins & Roe 2018; Bonanno & Mendis 2021) and non-metro areas, as well as by households below and above 185 percent of the poverty line (as food choices and expenditures may differ based on poverty level). Additionally, we perform two falsification exercises: 1) we assess the relationship between FTSP and liquor expenditure / expenditure shares of households with children and 2) we estimate the model for a sample of households without children. We expect to observe a null relationship between FTSP and expenditures in both cases.

The design of our study is similar to that of Brunello et al. (2014). These authors use scanner data and a difference-in-difference approach to compare sales of unhealthy snacks in supermarkets located within 1/2 km radius of schools participating in an EU campaign providing FV to school children (treated) to those located outside that radius (control) in Rome. Differently from these authors, we consider household purchases instead of store sales, and focus on FV.

Further, we contribute to the literature investigating potential spillovers of publicly funded programs to support nutrition and food security among children. Existing studies show mixed evidence of the existence of spillover effects. Bhattacharya et al. (2006) studies the effects of the School Breakfast program and finds that while recipients improved their nutritional outcomes, other household members experienced fewer positive effects. Investigating the spillover effects of WIC on dietary quality, Ver Ploeg (2009) finds that children ages 5 to 17 living in WIC-participating families have higher Healthy Eating Index (HEI) than children in non-participating families. Kuhn (2018), analyzing food acquisitions across the SNAP cycle, finds that households where children receive school meals benefit from reduced consumption over the SNAP cycle, although there was no statistically significant effect on the adults in the household. Using data prior to the Healthy Hunger-Free Kids act, Cleary et al. (2020), study the relationship between the number of meals consumed in schools (including free and reduced-price acquisitions) and household-level HEI, They find limited evidence of spillover effects between school children meal acquisitions and overall household diet quality.

Our findings indicate that, overall, FTSP exposure is associated with higher household FV expenditures and expenditure shares, suggesting that the FTSP has positive spillover effects. This relationship is mostly driven by cafeteria-based activities, including those related to school garden, and by promotional activities. Not all FTSP activities show a positive relationship with household FV expenditures; field trips and curriculum related activities do not show a positive and statistically significant relationship with FV expenditure and FV expenditure shares. These results suggest that implementing cafeteria-based activities could be more effective in improving household FV purchasing behavior for the most part. These results, which are robust to different specifications of the FTSP variables, are mostly driven by metro households; we fail to find clear patterns across households sub-sampled by poverty levels. The results of the two falsification exercises show that bias in the estimated relationship between children's exposure to FTSP activities and households FV expenditures share is likely minimal.

This chapter proceeds as follows: first, we describe the empirical model. Then we discuss the data used, our approach to match the FTSC data with the Consumer Network Panel, and the different metrics used to measure FTSP exposure intensity. A description of the empirical results comes next, followed by a discussion of their implications. Closing remarks and limitations conclude.

## 4.2 Empirical Methods

### 4.2.1 The econometric model

The objective of this analysis is to assess whether a relationship exists between a household's FV purchases and the intensity of FTSP activities school-aged children in the household are exposed to. As not all households shop for FV every shopping trip (or even every month), we treat

FV expenditures and expenditure shares as latent variables. In general terms, let $FV_i$ represent either the $i^{th}$ household's FV expenditure or its FV expenditure share, our latent variables. If $FV_i$>0, we assume it will take the value of the expenditures (expenditure shares) observed in the data or $FV_i$=$FV_i^*$. For households which do not show purchases of FV in our data, $FV_i \leq 0$, and $FV_i^* = 0$.

Thus, we assume $FV_i^*$ to be a function of a series of covariates as in the equations below:

$$
\begin{aligned}
&FV_i = f(FTSI_i, Dem_i, Market_i, Loc_i, Time_i|\beta) + \varepsilon_i \\
&FV_i^* = FV_i \quad if \quad FV_i > 0 \\
&FV_i^* = 0 \quad if \quad FV_i \leq 0
\end{aligned}
\tag{4.1}
$$

where, $FTSI$ is a measure of FTSP exposure intensity in the school districts where the household is located; $Dem$ is a vector of demographic characteristics of household $i$; $Market$ is a vector of market characteristics in the county where the household is located; $Loc$ is a vector of other time-invariant controls, including the level of urbanization/rurality and state fixed-effects; and $Time$ is a vector of time-variant control (i.e. month and year effects). For ease of exposition, these variables are collapsed in the matrix $X$; $\beta$ is a vector of coefficients to be estimated, conformable with $X$. Finally, $\varepsilon_i$ represents the unexplained variation in $FV_i$, where the vector $\varepsilon \sim N(0, \sigma^2)$. We use a maximum likelihood Tobit estimator (Tobin 1958) left-censored at zero to estimate equation 4.1[43].

Using a Tobit model allows us to estimate three marginal effects characterizing the relationship between FTSP children exposure and: 1) the probability of purchasing FV, 2) the overall

[43] Participation and continuation in the FTSP could reflect the community's interest in / easier access to local food, which may lead to endogeneity and self-selection bias. We attempted to correct for endogeneity of Farm-toSchool (FTS) participation and intensity / duration using the Endogenous Dose-Response Model (Baum & Cerulli 2016; Cerulli 2015; Filippetti & Cerulli 2018). Specifically, we attempted to use an Endogenous Dose-Response Model with two sets of instrumental variables, selected following (Bonanno & Mendis, 2021): 1. market characteristics to capture variation in FTSP participation (treatment equation) and past years' FTSP activities (dose equation), and 2. state-level policies that support FTSP participation and continuation in both equations. However, as the set of instruments failed to produce results satisfying standard statistical tests supporting their validity - Over identification (Hansen's J test) and Endogeneity test (C test) - and the results were likely to be biased upwards, we decided to use a standard Tobit estimator in place of instrumental variables methods.

(unconditional) FV expenditure (expenditure share), and 3) the conditional (on purchasing) FV expenditure (expenditure share). Following McDonald & Moffitt (1980), the three estimated effects of a marginal change in one of our measures of FTSP intensity ($FTSI$) are

$$\frac{\partial P(FV > 0)}{\partial FTSI} = f(z)\beta^{FTSI}/\sigma \tag{4.2}$$

$$\frac{\partial FV}{\partial FTSI} = F(z)\beta^{FTSI} \tag{4.3}$$

$$\frac{\partial FV^*}{\partial FTSI} = \beta^{FTSI}[1 - FTSIf(z)/F(z) - f(z)^2/F(z)^2]X \tag{4.4}$$

where $FTSI$ is a measure of FTSP Intensity, $\beta^{FTSI}$ is its estimated Tobit coefficient, $z = \beta' X/\sigma$, $f(z)$ is the standard normal probability density function (PDF) of $z$, and $F(z)$ is its standard cumulative normal distribution function (CDF).

### 4.2.2 Model specifications and FTSP exposure intensity measures

The specification of appropriate measures of FTSP intensity is of crucial importance for this analysis. Thus, we rely on previous studies of the FTSP and others investigating the effectiveness of other programs to create five different metrics of FTSP intensity.

There is a general agreement in the literature that repeated / multi-intervention programs influence school children's long-term acceptance of FV ($e.g.$ Blom-Hoffman et al. 2004; Lakkakula et al. 2010; Wardle et al. 2003)[44]. Thus, our first two measures of FTSP intensity ($FTSI$ in eq. 1.1) are: 1) the number of consecutive years a school district implemented FTSP (that is, the maximum number of years children are exposed to FTSP) to capture repeated exposure ($NFTS^{Years}$), and 2) the total number of activities implemented each year as a proxy for multi-intervention

[44] The effects of training programs on employment and earnings exhibit similar patterns. For example, Flores et al. (2012) found that increased length of exposure to the Job Corps program was associated with higher future earnings, although the effect decreased over the period of exposure.(Choe et al., 2015) found that longer exposure to job training programs led to higher employment probabilities, but only after passing a given threshold.

programming ($NFTS^{Act}$). Omitting time subscripts for simplicity,[45] Specifications 1 and 2 are, respectively

$$\begin{aligned}FV_i = \beta^{NFTS^{Years}} NFTS_i^{Years} + \sum_{d=1}^{D} \beta_d^{Dem} Dem_{di} + \sum_{m=1}^{M} \beta_m^{Market} Market_{mi} \\ + \sum_{l=1}^{L} \beta_l^{Loc} Loc_{li} + \sum_{t=1}^{T} \beta_t^{Time} Time_{ti} + \varepsilon_i.\end{aligned} \tag{4.5}$$

$$\begin{aligned}FV_i = \beta^{NFTS^{Act}} NFTS_i^{Act} + \sum_{d=1}^{D} \beta_d^{Dem} Dem_{di} + \sum_{m=1}^{M} \beta_m^{Market} Market_{mi} \\ + \sum_{l=1}^{L} \beta_l^{Loc} Loc_{li} + \sum_{t=1}^{T} \beta_t^{Time} Time_{ti} + \varepsilon_i.\end{aligned} \tag{4.6}$$

As different activities may be associated with households' FV purchases in different ways, Specification 3 includes a vector of 14 variables, one for each activity ($FTS_f^{Act}$); where $f$=(1,...,14) and each variable takes the value of one if a school district implemented the $f^{th}$ activity, and zero otherwise[46]. Specification 3 is

$$\begin{aligned}FV_i = \sum_{f=1}^{14} \beta_f^{FTS^{Act}} (FTS_{fi}^{Act}) + \sum_{d=1}^{D} \beta_d^{Dem} Dem_{di} + \sum_{m=1}^{M} \beta_m^{Market} Market_{mi} \\ + \sum_{l=1}^{L} \beta_l^{Loc} Loc_{li} + \sum_{t=1}^{T} \beta_t^{Time} Time_{ti} + \varepsilon_i.\end{aligned} \tag{4.7}$$

School districts tend to implement multiple FTSP activities during the same school year. Thus, in Specification 4, we account for the simultaneous implementation of multiple FTSP activities.

[45]Each of the following equations should contain two different time subscripts, one capturing the specific month where the FV expenditure is recorded, and another for the calendar year which each observation refers to. Note that the FTSI variables and the household characteristics do not vary across months, but only across years.

[46]Because we test multiple hypotheses related to single estimated parameters, we will conduct relevant statistical corrrects/ tests such Bonferroni correction and Wolf test in latter versions of this study

Following (Bonanno & Mendis, 2021) we use FTSI variables representing combinations of FTSP activities by means of standardized (0 to 100 indexes) activities generated based on the results of Principal Component Factor Analysis (PCFA), ($PCF_p^{Act}$), discussed in more detail in section 4.3.1.

$$\begin{aligned} FV_i = &\sum_{p=1}^{2} \beta_p^{PCF^{Act}} PCF_{pi}^{Act} + \sum_{d=1}^{D} \beta_d^{Dem} Dem_{di} + \sum_{m=1}^{M} \beta_m^{Market} Market_{mi} \\ &+ \sum_{l=1}^{L} \beta_l^{Loc} Loc_{li} + \sum_{t=1}^{T} \beta_t^{Time} Time_{ti} + \varepsilon_i. \end{aligned} \tag{4.8}$$

The results of Specification 4 will inform on the association between FV expenditures and the groups of FTSP activities identified by data. $\beta_p^{PCF^{Act}}$ informs how association between FV expenditure and groups of FTSP activities changes when the FTSI indexes move from 0 - the "worst" combination - to 100 - the "best" combination. However, a more intuitive, and more useful classification of FTSP activities is combining the activities with the highest loadings (>0.5) for each factor ($NPCF_n^{Act}$) or in other words, summing of activities with the highest contribution to each factor, which we do for Specification 5. This informs how the relation between FV expenditure and groups of FTSP activities changes when the number of activities in each group changes.

$$\begin{aligned} FV_i = &\sum_{p=1}^{2} \beta_n^{NPCF^{Act}} NPCF_{ni}^{Act} + \sum_{d=1}^{D} \beta_d^{Dem} Dem_{di} + \sum_{m=1}^{M} \beta_m^{Market} Market_{mi} \\ &+ \sum_{l=1}^{L} \beta_l^{Loc} Loc_{li} + \sum_{t=1}^{T} \beta_t^{Time} Time_{ti} + \varepsilon_i. \end{aligned} \tag{4.9}$$

## 4.3 Data

For this analysis, we primarily use two data sources: two years (2013 and 2015) of USDA's FTSC[47] and Information Resource Incorporated Consumer Network Panel (henceforth CNP) for

[47] The 2013 FTSC contains information about the 2011/12 school year and the 2015 FTSC contains information about the 2013/14 school year. In 2020, the USDA released another year of the FTSC. However, 2020 FTSC only

the years 2011-2014, accessed via a third-party agreement with the USDA ERS. The FTSC contains information on school districts' participation in the FTSP, including the activities implemented and the characteristics of the school districts. We only retain school districts appearing in both years of the FTSC located in a unique zip-code, for a total of 6,942 school districts[48]. The CNP provides data on daily household food purchases as well as households' demographic characteristics. In order to limit the number of non-purchase observations, we aggregate total food expenditures and expenditures for FV at the monthly level (more details below), and only include the CNP "static panel" of households, which account for 70 to 80 percent of all purchases recorded in the CNP data (Muth et al., 2016). Given that only school-age children can be exposed to FTSP activities, we only retain households with at least one child aged 6 to 18 years.

We combine the CNP data with the FTSC by matching households by their zip-code of residence with the corresponding school district. Implicitly, we assume that children attend school in a school district located within the same zip-code where they reside, because we are unable to identify with certainty which households with children were exposed to which school district's FTSP. Thus, our household sample can be defined as an "intent-to-treat" sample rather than a "treated" sample [49]. Because FTSP activities take place predominantly during the school year, we use monthly household purchase data from August 2011 to May 2014. As a result, the data set used in the estimation consists of 162,747 monthly observations.

### 4.3.1 School districts participation in FTSP and FTSP intensity variables

School districts' FTSP intensity variables are calculated using FTSC data. The 2013 (2015) FTSC contains information about school districts' FTSP implemented during the 2011/12 (2013/14)

---

contains data for the 2018/2019 school year. Because 2015-2017 FTSP information is not available, we cannot use FTSC 2020 in this study to investigate the effect of FTSP over time.

[48]7,330 school districts are present in both the 2013 and 2015 FTSC. Of those, 94.7% show unique zip-codes. For details on the procedure used to identify school districts participating in both FTSC years (2013 and 2015) see Bonanno & Mendis (2021).

[49]The likely implications of this assumption for our results will be discussed in the conclusions and limitations section (section 4.5)

school year and, for the school districts that did not have FTSP activities in 2011/12 (2013/14), the intention to begin these activities in 2012/13 (2014/15). Thus, school district participation in FTSP during the school year 2012/13 was inferred from the information about participation in the 2011/12 and 2013/14 school years, using the following three criteria:

1. If a school district implemented (did not implement) specific FTSP activities in both 2011/12 and 2013/14 school years, they were assumed to have implemented (not implemented) the same activities in 2012/13 as well.

2. If a school district implemented FTSP in 2011/12, but did not implement it in 2013/14, the probability that it continued FTSP in 2012/13 was predicted using the FTSP continuation and participation model developed by Bonanno & Mendis (2021)[50]. School districts with a predicted probability of FTSP continuation greater (lower) than 0.5, were assumed to continue (not to continue) FTSP in 2012/13.

3. If a school district which did not participate in FTSP in 2011/12 and participated in 2013/14, reported in the 2013 FTSC their intention to offer the program in 2012/13, it was assumed it participated in the 2012/13 school year as well.

After imputation, we calculated the five different measures of FTSP intensity discussed above in Section 4.2, each capturing a different pathway through which FTSP can influence FV expenditures. For Specification 1, we calculate the number of years a school district implemented FTSP consecutively ($NFTS^{Years}$) varying from 0 to 3. The FTSP intensity measures for Specifications 2 to 5 are created based upon the activities school districts implemented under FTSP. Specifically, in Specification 2, we include the total number of activities implemented in a school year ($NFTS^{Act}$), which varies from 0 to 14. In Specification 3, we use 14 binary indicator variables, one for each activity, taking the value of one if a school district implemented a certain activity,

[50]For those school districts implementing FTSP in 2011/12, but not in 2013/14, we don't have information on whether the school district exited the program in 2012/13 or in 2013/14. Hence, we predict school districts' decision to cease program participation based on the estimated probability of continuing FTSP in 2012/13 given their participation in 2011/12.

and zero otherwise ($Serve\ Local$, $Taste\ Demos$, $Food\ Coach$, $School\ Garden$, $Serve\ Garden$, $Taste\ Garden$, $Field\ Trip$, $Farmer\ Visit$, $Themed\ Promo$, $Promote\ Local$, $Media\ Cover$, $Hosted\ Events$, $F2S\ Month$, and $Curriculum$).

Since school districts in FTSP tend to implement multiple activities during the same school year, Bonanno & Mendis (2021) suggest the possibility of multi-collinearity between indicator variables representing each activity [51]. Thus, following Bonanno & Mendis (2021), we combine different activities in standardized (0-100) indexed obtained by means of PCFA (Specification 4), and in the number of activities that belonging to each Principal Component Factor (PCF) in Specification 5.

FTSP activities are coded as binary variables, which violates the multivariate normality assumption of Principal Component Factor Analysis (PCFA). Thus, we use a tetrachoric correlation matrix in our implementation of the PCFA (Harris, 2006)the PCFA. We retain factors which cumulatively explain 90% of the variance among the activities indicators, and apply the "Varimax" rotation to the matrix of factor-loadings. The loadings of the (rotated) components are reported in Table 4.1. Activity indicators with the highest loadings on factor 1 seem to either take place in the cafeteria (serving local foods, taste demonstrations, food coaches) or appear to represent promotional activities (themed promotions, promotion of local foods, media coverage, hosted events, celebration of farm to school month, and farmer visits). Activity indicators with the highest loadings on factor 2 are mostly activities related to the presence of a school garden (presence of a school garden, served food from the school garden, taste test of products from the garden), or educational (field trip, hosted community events, and curriculum).

For the fourth specification, we calculate standardized PCFs by dividing the difference between each factor and its minimum value by the factor's entire range of values (maximum value - minimum value), then multiplied by 100. Hence, the standardized PCF based on factor 1 is $Cafeteria/Promo\ Index$ and that based on factor 2 is $Education/Garden\ Index$. For the fifth model specification, the sum of activities with the highest loadings (>0.5) belonging to each factor

[51] See Table A.5. in the appendix for values of tetrachoric correlations between the 14 FTSP activity indicators

**Table 4.1:** Principal Component Factor Analysis Using Tetrachoric correlation; Variable Loadings on the Rotated Retained Factors.

| Variable | Factor1 | Factor2 |
|---|---|---|
| Serve Local | 0.8523 | 0.4449 |
| Taste Demos | 0.7416 | 0.4854 |
| Food Coach | 0.6901 | 0.3992 |
| School Garden | 0.3185 | 0.803 |
| Serve Garden | 0.3597 | 0.7838 |
| Taste Garden | 0.3831 | 0.7809 |
| Field Trip | 0.4285 | 0.6125 |
| Farmer Visit | 0.6594 | 0.4749 |
| Themed Promo | 0.8392 | 0.2741 |
| Promote Local | 0.8757 | 0.3168 |
| Media Cover | 0.7659 | 0.4429 |
| Hosted Events | 0.5575 | 0.5514 |
| F2S Month | 0.7871 | 0.2389 |
| Curriculum | 0.4217 | 0.7322 |

Note: The factors located in boxes indicate loadings greater than 0.5.

is used; the resulting variables are $NCafeteria/Promo\ Activities\ I$ and $NEducation/Garden\ Activities\ I$. Descriptions of the five different specifications of FTSP exposure intensity as well as summary statistics are presented in Table 4.2.

**Table 4.2:** Descriptive statistics - FTSP exposure intensity measures

| Spec | FTSP exposure intensity | Description | Mean | Std. Dev. |
|---|---|---|---|---|
| Spec 1 | $NFTS^{Years}$ | Number of years exposed to FTSP | 0.791 | 1.022 |
| Spec 2 | $NFTS^{Act}$ | Number of activities implemented under FTSP | 2.043 | 3.015 |
| Spec 3 | Serve Local | School district served locally produced foods in the cafeteria | 0.423 | 0.494 |
| | Taste Demos | School district held taste testing/demos of locally produced foods | 0.211 | 0.408 |
| | Food Coach | School district used cafeteria food coaches | 0.118 | 0.323 |
| | School Garden | School district conducted edible school gardening or orchard activities | 0.129 | 0.335 |
| | Serve Garden | Served products from school-based gardens or school-based farms | 0.112 | 0.316 |
| | Taste Garden | Held taste testing/demos of school-based gardens / farms products | 0.096 | 0.294 |
| | Field Trip | Conducted student field trips to farms | 0.131 | 0.338 |
| | Farmer Visit | Farmer(s) visit the cafeteria, classroom or other school-related setting | 0.092 | 0.289 |
| | Themed Promo | Promoted local efforts through themed or branded promotions | 0.155 | 0.362 |
| | Promote Local | Promoted locally produced foods at school in general | 0.236 | 0.425 |
| | Media Cover | Generated media coverage of local foods in schools | 0.098 | 0.297 |
| | Hosted Events | Hosted community events | 0.061 | 0.240 |
| | F2S Month | Farm to school month | 0.113 | 0.317 |
| | Curriculum | Integrated farm to school concepts into educational curriculum | 0.069 | 0.254 |
| Spec 4 | Cafeteria/Promo Index | 0-100 Index based on the values of the $1^{st}$ factor generated by PCFA | 52.293 | 15.451 |
| | Education/Garden Index | 0-100 Index based on the values of the $2^{nd}$ factor generated by PCFA | 29.977 | 13.681 |
| Spec 5 | NCafeteria/Promo Activities I | Number of activities belonging to $1^{st}$ factor | 1.505 | 2.204 |
| | NEducation/Garden Activities I | Number of activities belonging to $2^{nd}$ factor | 0.599 | 1.222 |

Source: Author's elaborations on FTSC data.

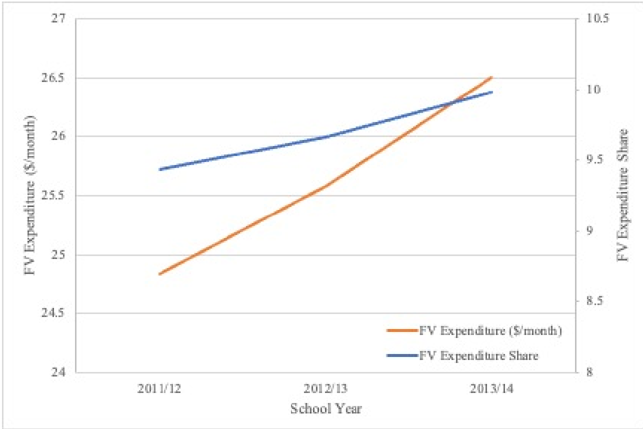
### 4.3.2 Dependent Variables

Households' monthly FV expenditures ($FVExp$) and expenditure shares (over the total food expenditure - $FVSh$) were calculated by aggregating household purchases of all fresh, frozen, canned, and dried fruits and vegetables which are included in the National School Lunch Program and School Breakfast Program. Of the 162,747 household-month observations in the data, approximately 22.4% (36,550 observations) report no FV expenditures. The average conditional (on purchasing) and unconditional monthly FV expenditure shares are 11.75%, and 9.11%, respectively, whereas monthly FV expenditures are \$30.28 and \$23.48.

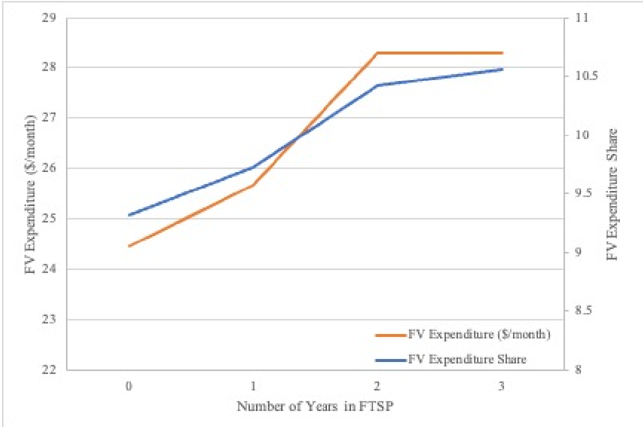
Figure 4.1 shows households' average monthly unconditional FV expenditures and expenditure shares for the school years 2011/12, 2012/13 and 2013/14 (top panel), by the different number of school years FTSP was implemented in the school district of residence (middle panel), and by the number of FTSP activities implemented (bottom panel). The data shows average monthly FV expenditures and expenditure shares having increased over the three school years included in the analysis (top panel). Additionally, there seems to be a positive relationship between FV expenditures, expenditure shares, and prolonged exposure to FTSP activities (middle panel). The relationship between FV expenditures and expenditure shares, and the number of FTSP activities implemented (bottom panel) is not clear, but there seems to be a positive relationship between the number of FTSP activities and FV expenditure shares up to 13 activities.

### 4.3.3 Control Variables

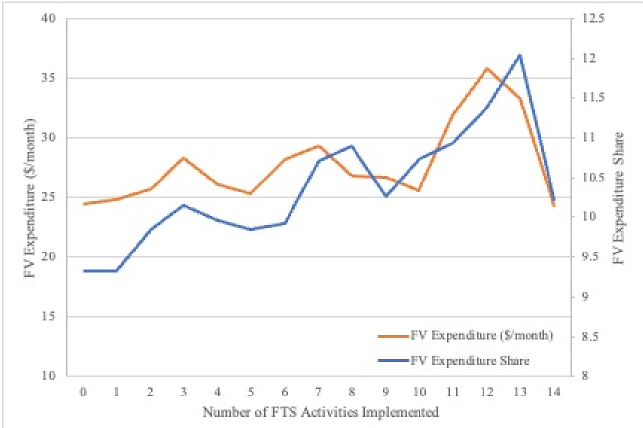
We follow the existing literature on FV purchases ($e.g.$ Kirkpatrick & Tarasuk 2003) and use household (or household-head) characteristics as controls in our model. Household characteristics controls include: household size ($HH\ Size$); household income ($HH\ Income$; in \$ thousands), calculated as the mid-point of the income category each household belongs to; a series of indicator variables capturing the presence of children in the household younger than 6 years of age category ($Child\ 0-6$), from 6 to 13 years of age ($Child\ 6-13$), and from 13 to 18 years ($Child\ 13-18$); and indicator variables capturing whether the household rents the home where




**(a)** Monthly FV expenditure and expenditure share by school year




**(b)** Monthly FV expenditure and expenditure share by number of years a school district implements FTS




**(c)** Monthly FV expenditure and expenditure share by number of FTSP activities

**Figure 4.1:** Variation in monthly FV expenditure and expenditure share by: school year (top panel), number of years a school district implements FTSP (middle panel), and number of FTSP activities (bottom panel).

Source: Authors' elaborations on IRI CNP and FTSC data they live ($Rent\ Home$) or if arrangements other than ownership or renting ($Oth\ HomeOwn$) are in place (owning home is the excluded category). Household head characteristics included in the model are: indicator variables capturing the ethnic / race group the household head belongs to (Hispanic - $Hisp\ HH$; African American - $Black\ HH$; Asian American - $Asian\ HH$; and "others" - $Others\ HH$; excluded group is White); three indicator variables capturing the marital status of the household head (Widowed - $Widow\ HH$; Separated - $Separated\ HH$; Single - $Single\ HH$; excluded group is married); and an indicator variable capturing if the household head has attained college degree or more ($Head\ Edu$);

We control for local food supply chain attributes to capture confounding factors that may affect both a school district decision to participate in FTSP (or to implement a given activity) and FV expenditures. Following Botkins & Roe (2018) and Bonanno & Mendis (2021), we control for the average farm income of the county- $FarmInc$ (in 2012) and the county-level percentage of farms with direct-to-retail sales -$\%Direct$ (in 2012) to capture overall farm activity and farmers' propensity to sell through direct channels. $FarmInc$ and $\%Direct$ are calculated as inverse distance weighted (IDW)[52] as explained in detail in Botkins & Roe (2018).[53]. We also include the county-level number of farmer's markets per 10,000 people ($PCFM$) and a binary variable capturing the existence of food hubs in the county where a school district is located ($Foodhubs$) as proxies for ease of access to local foods. Finally, we include the ratio of a county's milk price to the national average ($Milkprice$). Local milk is one of the most prominent kinds of "local food" served in many schools and milk price is highly correlated with that of non-produce foods (Botkins & Roe, 2018). USDA's Food Environment Atlas (USDA, 2015) provides data on farmers' markets in 2010[54], 2012, and 2013; food hubs in 2011, 2012 and 2013; and milk price in 2010.

To control for time-invariant factors that may affect both a school district's decision to adopt FTSP and a household's purchase habits, we include two sets of fixed effects. First, given that

[52]For the purposes of constructing $FarmInc$ and $\%Direct$ local food is defined as food produced within 400miles radius (Food, Conservation and Energy Act of 2008).

[53]We thank Botkins & Roe (2018) for sharing the IDW variables' data.

[54]Farmers' markets data in 2010 is used in place of 2011.

school districts' participation in FTSP occurs at different rates depending upon the level of rurality (Botkins & Roe 2018; Bonanno & Mendis 2021), we add indicator variables capturing the Rural-Urban Continuum Code (RUCC) classification of the county the zip-code belongs to[55]. Second, we control for state-level fixed effects to capture State-level policies that may affect implementing FTSP (Bonanno & Mendis 2021; Lyson 2016), as well as unobserved variation in dietary/purchasing patterns across geographic areas. Further, we control for time-dependent variation in FV expenditures, by including two sets of time effects: indicator variables for each month of the calendar year, capturing seasonal variation in FV purchase/consumption, and indicator variables for each year to capture possible intermediate/long-run trends in FV purchases. Summary statistics for household-level, household-head and food supply chain characteristics are in Table 4.3.

For the sub-sample analysis of the households resided in metro vs non-metro area, a household is considered residing in a metro area if the household is located in a county with RUCCs 1, 2 and 3; a non-metro area if located in a county with RUCCs from 4 to 9[56].

## 4.4 Results and Discussion

This section focuses on the estimated associations between FTSP exposure intensity and households' with school aged children FV expenditures (and expenditure shares). Before discussing the main results of interest, we present a brief discussion of the estimated parameters for selected control variables.

### 4.4.1 Control variables

Estimates for specifications 1 and 2 (equation 4.5 and 4.6, respectively) are reported in Table 4.4 for both FV expenditures ($FVExp$) and FV expenditure shares ($FVSh$); estimates obtained

[55]The RUCCs range from 1 to 9, 1 indicating largely populated metro areas, 9 low-population rural areas. For details, see https://www.ers.usda.gov/data-products/rural-urban-continuum-codes.aspx

[56]more information regarding this classification can be found in https://seer.cancer.gov/seerstat/variables/county attribs/ruralurban.html

**Table 4.3:** Descriptive statistics - Household-level and local food supply chain control variables

| Variable | Mean | std. dev. | Min | Max |
|---|---|---|---|---|
| **Household-level Control Variables** | | | | |
| HH size | 4.171 | 1.186 | | |
| HH income | 74.601 | 48.59 | | |
| Hisp HH | 0.079 | 0.270 | 0 | 1 |
| Black HH | 0.081 | 0.273 | 0 | 1 |
| Asian HH | 0.038 | 0.190 | 0 | 1 |
| Other HH | 0.054 | 0.226 | 0 | 1 |
| White HH | 0.827 | 0.378 | 0 | 1 |
| Child 0-6 | 0.229 | 0.420 | 0 | 1 |
| Child 6-13 | 0.560 | 0.496 | 0 | 1 |
| Child 13-18 | 0.629 | 0.483 | 0 | 1 |
| HH Married | 0.830 | 0.376 | 0 | 1 |
| HH Widow | 0.017 | 0.129 | 0 | 1 |
| HH Separated | 0.101 | 0.301 | 0 | 1 |
| Single | 0.053 | 0.224 | 0 | 1 |
| Less than HS | 0.002 | 0.050 | 0 | 1 |
| High School | 0.192 | 0.394 | 0 | 1 |
| College | 0.693 | 0.461 | 0 | 1 |
| Postgraduate | 0.112 | 0.315 | 0 | 1 |
| Own Home | 0.774 | 0.418 | 0 | 1 |
| Rent Home | 0.205 | 0.404 | 0 | 1 |
| Oth HomeOwner | 0.020 | 0.140 | 0 | 1 |
| **Local Food Supply Chain Control Variables** | | | | |
| FarmInc | 0.251 | 0.181 | 0.020 | 1.190 |
| %Direct | 3.669 | 2.960 | 0.215 | 19.849 |
| Foodhubs | 0.041 | 0.199 | 0 | 1 |
| PCFM | 0.136 | 0.234 | 0 | 3.073 |
| Milkprice | 0.959 | 0.138 | 0.722 | 1.217 |

Source: Author's elaborations on FTSC and IRI data.

using the other model specifications are similar to those reported in Table 4.4 and available in the Appendix.[57]

The sign and significance of the estimated parameters in Table 4.4 are consistent with previous literature and prior expectations. Larger households show higher (lower) FV expenditures (expenditure shares). Household income ($HH\ Income$) is associated with higher FV expenditures and expenditure shares. Ethnicity / race of the household head other than white (and non-Hispanic) shows a negative relationship with $FVExp$ (although not statistically significant for $Others\ HH$) and a positive and statistically significant relationship with $FVSh$ for $Asian\ HH$ and $Other\ HH$. The presence of children age 0-6 is negatively associated with both $FVExp$ and $FVSh$; that of older children (age 6-13) is related to lower $FVExp$ but higher $FVSh$, whereas the presence of high-school age (13-18) children is associated with lower $FVSh$ and higher $FVExp$. HH head's marital statuses other than "Married" is associated with lower FV purchases, both in absolute and relative terms. Our results suggest that household head with college education or higher is associated with larger amounts spent on FV and FV expenditure shares. Housing arrangements other than homeownership are associated with lower $FVExp$ and $FVSh$. Considering the local food supply chain control variables, Farm Income, presence of food hubs and farmers markets per 10,000 people, and the ratio of county milk price to the national average are negatively related to $FVSh$ and $FVExp$, however, the association between $FarmInc$ ($Foodhubs$, $PCFM$, or $Milkprice$) and $FVExp$ is ($FVSh$ are) not statistically significant. $\%Direct$ is associated with higher FV expenditure in both absolute and relative terms.

### 4.4.2 FTSP intensity and marginal effects

The estimated coefficients of the FTSP exposure intensity measures for all five specifications are reported in Table 4.5. Even though the magnitude of the tobit coefficients cannot be directly interpreted, their sign and significance provide an initial indication of the relationship between FTSP exposure and FV expenditures/expenditure shares. The continued exposure to FTSP

[57] Please see Appendix Table A.6. for the full set of estimated parameters.

**Table 4.4:** Selected Estimated Tobit Coefficients of Control Variables for Specifications 1 and 2 – Dependent Variables are Monthly FV Expenditure Shares (FVSh) and FV expenditure (FVExp)

| Control Variable | Specification 1 FVExp | | Specification 1 FVSh | | Specification 2 FVExp | | Specification 2 FVSh | |
|---|---|---|---|---|---|---|---|---|
| **Household-level Control Variables** | | | | | | | | |
| HH Size | 0.775 | *** | -0.395 | *** | 0.764 | *** | -0.402 | *** |
| | (0.096) | | (0.031) | | (0.096) | | (0.031) | |
| HH Income | 0.057 | *** | 0.015 | *** | 0.057 | *** | 0.015 | *** |
| | (0.002) | | (0.001) | | (0.002) | | (0.001) | |
| Hisp HH | -3.315 | *** | -0.184 | | -3.278 | *** | -0.206 | |
| | (0.391) | | (0.125) | | (0.392) | | (0.125) | |
| Black HH | -3.695 | *** | 0.176 | | -3.738 | *** | 0.154 | |
| | (0.357) | | (0.114) | | (0.359) | | (0.114) | |
| Asian HH | -4.051 | *** | 1.037 | *** | -4.057 | *** | 1.050 | *** |
| | (0.508) | | (0.162) | | (0.507) | | (0.162) | |
| Others HH | 0.014 | | 0.383 | *** | -0.032 | | 0.388 | *** |
| | (0.461) | | (0.147) | | (0.461) | | (0.147) | |
| Child 0-6 | -3.116 | *** | -0.262 | *** | -3.140 | *** | -0.259 | *** |
| | (0.265) | | (0.085) | | (0.266) | | (0.085) | |
| Child 6-13 | -0.713 | *** | 0.237 | *** | -0.685 | ** | 0.250 | *** |
| | (0.265) | | (0.085) | | (0.265) | | (0.085) | |
| Child 13-18 | 0.674 | ** | -0.280 | *** | 0.683 | ** | -0.276 | *** |
| | (0.280) | | (0.090) | | (0.280) | | (0.090) | |
| Widow HH | -3.959 | *** | 0.164 | | -4.000 | *** | 0.119 | |
| | (0.734) | | (0.234) | | (0.734) | | (0.235) | |
| Separated HH | -6.503 | *** | -1.142 | *** | -6.520 | *** | -1.151 | *** |
| | (0.339) | | (0.108) | | (0.339) | | (0.108) | |
| Single HH | -9.237 | *** | -1.684 | *** | -9.307 | *** | -1.713 | *** |
| | (0.449) | | (0.143) | | (0.449) | | (0.143) | |
| Head Edu | 3.774 | *** | 1.416 | *** | 3.713 | *** | 1.390 | *** |
| | (0.244) | | (0.078) | | (0.244) | | (0.078) | |
| Rent Home | -5.317 | *** | -1.728 | *** | -5.346 | *** | -1.727 | *** |
| | (0.254) | | (0.081) | | (0.255) | | (0.081) | |
| Oth HomeOwner | -4.552 | *** | -1.345 | *** | -4.499 | *** | -1.331 | *** |
| | (0.676) | | (0.216) | | (0.677) | | (0.216) | |
| **Local Food Supply Chain Control Variables** | | | | | | | | |
| FarmInc | -0.175 | | -0.919 | *** | -0.130 | | -0.910 | *** |
| | (0.920) | | (0.295) | | (0.920) | | (0.295) | |
| %Direct | 0.734 | *** | 0.171 | *** | 0.728 | *** | 0.161 | *** |
| | (0.092) | | (0.029) | | (0.093) | | (0.030) | |
| Foodhubs | -1.412 | *** | -0.243 | | -1.599 | *** | -0.288 | * |
| | (0.536) | | (0.171) | | (0.537) | | (0.172) | |
| PCFM | -1.279 | *** | 0.161 | | -1.282 | *** | 0.139 | |
| | (0.462) | | (0.148) | | (0.462) | | (0.148) | |
| Milkprice | -4.887 | *** | -0.665 | | -4.885 | *** | -0.607 | |
| | (1.555) | | (0.498) | | (1.557) | | (0.498) | |
| Constant | 13.330 | *** | 6.528 | *** | 13.093 | *** | 6.399 | *** |
| | (1.781) | | (0.570) | | (1.783) | | (0.571) | |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively. Coefficients for RUCCs, Month, Year, and State-level fixed-effects are omitted for brevity.

($NFTS_i^{Years}$, Specification 1) has a positive and statistically significant relationship with both $FVSh$ and $FVExp$; similarly, the larger the number of activities implemented by a school district (Specification 2), the larger monthly FV expenditure and FV expenditure shares. The results of the third model specification suggest that children's exposure to promotion and taste demonstrations activities such as $Taste\ Demos$, $Serve\ Garden$, $Themed\ Promo$, $Promote\ Local$, $Hosted\ Events$, and $F2S\ Month$ are associated with higher household-level $FVExp$ and $FVSh$; also, $Serve\ Local$, $Taste\ Garden$, and $Farmer\ Visit$ are related to higher monthly FV expenditure but show no statistically significant relationship with FV expenditure shares; in contrast $Food\ Coach$ and $Media\ Cover$ show a statistically significant association with higher FV expenditure shares, but not with monthly FV expenditure. We do not find evidence of a relationship between $School\ Garden$, $Field\ Trip$, and $Curriculum$ and both FV expenditures and FV expenditure shares. The coefficients for the FTSP intensity indexes used in Specification 4 and the corresponding activity counts (in Specification 5) are positive and statistically significant, showing a relationship with higher FV expenditures and expenditure shares.

The estimated marginal effects of the FTSP exposure variables on FV expenditures and expenditure shares are reported in Table 4.6. The effect of one additional year of exposure to FTSP activities on the probability of having a positive FV expenditure (FV expenditure share) is about 0.4% (0.7%). The marginal effects of one additional year of children's FTSP exposure on conditional and unconditional monthly FV expenditures (expenditure shares) are \$0.198 and \$0.278 (0.13 and 0.18), respectively.

The marginal effects of one additional activity on the probability of observing positive FV expenditure (0.3%) and FV expenditure share (0.3%) are similar in magnitude. One additional activity is associated with an increase in 0.06 (unconditional) and 0.08 (conditional) FV expenditure shares (about 0.6% and 0.7% of the sample averages) and \$0.13 and \$0.19 monthly FV expenditures (about 0.55% and 0.63% of unconditional and conditional expenditures, respectively).

Considering the results of Specification 3 we find that, on average, $Taste\ Demos$, $Food\ Coach$, and $Themed\ Promo$ are associated with \$0.39, \$0.66, and \$0.78 lower unconditional FV expendi-

**Table 4.5:** Estimated Tobit Coefficients of FTSP exposure intensity measures – Dependent Variables are Monthly FV Expenditure Shares (FVSh) and FV expenditure (FVExp)

| Specification | FTSP exposure intensity measures | FVSh | | FVExp | |
|---|---|---|---|---|---|
| Spec 1 | $NFTS^{Years}$ | 0.245 | *** | 0.399 | *** |
| | | (0.035) | | (0.109) | |
| Spec 2 | $NFTS^{Act}$ | 0.108 | *** | 0.270 | *** |
| | | (0.011) | | (0.035) | |
| Spec 3 | Serve Local | 0.234 | *** | 0.331 | |
| | | (0.087) | | (0.272) | |
| | Taste Demos | -0.392 | *** | -0.791 | ** |
| | | (0.102) | | (0.320) | |
| | Food Coach | -0.107 | | -1.338 | *** |
| | | (0.113) | | (0.353) | |
| | School Garden | 0.185 | | 0.055 | |
| | | (0.113) | | (0.354) | |
| | Serve Garden | 0.523 | *** | 2.185 | *** |
| | | (0.122) | | (0.380) | |
| | Taste Garden | -0.331 | ** | -0.589 | |
| | | (0.132) | | (0.414) | |
| | Field Trip | 0.007 | | -0.303 | |
| | | (0.106) | | (0.332) | |
| | Farmer Visit | 0.264 | ** | 0.023 | |
| | | (0.130) | | (0.405) | |
| | Themed Promo | -0.367 | *** | -1.572 | *** |
| | | (0.115) | | (0.359) | |
| | Promote Local | 0.634 | *** | 1.385 | *** |
| | | (0.105) | | (0.328) | |
| | Media Cover | 0.066 | | 1.389 | *** |
| | | (0.138) | | (0.430) | |
| | Hosted Events | 0.599 | *** | 1.933 | *** |
| | | (0.149) | | (0.464) | |
| | F2S Month | 0.498 | *** | 1.966 | *** |
| | | (0.118) | | (0.367) | |
| | Curriculum | -0.216 | | -0.119 | |
| | | (0.143) | | (0.447) | |
| Spec 4 | Cafeteria/Promo Index | 0.027 | *** | 0.063 | *** |
| | | (0.003) | | (0.009) | |
| | Education/Garden Index | 0.025 | *** | 0.075 | *** |
| | | (0.003) | | (0.010) | |
| Spec 5 | NCafeteria/Promo Activities I | 0.119 | *** | 0.195 | *** |
| | | (0.020) | | (0.062) | |
| | NEducation/Garden Activities I | 0.077 | ** | 0.400 | *** |
| | | (0.034) | | (0.105) | |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively.

ture; 0.21, 0.06, and 0.2 percentage points lower unconditional FV expenditure shares, respectively, although $Food\ Coach$ is not related in a statistically significant way to unconditional FV expenditure shares. $Serve\ Garden$, $Promote\ Local$, $Media\ Cover$, $Hosted\ Events$, and $F2S\ Month$ are associated with higher unconditional FV expenditure by \$1.09, \$0.69, \$0.69, \$0.96, and \$0.98 respectively. $Serve\ Local$, $Serve\ Garden$, $Farmer\ Visit$, $Promote\ Local$, $Hosted\ Events$, and $F2S\ Month$ are related to higher unconditional FV expenditure share by 0.13, 0.28, 0.14, 0.34, 0.32, and 0.27 percentage points respectively.

A $1\%$ higher value of either FTSP activity indexes (cafeteria-based and promotional activities, and education and garden-based activities index) is associated with a $0.1\%$ increase in the probability of having positive FV expenditures and expenditure shares. That means that households with children residing in school districts with the "best" combination of activities (that is, an index value of 100) can have up to $10\%$ higher probability of purchasing FV than those residing in areas with school districts scoring "0" in either activity index. However, having one more activity related to cafeteria and promotion based activities is related to a larger increase in FV expenditure shares compared to having one more education/garden related activity. The values of the estimated marginal effects are roughly one third smaller than those observed for cafeteria/promotion activities. Conversely, for FV expenditure - having more education/garden related activities is related to higher FV expenditure, and the magnitude of the marginal effects are almost twice as large as cafeteria/promotion activities.

**Table 4.6:** Marginal Effects: Changes in FTSP exposure intensity – Dependent Variables: Monthly FV Expenditure (FVExp) and FV Expenditure share (FVExpSh)

| Spec | FTSP exposure intensity | FVExp | | | FVExpSh | | |
|---|---|---|---|---|---|---|---|
| | | Pr(FV>0) | E(FV) | E(FV\|FV>0) | Pr(FV>0) | E(FV) | E(FV\|FV>0) |
| Spec1 | NFTS$^{Years}$ | 0.004 *** | 0.198 *** | 0.278 *** | 0.007 *** | 0.131 *** | 0.183 *** |
| | | (0.001) | (0.054) | (0.076) | (0.001) | (0.019) | (0.026) |
| Spec2 | NFTS$^{Act}$ | 0.003 *** | 0.134 *** | 0.188 *** | 0.003 *** | 0.058 *** | 0.081 *** |
| | | (0.000) | (0.017) | (0.024) | (0.000) | (0.006) | (0.008) |
| Spec3 | Serve Local | 0.003 | 0.165 | 0.231 | 0.007 *** | 0.125 *** | 0.174 *** |
| | | (0.003) | (0.135) | (0.189) | (0.002) | (0.047) | (0.065) |
| | Taste Demos | -0.008 ** | -0.393 ** | -0.550 ** | -0.011 *** | -0.210 *** | -0.293 *** |
| | | (0.003) | (0.159) | (0.223) | (0.003) | (0.055) | (0.077) |
| | Food Coach | -0.013 *** | -0.664 *** | -0.931 *** | -0.003 | -0.057 | -0.080 |
| | | (0.003) | (0.175) | (0.246) | (0.003) | (0.061) | (0.084) |
| | School Garden | 0.001 | 0.028 | 0.039 | 0.005 | 0.099 | 0.138 |
| | | (0.003) | (0.176) | (0.246) | (0.003) | (0.061) | (0.085) |
| | Serve Garden | 0.022 *** | 1.085 *** | 1.521 *** | 0.015 *** | 0.281 *** | 0.391 *** |
| | | (0.004) | (0.189) | (0.264) | (0.003) | (0.065) | (0.091) |
| | Taste Garden | -0.006 | -0.292 | -0.410 | -0.009 ** | -0.178 ** | -0.247 ** |
| | | (0.004) | (0.205) | (0.288) | (0.004) | (0.071) | (0.099) |
| | Field Trip | -0.003 | -0.151 | -0.211 | 0.000 | 0.004 | 0.005 |
| | | (0.003) | (0.165) | (0.231) | (0.003) | (0.057) | (0.079) |
| | Farmer Visit | 0.000 | 0.011 | 0.016 | 0.007 ** | 0.142 ** | 0.197 ** |
| | | (0.004) | (0.201) | (0.282) | (0.004) | (0.070) | (0.097) |
| | Themed Promo | -0.015 *** | -0.780 *** | -1.094 *** | -0.010 *** | -0.197 *** | -0.274 *** |
| | | (0.004) | (0.178) | (0.250) | (0.003) | (0.062) | (0.086) |
| | Promote Local | 0.014 *** | 0.688 *** | 0.964 *** | 0.018 *** | 0.341 *** | 0.474 *** |
| | | (0.003) | (0.163) | (0.228) | (0.003) | (0.056) | (0.078) |
| | Media Cover | 0.014 *** | 0.690 *** | 0.967 *** | 0.002 | 0.035 | 0.049 |
| | | (0.004) | (0.213) | (0.299) | (0.004) | (0.074) | (0.103) |
| | Hosted Events | 0.019 *** | 0.960 *** | 1.345 *** | 0.017 *** | 0.322 *** | 0.447 *** |
| | | (0.005) | (0.230) | (0.323) | (0.004) | (0.080) | (0.111) |
| | F2S Month | 0.019 *** | 0.976 *** | 1.368 *** | 0.014 *** | 0.267 *** | 0.372 *** |
| | | (0.004) | (0.182) | (0.255) | (0.003) | (0.063) | (0.088) |
| | Curriculum | -0.001 | -0.059 | -0.083 | -0.006 | -0.116 | -0.161 |
| | | (0.004) | (0.222) | (0.311) | (0.004) | (0.077) | (0.107) |
| Spec4 | Cafeteria/Promo Index | 0.001 *** | 0.031 *** | 0.044 *** | 0.001 *** | 0.014 *** | 0.020 *** |
| | | (0.000) | (0.005) | (0.006) | (0.000) | (0.002) | (0.002) |
| | Education/Garden Index | 0.001 *** | 0.037 *** | 0.052 *** | 0.001 *** | 0.014 *** | 0.019 *** |
| | | (0.000) | (0.005) | (0.007) | (0.000) | (0.002) | (0.002) |
| Spec5 | NCafeteria/Promo Activities I | 0.002 *** | 0.097 *** | 0.135 *** | 0.003 *** | 0.064 *** | 0.089 *** |
| | | (0.001) | (0.031) | (0.043) | (0.001) | (0.011) | (0.015) |
| | NEducation/Garden Activities I | 0.004 *** | 0.199 *** | 0.278 *** | 0.002 ** | 0.041 ** | 0.057 ** |
| | | (0.001) | (0.052) | (0.073) | (0.001) | (0.018) | (0.025) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively.

### 4.4.3 Analysis by household sub-samples

As the first sub-sample analysis, we estimate marginal effects of the FTSP intensity exposure variables on FV expenditures and expenditure shares of households with children by metropolitan status of the county where they reside. Estimates are reported by outcome variable in Table 4.7 and Table 4.8, for FV expenditure and FV expenditure share, respectively. One additional year of FTSP exposure is associated with higher FV expenditures for households with children residing in metro counties; this association is not statistically different from zero in non-metro areas. Instead, the association with higher FV expenditure shares is positive and statistically different from zero for both households residing in metro and non-metro households. The marginal effects of one additional FTSP activity follow a similar pattern.

Exposure to $Taste\ Demos$ and $Food\ Coach$ is associated with lower FV expenditures for both metro and non-metro households. $Themed\ Promo$ is associated with \$1.14 and 0.31 percentage points decrease in unconditional FV expenditures and expenditure shares of metro households, and with \$1.02 and 0.49 percentage points increase in unconditional FV expenditures and shares of non-metro households, respectively. The magnitudes of the marginal effects of $Serve\ Local$, $Promote\ Local$, $Hosted\ Events$, and $F2S\ Month$ are, respectively, 3.32 time, 1.32 time, 11.5 time, and 2.34 time higher for metro households' unconditional FV expenditure shares than non-metro households. The marginal effects of $Serve\ Garden$, and $Farmer\ Visit$ on unconditional FV expenditure shares are, respectively, 1.09 times and nearly 200 times greater for non-metro households compared to metro ones. The same pattern is observed for both conditional FV expenditures and expenditure shares, but with larger magnitudes. The results of the metro / non-metro sub-samples analysis further suggest that the association between cafeteria and promotion based activities and education and garden based activities and FV expenditure (and FV shares) is much stronger for households in metro than in non-metro areas.

The second sub-sample analysis was conducted for the households above vs below the 185% of the poverty guideline. The estimated average marginal effects of FTSP exposure intensity on FV expenditure and expenditure shares for two household sub-samples are reported in Tables 4.9

and 4.10 for FV expenditure and FV expenditure share, respectively. One additional year of FTSP exposure is associated with higher FV expenditures for households above 185% of poverty, and with higher FV expenditure shares for both sub-samples of households. For households below (above) 185% of poverty, one additional year of FTSP exposure is associated with 0.23 (0.17) percentage points increase in conditional expenditure shares. Exposure to one additional FTSP activity is associated with higher FV expenditures and shares for both household types; while the estimated conditional marginal effect on FV expenditure is 1.16 times larger for households below the 185% of poverty guideline, for FV expenditures, we find the opposite pattern for FV expenditure shares - 0.28 times smaller for households below the 185% of poverty guideline.

$Serve\ Garden$, $Promote\ Local$, and $F2S\ Month$ are associated with higher FV expenditures and expenditure shares of both types of households; $Serve\ Local$, $Hosted\ Events$ are associated with higher FV expenditure shares. $Promote\ Local$ is associated with \$1.42 increase in conditional FV expenditure for households below 185% of poverty. $Themed\ Promo$ is negatively associated with FV expenditures of both household types below and above 185% of poverty with, respectively, \$1.27 and \$1.06 decrease in conditional FV expenditures. $Taste\ Demos$ is negatively associated with FV expenditure shares with, respectively, \$0.36 and \$0.27 decrease in conditional FV expenditure shares. $Farmer\ Visit$ and $Curriculum$ are positively associated with FV expenditures of households below 185% of poverty with an increase in \$2.37 and \$2.53 of conditional FV expenditures, respectively, but negatively associated with FV expenditures of households above the threshold with a decrease in \$0.79 and \$1.40 of conditional FV expenditures, respectively. While the marginal effects of $Serve\ Local$, $Media\ Cover$, and $Hosted\ Events$ on FV expenditure are positive for more affluent households, marginal effects of $Taste\ Demos$ on FV expenditures of those households are negative. Marginal effects of these activities on FV expenditures of poor households are not significantly different from zero. Moreover, $Themed\ Promo$, and $Curriculum$ are negatively associated with affluent households' FV expenditure shares, but not with poor households' FV expenditure shares. On the other hand, while $School\ Garden$ and $Farmer\ Visit$ are associated with higher FV expenditures and shares for poor households, and

$Food\ Coach$ and $Media\ Cover$ are associated with lower FV expenditures and shares of the same households, those associations for households above 185% of poverty are not statistically significantly different from zero. Specification 5's results suggest that while cafeteria/promo activities have a stronger relationship with FV expenditures and shares for those households above 185% of poverty, education/garden activities have a stronger relationship with FV expenditures and shares for those households below 185% of poverty.

**Table 4.7:** Marginal Effects: Changes in FTSP exposure intensity – Dependent Variable: Household with children Monthly FV Expenditure (FVExp) - Metro and Non-metro sub-samples

| Spec | FTSP exposure intensity | Households in metro areas | | | Households in non-metro areas | | |
|---|---|---|---|---|---|---|---|
| | | **Pr(FV>0)** | **E(FV)** | **E(FV\|FV>0)** | **Pr(FV>0)** | **E(FV)** | **E(FV\|FV>0)** |
| Spec1 | NFTS$^{Years}$ | 0.004 *** | 0.210 *** | 0.294 *** | 0.000 | -0.015 | -0.020 |
| | | (0.001) | (0.063) | (0.088) | (0.003) | (0.109) | (0.152) |
| Spec2 | NFTS$^{Act}$ | 0.003 *** | 0.162 *** | 0.227 *** | -0.001 | -0.049 | -0.069 |
| | | (0.000) | (0.020) | (0.028) | (0.001) | (0.036) | (0.051) |
| Spec3 | Serve Local | 0.004 | 0.196 | 0.274 | 0.000 | 0.013 | 0.018 |
| | | (0.003) | (0.159) | (0.223) | (0.006) | (0.255) | (0.357) |
| | Taste Demos | -0.006 * | -0.301 * | -0.421 * | -0.034 *** | -1.432 *** | -2.004 *** |
| | | (0.003) | (0.180) | (0.252) | (0.009) | (0.363) | (0.507) |
| | Food Coach | -0.015 *** | -0.780 *** | -1.093 *** | -0.033 *** | -1.403 *** | -1.963 *** |
| | | (0.004) | (0.201) | (0.282) | (0.009) | (0.385) | (0.538) |
| | School Garden | 0.000 | -0.015 | -0.021 | 0.015 * | 0.648 * | 0.907 * |
| | | (0.004) | (0.202) | (0.283) | (0.009) | (0.373) | (0.522) |
| | Serve Garden | 0.023 *** | 1.211 *** | 1.697 *** | 0.011 | 0.469 | 0.656 |
| | | (0.004) | (0.220) | (0.309) | (0.009) | (0.374) | (0.523) |
| | Taste Garden | -0.002 | -0.096 | -0.134 | -0.034 *** | -1.460 *** | -2.044 *** |
| | | (0.004) | (0.232) | (0.325) | (0.011) | (0.480) | (0.672) |
| | Field Trip | -0.002 | -0.130 | -0.182 | 0.005 | 0.194 | 0.271 |
| | | (0.004) | (0.194) | (0.272) | (0.007) | (0.312) | (0.436) |
| | Farmer Visit | -0.007 | -0.386 | -0.541 | 0.028 *** | 1.192 *** | 1.669 *** |
| | | (0.004) | (0.235) | (0.330) | (0.009) | (0.388) | (0.543) |
| | Themed Promo | -0.022 *** | -1.144 *** | -1.603 *** | 0.024 ** | 1.024 ** | 1.433 ** |
| | | (0.004) | (0.201) | (0.282) | (0.010) | (0.410) | (0.574) |
| | Promote Local | 0.014 *** | 0.761 *** | 1.066 *** | 0.012 | 0.508 | 0.711 |
| | | (0.004) | (0.187) | (0.262) | (0.008) | (0.346) | (0.484) |
| | Media Cover | 0.026 *** | 1.348 *** | 1.889 *** | -0.037 *** | -1.561 *** | -2.186 *** |
| | | (0.005) | (0.247) | (0.347) | (0.010) | (0.440) | (0.616) |
| | Hosted Events | 0.021 *** | 1.096 *** | 1.536 *** | 0.007 | 0.281 | 0.393 |
| | | (0.005) | (0.266) | (0.373) | (0.011) | (0.476) | (0.666) |
| | F2S Month | 0.017 *** | 0.873 *** | 1.223 *** | 0.032 *** | 1.377 *** | 1.927 *** |
| | | (0.004) | (0.210) | (0.294) | (0.009) | (0.381) | (0.533) |
| | Curriculum | 0.001 | 0.046 | 0.064 | -0.021 * | -0.870 * | -1.218 * |
| | | (0.005) | (0.257) | (0.360) | (0.011) | (0.452) | (0.633) |
| Spec4 | Cafeteria/Promo Index | 0.001 *** | 0.036 *** | 0.051 *** | 0.000 | -0.006 | -0.008 |
| | | (0.000) | (0.005) | (0.007) | (0.000) | (0.009) | (0.013) |
| | Education/Garden Index | 0.001 *** | 0.049 *** | 0.068 *** | -0.001 *** | -0.029 *** | -0.041 *** |
| | | (0.000) | (0.006) | (0.008) | (0.000) | (0.011) | (0.015) |
| Spec5 | NCafeteria/Promo Act. I | 0.001 ** | 0.078 ** | 0.109 ** | 0.001 | 0.047 | 0.065 |
| | | (0.001) | (0.035) | (0.049) | (0.002) | (0.066) | (0.092) |
| | NEducation/Garden Act. I | 0.006 *** | 0.312 *** | 0.437 *** | -0.005 ** | -0.228 ** | -0.320 ** |
| | | (0.001) | (0.059) | (0.083) | (0.003) | (0.115) | (0.161) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively. aN=114,208; bN=34,550

**Table 4.8:** Marginal Effects: Changes in FTSPexposure intensity – Dependent Variable: Household with children Monthly FV Expenditure share (FVExpSh)- Metro and Non-metro sub-samples

| Spec | FTSP exposure intensity | Households in metro areas | | | Households in non-metro areas | | |
|---|---|---|---|---|---|---|---|
| | | Pr(FV>0) | E(FV) | E(FV\|FV>0) | Pr(FV>0) | E(FV) | E(FV\|FV>0) |
| Spec1 | NFTS$^{Years}$ | 0.007 *** | 0.139 *** | 0.193 *** | 0.006 ** | 0.097 ** | 0.136 ** |
| | | (0.001) | (0.021) | (0.030) | (0.002) | (0.040) | (0.056) |
| Spec2 | NFTS$^{Act}$ | 0.004 *** | 0.069 *** | 0.095 *** | 0.001 | 0.012 | 0.016 |
| | | (0.000) | (0.007) | (0.009) | (0.001) | (0.013) | (0.019) |
| Spec3 | Serve Local | 0.009 *** | 0.183 *** | 0.254 *** | -0.005 | -0.079 | -0.110 |
| | | (0.003) | (0.054) | (0.076) | (0.006) | (0.095) | (0.132) |
| | Taste Demos | -0.011 *** | -0.209 *** | -0.290 *** | -0.019 ** | -0.318 ** | -0.443 ** |
| | | (0.003) | (0.061) | (0.085) | (0.008) | (0.134) | (0.187) |
| | Food Coach | -0.002 | -0.048 | -0.066 | -0.015 * | -0.250 * | -0.349 * |
| | | (0.004) | (0.069) | (0.096) | (0.008) | (0.142) | (0.199) |
| | School Garden | 0.003 | 0.057 | 0.079 | 0.020 ** | 0.333 ** | 0.464 ** |
| | | (0.004) | (0.069) | (0.096) | (0.008) | (0.138) | (0.193) |
| | Serve Garden | 0.014 *** | 0.274 *** | 0.381 *** | 0.018 ** | 0.301 ** | 0.419 ** |
| | | (0.004) | (0.075) | (0.105) | (0.008) | (0.139) | (0.193) |
| | Taste Garden | -0.006 | -0.126 | -0.175 | -0.021 * | -0.349 * | -0.486 * |
| | | (0.004) | (0.079) | (0.110) | (0.011) | (0.178) | (0.248) |
| | Field Trip | 0.002 | 0.036 | 0.050 | 0.005 | 0.081 | 0.113 |
| | | (0.003) | (0.066) | (0.092) | (0.007) | (0.116) | (0.161) |
| | Farmer Visit | 0.000 | -0.003 | -0.005 | 0.035 *** | 0.589 *** | 0.821 *** |
| | | (0.004) | (0.080) | (0.112) | (0.009) | (0.144) | (0.201) |
| | Themed Promo | -0.016 *** | -0.307 *** | -0.427 *** | 0.029 *** | 0.494 *** | 0.689 *** |
| | | (0.004) | (0.069) | (0.095) | (0.009) | (0.152) | (0.212) |
| | Promote Local | 0.018 *** | 0.357 *** | 0.496 *** | 0.016 ** | 0.271 ** | 0.378 ** |
| | | (0.003) | (0.064) | (0.089) | (0.008) | (0.128) | (0.179) |
| | Media Cover | 0.009 ** | 0.173 ** | 0.241 ** | -0.033 *** | -0.554 *** | -0.772 *** |
| | | (0.004) | (0.084) | (0.117) | (0.010) | (0.163) | (0.227) |
| | Hosted Events | 0.019 *** | 0.369 *** | 0.512 *** | 0.002 | 0.032 | 0.045 |
| | | (0.005) | (0.091) | (0.126) | (0.010) | (0.176) | (0.246) |
| | F2S Month | 0.015 *** | 0.285 *** | 0.396 *** | 0.007 | 0.122 | 0.171 |
| | | (0.004) | (0.072) | (0.100) | (0.008) | (0.141) | (0.197) |
| | Curriculum | 0.000 | -0.002 | -0.003 | -0.045 *** | -0.759 *** | -1.058 *** |
| | | (0.004) | (0.088) | (0.122) | (0.010) | (0.168) | (0.234) |
| Spec4 | Cafeteria/Promo Index | 0.001 *** | 0.017 *** | 0.024 *** | 0.000 | 0.002 | 0.003 |
| | | (0.000) | (0.002) | (0.003) | (0.000) | (0.003) | (0.005) |
| | Education/Garden Index | 0.001 *** | 0.017 *** | 0.024 *** | 0.000 | -0.001 | -0.001 |
| | | (0.000) | (0.002) | (0.003) | (0.000) | (0.004) | (0.006) |
| Spec5 | NCafeteria/Promo Act I | 0.003 *** | 0.065 *** | 0.090 *** | 0.003 ** | 0.049 ** | 0.069 ** |
| | | (0.001) | (0.012) | (0.017) | (0.001) | (0.024) | (0.034) |
| | NEducation/Garden Act I | 0.004 *** | 0.069 *** | 0.096 *** | -0.004 | -0.065 | -0.090 |
| | | (0.001) | (0.020) | (0.028) | (0.003) | (0.043) | (0.059) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively. aN=114,208; bN=34,550

**Table 4.9:** Marginal Effects: Changes in FTSP exposure intensity – Dependent Variable: Monthly FV Expenditure (FVExp) by households with income below and above 185% of poverty guideline

| Spec | FTSP exposure intensity | Households below 185% of poverty guideline | | | Households above 185% of poverty guideline | | |
|---|---|---|---|---|---|---|---|
| | | Pr(FV>0) | E(FV) | E(FV\|FV>0) | Pr(FV>0) | E(FV) | E(FV\|FV>0) |
| Spec1 | N FTS Years | 0.003 | 0.127 | 0.179 | 0.005 *** | 0.255 *** | 0.357 *** |
| | | (0.002) | (0.081) | (0.115) | (0.001) | (0.070) | (0.097) |
| Spec2 | NFTS$^{Act}$ | 0.004 *** | 0.149 *** | 0.210 *** | 0.002 *** | 0.128 *** | 0.180 *** |
| | | (0.001) | (0.027) | (0.038) | (0.000) | (0.022) | (0.031) |
| Spec3 | Serve Local | -0.007 | -0.269 | -0.378 | 0.008 ** | 0.423 ** | 0.592 ** |
| | | (0.005) | (0.201) | (0.284) | (0.003) | (0.175) | (0.245) |
| | Taste Demos | -0.010 | -0.391 | -0.551 | -0.008 ** | -0.447 ** | -0.626 ** |
| | | (0.006) | (0.245) | (0.345) | (0.004) | (0.203) | (0.285) |
| | Food Coach | -0.040 *** | -1.592 *** | -2.242 *** | -0.004 | -0.245 | -0.342 |
| | | (0.007) | (0.272) | (0.383) | (0.004) | (0.224) | (0.313) |
| | School Garden | 0.016 ** | 0.614 ** | 0.866 ** | -0.003 | -0.163 | -0.228 |
| | | (0.007) | (0.274) | (0.385) | (0.004) | (0.224) | (0.314) |
| | Serve Garden | 0.018 ** | 0.701 ** | 0.987 ** | 0.024 *** | 1.355 *** | 1.897 *** |
| | | (0.007) | (0.277) | (0.390) | (0.004) | (0.246) | (0.345) |
| | Taste Garden | -0.006 | -0.239 | -0.337 | -0.005 | -0.274 | -0.384 |
| | | (0.008) | (0.318) | (0.448) | (0.005) | (0.263) | (0.368) |
| | Field Trip | -0.008 | -0.334 | -0.471 | -0.003 | -0.181 | -0.254 |
| | | (0.006) | (0.249) | (0.351) | (0.004) | (0.213) | (0.298) |
| | Farmer Visit | 0.043 *** | 1.684 *** | 2.372 *** | -0.010 ** | -0.563 ** | -0.788 ** |
| | | (0.008) | (0.316) | (0.444) | (0.005) | (0.256) | (0.359) |
| | Themed Promo | -0.023 *** | -0.903 *** | -1.272 *** | -0.014 *** | -0.754 *** | -1.056 *** |
| | | (0.007) | (0.273) | (0.384) | (0.004) | (0.229) | (0.320) |
| | Promote Local | 0.025 *** | 1.006 *** | 1.416 *** | 0.009 ** | 0.525 ** | 0.734 ** |
| | | (0.006) | (0.244) | (0.344) | (0.004) | (0.212) | (0.296) |
| | Media Cover | -0.009 | -0.370 | -0.521 | 0.017 *** | 0.921 *** | 1.289 *** |
| | | (0.009) | (0.350) | (0.493) | (0.005) | (0.267) | (0.374) |
| | Hosted Events | 0.014 | 0.539 | 0.759 | 0.021 *** | 1.187 *** | 1.663 *** |
| | | (0.009) | (0.347) | (0.489) | (0.005) | (0.297) | (0.416) |
| | F2S Month | 0.017 ** | 0.666 ** | 0.937 ** | 0.022 *** | 1.198 *** | 1.678 *** |
| | | (0.007) | (0.288) | (0.405) | (0.004) | (0.231) | (0.324) |
| | Curriculum | 0.045 *** | 1.793 *** | 2.526 *** | -0.018 *** | -0.998 *** | -1.397 *** |
| | | (0.009) | (0.337) | (0.474) | (0.005) | (0.285) | (0.399) |
| Spec4 | Cafeteria/Promo Index | 0.001 *** | 0.038 *** | 0.054 *** | 0.001 *** | 0.030 *** | 0.042 *** |
| | | (0.000) | (0.007) | (0.010) | (0.000) | (0.006) | (0.008) |
| | Education/Garden Index | 0.001 *** | 0.052 *** | 0.073 *** | 0.001 *** | 0.030 *** | 0.042 *** |
| | | (0.000) | (0.008) | (0.011) | (0.000) | (0.006) | (0.009) |
| Spec5 | NCafeteria/Promo Act I | -0.001 | -0.045 | -0.064 | 0.003 *** | 0.159 *** | 0.222 *** |
| | | (0.001) | (0.048) | (0.068) | (0.001) | (0.039) | (0.054) |
| | NEducation/Garden Act I | 0.013 *** | 0.511 *** | 0.720 *** | 0.001 | 0.064 | 0.089 |
| | | (0.002) | (0.083) | (0.117) | (0.001) | (0.065) | (0.092) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively. aN=114,208; bN=34,550

**Table 4.10:** Marginal Effects: Changes in FTSP exposure intensity – Dependent Variable: Monthly FV Expenditure share (FVExpSh) by households with income below and above 185% of poverty guideline

| Spec | FTSP exposure intensity | Households below 185% of poverty guideline | | | Households above 185% of poverty guideline | | |
|---|---|---|---|---|---|---|---|
| | | Pr(FV>0) | E(FV) | E(FV\|FV>0) | Pr(FV>0) | E(FV) | E(FV\|FV>0) |
| Spec1 | $\text{NFTS}^{Years}$ | 0.010 *** | 0.159 *** | 0.225 *** | 0.006 *** | 0.125 *** | 0.172 *** |
| | | (0.002) | (0.031) | (0.044) | (0.001) | (0.023) | (0.032) |
| Spec2 | $\text{NFTS}^{Act}$ | 0.003 *** | 0.046 *** | 0.065 *** | 0.003 *** | 0.064 *** | 0.088 *** |
| | | (0.001) | (0.010) | (0.014) | (0.000) | (0.007) | (0.010) |
| Spec3 | Serve Local | 0.010 ** | 0.155 ** | 0.218 ** | 0.005 * | 0.103 * | 0.143 * |
| | | (0.005) | (0.077) | (0.109) | (0.003) | (0.059) | (0.081) |
| | Taste Demos | -0.016 *** | -0.253 *** | -0.357 *** | -0.009 *** | -0.196 *** | -0.270 *** |
| | | (0.006) | (0.094) | (0.133) | (0.003) | (0.068) | (0.094) |
| | Food Coach | -0.016 ** | -0.253 ** | -0.357 ** | 0.002 | 0.048 | 0.067 |
| | | (0.007) | (0.104) | (0.147) | (0.004) | (0.075) | (0.103) |
| | School Garden | 0.014 ** | 0.220 ** | 0.310 ** | 0.002 | 0.049 | 0.067 |
| | | (0.007) | (0.105) | (0.148) | (0.004) | (0.075) | (0.104) |
| | Serve Garden | 0.017 ** | 0.268 ** | 0.378 ** | 0.015 *** | 0.314 *** | 0.433 *** |
| | | (0.007) | (0.107) | (0.150) | (0.004) | (0.083) | (0.114) |
| | Taste Garden | -0.028 *** | -0.432 *** | -0.609 *** | -0.002 | -0.047 | -0.064 |
| | | (0.008) | (0.122) | (0.173) | (0.004) | (0.088) | (0.122) |
| | Field Trip | 0.002 | 0.028 | 0.040 | -0.001 | -0.020 | -0.028 |
| | | (0.006) | (0.096) | (0.135) | (0.003) | (0.071) | (0.098) |
| | Farmer Visit | 0.027 *** | 0.428 *** | 0.604 *** | 0.004 | 0.087 | 0.120 |
| | | (0.008) | (0.121) | (0.171) | (0.004) | (0.086) | (0.119) |
| | Themed Promo | -0.005 | -0.083 | -0.117 | -0.013 *** | -0.262 *** | -0.362 *** |
| | | (0.007) | (0.105) | (0.148) | (0.004) | (0.077) | (0.106) |
| | Promote Local | 0.017 *** | 0.273 *** | 0.385 *** | 0.019 *** | 0.388 *** | 0.536 *** |
| | | (0.006) | (0.094) | (0.132) | (0.003) | (0.071) | (0.098) |
| | Media Cover | -0.022 ** | -0.337 ** | -0.476 ** | 0.005 | 0.105 | 0.144 |
| | | (0.009) | (0.135) | (0.190) | (0.004) | (0.090) | (0.124) |
| | Hosted Events | 0.020 ** | 0.314 ** | 0.443 ** | 0.016 *** | 0.336 *** | 0.464 *** |
| | | (0.008) | (0.133) | (0.188) | (0.005) | (0.100) | (0.138) |
| | F2S Month | 0.012 * | 0.189 * | 0.266 * | 0.015 *** | 0.300 *** | 0.414 *** |
| | | (0.007) | (0.111) | (0.156) | (0.004) | (0.077) | (0.107) |
| | Curriculum | 0.012 | 0.192 | 0.271 | -0.013 *** | -0.276 *** | -0.381 *** |
| | | (0.008) | (0.129) | (0.183) | (0.005) | (0.095) | (0.132) |
| Spec4 | Cafeteria/Promo Index | 0.001 *** | 0.014 *** | 0.020 *** | 0.001 *** | 0.015 *** | 0.021 *** |
| | | (0.000) | (0.003) | (0.004) | (0.000) | (0.002) | (0.003) |
| | Education/Garden Index | 0.001 *** | 0.011 *** | 0.016 *** | 0.001 *** | 0.015 *** | 0.021 *** |
| | | (0.000) | (0.003) | (0.004) | (0.000) | (0.002) | (0.003) |
| Spec5 | NCafeteria/Promo Act I | 0.002 * | 0.033 * | 0.046 * | 0.004 *** | 0.078 *** | 0.107 *** |
| | | (0.001) | (0.019) | (0.026) | (0.001) | (0.013) | (0.018) |
| | NEducation/Garden Act I | 0.004 ** | 0.069 ** | 0.097 ** | 0.002 | 0.032 | 0.044 |
| | | (0.002) | (0.032) | (0.045) | (0.001) | (0.022) | (0.030) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively. aN=114,208; bN=34,550

### 4.4.4 Falsification exercise

The results discussed above highlight the positive association between exposure to children's FTSP and household FV expenditures and FV expenditure shares. However, it is possible that the estimated positive relationship between FTSP and FV expenditures is due to overall changes in dietary quality over time, or to other factors that are correlated with both higher FV expenditures as well as school districts' incentives to adopt FTSP, and not necessarily because of children's direct exposure to FTSP. To verify the extent to which our results may be an artifact of other forces at play, we conduct two falsification exercises [58]. In the first falsification exercise, we estimate our model using liquor expenditures and expenditure shares (out of total expenditures for food and liquor) by households with children as dependent variables[59]. Intuitively, there should be no relationship between children in the household being exposed to FTSP, and the decisions of the adults in the households to purchase liquors. Thus, we expect not to find any relationship between exposure to FTSP activities and liquor expenditures (and expenditure shares). Instead, if there is a strong correlation between forces driving FTSP adoption and overall changes in dietary habit, unrelated to FTSP per se, we should observe a negative and statistically significant relationship of FTSP intensity and liquor expenditures. Similarly, if the results for FV expenditures illustrated above capture household expenditures in food and non-food items (such as liquor) being higher in more affluent areas, which also tend to show higher rates of FTSP adoption, regressing liquor expenditure on FTSP we should observe a positive relationship between household liquor expenditures and FTSP exposure.

The average marginal effects of the FTSP intensity measures (Specifications 2, 3 and 5) are reported in Table 4.11. We fail to find a statistically significant relationship between liquor expenditures (in level and share) and most of our FTSP Intensity measures: $NFTS^{Act}$, $NCafeteria$

[58]We only conduct the falsification exercise for Specification 2, 3, and 5. We did not conduct the falsification exercise for Specification 1, because, it may still capture a time trend. Also, the reason behind not conducting the falsification exercise for Specification 4 is that, the PCFs for the second falsification may not be similar to the PCFs used in the main study as the sample we use in the second falsification test (households with without children) is different from the main study (households with children), which would not allow us to generate comparable results.

[59]We use the same control variables used in the main model.

$/Promo\ Activities\ I$, and $NEducation/Garden\ Activities\ I$. However, we do find negative (positive) and statistically significant associations with liquor expenditures and expenditure shares for $Serve\ Local$, $Food\ Coach$, and $Taste\ Garden$ ($Field\ Trip$ and $F2S\ Month$). Most average marginal effects of the FTSP exposure measures on liquor expenditures and shares (reported in Table 4.11) are not significantly different from zero. Also, the marginal effects of the activities that have a positive association with FV expenditure (FV expenditure share)-$Field\ Trip$ and $F2S\ Month$ ($Hosted\ Events$ and $F2S\ Month$)- resulted in smaller magnitude compared to the results in Table 4.6. This suggests the association between FTSP exposure intensity variables and FV expenditures or shares is more likely to be driven by childrens' exposure to FTSP itself, and not because of other unobservables patterns such as a general movement towards a healthier diet.[60]

[60]We acknowledge that unlike FV purchases, purchasing liquor from grocery stores may not be common given the availability of liquor choices at the grocery stores. In fact, 83.2% of the observations (representing monthly liquor expenditure by households with children) in the data represent zero purchases.

**Table 4.11:** Marginal Effects: Changes in FTSP exposure intensity – Dependent Variables: Liquor Expenditure and expenditure share

| Spec | FTSP exposure intensity | Liquor Expenditure (LEx) | | | Liquor Expenditure Share (LSh) | | |
|---|---|---|---|---|---|---|---|
| | | Pr(LEx>0) | E(LEx) | E(LEx\|LEx>0) | Pr(LSh>0) | E(LSh) | E(LSh\|LSh>0) |
| Spec2 | NFTS$^{Act}$ | 0.000 | -0.010 | -0.008 | 0.000 | -0.004 | -0.003 |
| | | (0.000) | (0.020) | (0.016) | (0.000) | (0.007) | (0.005) |
| Spec3 | Serve Local | -0.006 ** | -0.343 ** | -0.277 ** | -0.003 | -0.056 | -0.045 |
| | | (0.003) | (0.159) | (0.128) | (0.003) | (0.053) | (0.043) |
| | Taste Demos | 0.001 | 0.074 | 0.059 | 0.001 | 0.017 | 0.014 |
| | | (0.003) | (0.187) | (0.151) | (0.003) | (0.062) | (0.050) |
| | Food Coach | -0.014 *** | -0.847 *** | -0.683 *** | -0.013 *** | -0.267 *** | -0.217 *** |
| | | (0.003) | (0.206) | (0.167) | (0.003) | (0.068) | (0.055) |
| | School Garden | 0.005 | 0.311 | 0.251 | 0.005 | 0.096 | 0.078 |
| | | (0.003) | (0.204) | (0.165) | (0.003) | (0.067) | (0.055) |
| | Serve Garden | -0.003 | -0.160 | -0.129 | -0.006 * | -0.125 * | -0.102 * |
| | | (0.004) | (0.220) | (0.177) | (0.004) | (0.073) | (0.059) |
| | Taste Garden | -0.013 *** | -0.783 *** | -0.631 *** | -0.010 ** | -0.204 ** | -0.166 ** |
| | | (0.004) | (0.243) | (0.196) | (0.004) | (0.080) | (0.065) |
| | Field Trip | 0.005 * | 0.331 * | 0.267 * | 0.003 | 0.055 | 0.045 |
| | | (0.003) | (0.195) | (0.157) | (0.003) | (0.064) | (0.052) |
| | Farmer Visit | 0.005 | 0.285 | 0.229 | 0.002 | 0.042 | 0.034 |
| | | (0.004) | (0.237) | (0.191) | (0.004) | (0.078) | (0.064) |
| | Themed Promo | -0.003 | -0.166 | -0.134 | -0.001 | -0.018 | -0.015 |
| | | (0.003) | (0.208) | (0.168) | (0.003) | (0.069) | (0.056) |
| | Promote Local | 0.001 | 0.050 | 0.040 | 0.002 | 0.035 | 0.028 |
| | | (0.003) | (0.192) | (0.155) | (0.003) | (0.063) | (0.052) |
| | Media Cover | 0.006 | 0.393 | 0.317 | 0.006 | 0.126 | 0.102 |
| | | (0.004) | (0.253) | (0.204) | (0.004) | (0.083) | (0.068) |
| | Hosted Events | 0.006 | 0.380 | 0.307 | 0.008 * | 0.157 * | 0.128 * |
| | | (0.004) | (0.271) | (0.219) | (0.005) | (0.089) | (0.073) |
| | F2S Month | 0.012 *** | 0.722 *** | 0.582 *** | 0.007 * | 0.137 * | 0.112 * |
| | | (0.004) | (0.215) | (0.174) | (0.004) | (0.071) | (0.058) |
| | Curriculum | -0.002 | -0.130 | -0.105 | -0.001 | -0.011 | -0.009 |
| | | (0.004) | (0.262) | (0.211) | (0.004) | (0.086) | (0.070) |
| Spec5 | NCafeteria/Promo Act I | 0.000 | 0.002 | 0.002 | 0.000 | 0.005 | 0.004 |
| | | (0.001) | (0.036) | (0.029) | (0.001) | (0.012) | (0.010) |
| | NEducation/Garden Act. I | 0.000 | -0.023 | -0.018 | -0.001 | -0.018 | -0.014 |
| | | (0.001) | (0.061) | (0.049) | (0.001) | (0.020) | (0.016) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively. N=148,758

In the second falsification exercise, we estimate the relationship between FTSP exposure intensity and FV expenditure (expenditure shares) using a sample of households without children [61]. For the results discussed above to truly capture the relationship between FTSP intensity and FV expenditures, we should find no relationship among household without children, as these households are not exposed to FTSP. Positive and statistically significant relationships would be evidence that the relationship between FTSP intensity and FV expenditures are inflated due to spurious correlation; the magnitude of such relationships (by means of estimated average marginal effects) can inform us on the magnitude of such bias.

The average marginal effects of the FTSP intensity measures (Specifications 2, 3, and 5) are reported in Table 4.12. We observe a positive association between some FTSP intensity variables ($NFTS^{Act}$, some FTSP activities, and $NCafeteria/Promo\ Activities\ I$) and FV expenditure or expenditure share for households without children, suggesting that spurious correlation and unobservables such as a trend towards healthier diets may be in part driving our main results. However, the magnitudes of the marginal effects of the FTSP intensity variables on households without children are much smaller than those obtained for households with children. For instance, implementing one more FTSP activity is associated with \$0.18 increase in conditional FV expenditure for households with children, but only with \$0.04 for households without children, suggesting the bias is +22%. Thus, although some upward bias may be present, the association between FTSP exposure intensity and FV expenditure or shares among households with children is more likely to be driven by the effect of kids' exposure to FTSP.

[61] We use the same control variables used in the main model, except variables capturing the age group of children in the households

**Table 4.12:** Marginal Effects: Changes in FTSP exposure intensity – Dependent Variables: Monthly FV Expenditure (FVExp) and FV Expenditure share (FVExpSh)

| Spec | FTSP exposure intensity | FVExp | | | FVExpSh | | |
|---|---|---|---|---|---|---|---|
| | | Pr(FV>0) | E(FV) | E(FV\|FV>0) | Pr(FV>0) | E(FV) | E(FV\|FV>0) |
| Spec2 | NFTS$^{Act}$ | 0.001 *** | 0.030 *** | 0.041 *** | 0.001 *** | 0.031 *** | 0.040 *** |
| | | (0.000) | (0.010) | (0.013) | (0.000) | (0.004) | (0.005) |
| Spec3 | Serve Local | 0.000 | -0.025 | -0.034 | 0.004 *** | 0.129 *** | 0.167 *** |
| | | (0.001) | (0.077) | (0.104) | (0.001) | (0.032) | (0.042) |
| | Taste Demos | 0.002 | 0.116 | 0.156 | 0.002 * | 0.056 * | 0.073 * |
| | | (0.001) | (0.078) | (0.106) | (0.001) | (0.033) | (0.043) |
| | Food Coach | -0.004 *** | -0.244 *** | -0.329 *** | 0.002 | 0.059 | 0.076 |
| | | (0.001) | (0.086) | (0.116) | (0.001) | (0.036) | (0.047) |
| | School Garden | 0.004 *** | 0.262 *** | 0.354 *** | 0.000 | 0.009 | 0.012 |
| | | (0.001) | (0.087) | (0.118) | (0.001) | (0.037) | (0.048) |
| | Serve Garden | -0.001 | -0.052 | -0.070 | 0.002 | 0.055 | 0.072 |
| | | (0.002) | (0.090) | (0.122) | (0.001) | (0.038) | (0.049) |
| | Taste Garden | 0.003 | 0.155 | 0.209 | 0.000 | 0.000 | 0.000 |
| | | (0.002) | (0.100) | (0.136) | (0.001) | (0.042) | (0.055) |
| | Field Trip | 0.001 | 0.048 | 0.065 | -0.002 | -0.051 | -0.066 |
| | | (0.001) | (0.081) | (0.109) | (0.001) | (0.034) | (0.044) |
| | Farmer Visit | 0.001 | 0.083 | 0.111 | 0.002 | 0.060 | 0.078 |
| | | (0.002) | (0.097) | (0.131) | (0.001) | (0.041) | (0.053) |
| | Themed Promo | -0.001 | -0.037 | -0.050 | -0.001 | -0.030 | -0.038 |
| | | (0.001) | (0.088) | (0.119) | (0.001) | (0.037) | (0.048) |
| | Promote Local | 0.002 | 0.090 | 0.121 | 0.001 | 0.029 | 0.037 |
| | | (0.001) | (0.079) | (0.107) | (0.001) | (0.034) | (0.043) |
| | Media Cover | -0.002 | -0.102 | -0.137 | 0.000 | -0.007 | -0.009 |
| | | (0.002) | (0.104) | (0.141) | (0.001) | (0.044) | (0.057) |
| | Hosted Events | 0.008 *** | 0.485 *** | 0.655 *** | 0.001 | 0.021 | 0.027 |
| | | (0.002) | (0.114) | (0.154) | (0.001) | (0.048) | (0.062) |
| | F2S Month | 0.004 ** | 0.232 ** | 0.313 ** | 0.003 ** | 0.087 ** | 0.113 ** |
| | | (0.002) | (0.091) | (0.123) | (0.001) | (0.038) | (0.050) |
| | Curriculum | -0.011 *** | -0.647 *** | -0.873 *** | 0.000 | 0.011 | 0.014 |
| | | (0.002) | (0.112) | (0.151) | (0.001) | (0.047) | (0.061) |
| Spec5 | NCafeteria/Promo Activities I | 0.002 *** | 0.097 *** | 0.135 *** | 0.003 *** | 0.064 *** | 0.089 *** |
| | | 0.001 * | 0.033 * | 0.044 * | 0.001 *** | 0.045 *** | 0.058 *** |
| | NEducation/Garden Activities I | (0.000) | (0.017) | (0.023) | (0.000) | (0.007) | (0.009) |
| | | 0.000 | 0.029 | 0.040 | 0.000 | 0.002 | 0.003 |
| | | (0.000) | (0.026) | (0.035) | (0.000) | (0.011) | (0.014) |

Note: Standard errors in parenthesis. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively. N=320,537

### 4.4.5 Discussion

The results illustrated above present evidence that a positive and statistically significant relationship exists between (most) FTSP activities and a household's FV expenditures and FV expenditure shares. Overall, it appears that this relationship is the strongest for cafeteria based activities, including those related to school garden and promotional activities; field trips and curriculum related activities do not show a positive and statistically significant relationship with FV expenditures and shares for the most part. Also, households with children residing in metro areas seem to benefit more from the children's exposure to FTSP than those in non-metro areas. Similarly, households above the 185% poverty thresholds benefit more by their children being exposed to cafeteria-based and promotional activities than households below the 185% poverty thresholds. Conversely, households below the 185% poverty thresholds benefit more from education and school garden related activities.

From a policy standpoint, even though our results do suggest beneficial spillovers of children FTSP exposure to the entire household, the fact that households benefiting the most are those residing in metro areas and those above the 185% poverty threshold may raise concerns that FTSP may not be benefiting those who may need it the most. Some may find that the funding used for FTSP could be reallocated to programs that affect households in a more equitable manner.

Additionally, from the standpoint of promoting healthier diets, our results should be contextualized properly. First, it is important to note that even the largest estimated marginal effects are, in fact, rather small. The largest estimated marginal effects of a FTSP activity are $1.37 of "celebrating FTS" and about 0.47 percentage points of promoting locally produced foods at school, respectively on conditional FV expenditure and conditional FV expenditure shares, corresponding to a 4.52% increase in conditional FV expenditures and a 4% increase in conditional FV expenditure share. The magnitude of these effects are likely too small to indicate any meaningful changes in purchasing behavior leading to healthier diets. Further, the presence of a slight upward bias in the estimates, confirmed by the falsification exercises, reinforces our view that our results are unlikely to indicate a beneficial effect on diets of FTSP. Second, as the results of the falsification exercises show, it is possible that, in some cases, the estimated associations are biased upward and represent an upper bound to the actual effects of FTSP intensity on FV expenditures. Although the bias is likely low in most cases when considering the relationship between FV expenditure and most of the activities (in Spec 3) or *NEducation/Garden Activities I* (in Spec 5), in others the bias can be rather large - for instance Spec 2 and *NCafeteria/Promo Activities I* in Spec 5. Third, given the aggregate nature of the FV expenditure variables, it is possible that households whose children are exposed to locally procured foods may decide to purchase local / organic / higher value produce, which may imply that the positive and statistically significant relationship between school children exposure to FTSP and their household's FV expenditures includes households potentially switching to better quality produce rather than purchasing more. Fourth, it should be noted that because we are unable to identify with certainty which households with children were exposed to FTSP, our results should be interpreted as "intent-to-treat" households, and one could expect a higher spillover effect on the actual treated households, which suggest that the positive relationships we find between FTSP participation and FV expenditure may actually be biased downwards.

## 4.5 Conclusions, Limitations and Future Research

In this analysis, we used FTS Census data matched with three years of households' monthly FV purchases to study the indirect relationship between children's exposure to FTSP activities and household expenditure / expenditure share of FV. Our results indicate a positive and statistically significant relationship between children's exposure to FTSP activities, and both FV expenditures and expenditure shares. This relationship is the strongest for cafeteria-based activities, including those related to school garden and promotional activities; field trips and curriculum related activities do not show a positive and statistically significant relationship with FV expenditure and shares for the most part. The magnitude of the estimated marginal effects show that this positive association is more prominent in households residing in metro areas than non-metro areas; and for households above the 185% poverty threshold than for those below, with some exceptions.

This study has four main limitations. First, our outcome variables are, at best, proxies for FV consumption as they do not account for difference in "quality" differentials in household purchases, as well as price differences across time and space. It is possible that a positive relationship between FV expenditures and FTSP exposure may capture households switching to higher priced local or organic produce, in place of conventional.

Second, as discussed in Sweitzer et al. (2017), the IRI data used in this work report lower expenditures for the FV category than other datasets (i.e. the Consumer Expenditure Survey and USDA's National Household Food Acquisition and Purchase Survey). As a result, our estimated relationship between FTSP and FV expenditures may be biased downward.

The third limitation of this study is our failure to account for school districts' decision to participate/continue participation in FTS. Participation and continuation in the FTSP could reflect the community's interest in / easier access to local food, which may introduce bias in our estimates. (Botkins & Roe, 2018) found that counties with more farmer's markets per 10,000 people and counties with a food hub were more likely to participate in the FTSP. (Bonanno & Mendis, 2021) find that school districts' continuation decision is heavily influenced by the number and types of activities that were implemented in the previous year. Future work should explore methods to address the endogeneity of FTSP participation and intensity / duration.

Fourth, and last, we do not observe where the children of the households in the CNP attend school. Our results only capture whether residing in an area where the school implemented one or more FTSP activities (or have had them longer) is related to higher monthly FV expenditure. Thus, in this sense, the positive relationships we find between FTSP participation and FV expenditure may actually be biased downwards, as we 1) fail to capture the effect on households residing in a different zipcode, and 2) we are likely to be including households whose children do not attend a school implementing FTSP in another school district, for which the effect would be null.

# References

Aguiar, M., & Hurst, E. (2007). Life-cycle prices and production. *American Economic Review*, *97*(5), 1533–1559.

Allen, P., & Guthman, J. (2006). From "old school" to "farm-to-school": Neoliberalization from the ground up. *Agriculture and human values*, *23*(4), 401–415.

Asirvatham, J. (2009). Examining diet quality and body mass index in rural areas using a quantile regression framework. *Review of Regional Studies*, *39*(2), 149–169.

Baral, R., Davis, G. C., & You, W. (2011). Consumption time in household production: Implications for the goods-time elasticity of substitution. *Economics Letters*, *112*(2), 138–140.

Baum, C. F., & Cerulli, G. (2016). Estimating a dose-response function with heterogeneous response to confounders when treatment is continuous and endogenous. In *Working paper 9388, ecomod.*

Beatty, T. K., Nanney, M. S., & Tuttle, C. (2014). Time to eat? the relationship between food security and food-related time use. *Public health nutrition*, *17*(1), 66–72.

Becker, G. S. (1965). A theory of the allocation of time. *The economic journal*, 493–517.

Bhattacharya, J., Currie, J., & Haider, S. J. (2006). Breakfast of champions? the school breakfast program and the nutrition of children and families. *Journal of Human Resources*, *41*(3), 445–466.

Blisard, N., Smallwood, D., & Lutz, S. (1999). *Food cost indexes for low-income households and the general population* (Tech. Rep.). USDA ERS Technical Bulletin No. (TB-1872) 29 pp.

Blom-Hoffman, J., Kelleher, C., Power, T. J., & Leff, S. S. (2004). Promoting healthy food consumption among young children: Evaluation of a multi-component nutrition education program. *Journal of School Psychology*, *42*(1), 45–60.

Bonanno, A., & Mendis, S. S. (2021). Too cool for farm to school? analyzing the determinants of farm to school programming continuation. *Food Policy*, *102*, 102045.

Borah, B. J., & Basu, A. (2013). Highlighting differences between conditional and unconditional quantile regression approaches through an application to assess medication adherence. *Health economics*, *22*(9), 1052–1070.

Botkins, E. R., & Roe, B. E. (2018). Understanding participation in farm to school programs: Results integrating school and supply-side factors. *Food Policy*, *74*, 126–137.

Bruins, M. J., Van Dael, P., & Eggersdorfer, M. (2019). The role of nutrients in reducing the risk for noncommunicable diseases during aging. *Nutrients*, *11*(1), 85.

Brunello, G., De Paola, M., & Labartino, G. (2014). More apples fewer chips? the effect of school fruit schemes on the consumption of junk food. *Health policy*, *118*(1), 114–126.

Castagnini, R., Menon, M., & Perali, F. (2004). Extended and full incomes at the household and individual level: an application to farm households. *American Journal of Agricultural Economics*, *86*(3), 730–736.

Center for American Progress. (2021). *5 details about the largest increase to snap benefits in the program's history.* https://www.americanprogress.org/issues/poverty/news/2021/08/25/503024/5-details-largest-increase-snap-benefits-programs-history/. (Accessed: 2021-9-11)

Center on Budget and Policy Priorities. (2019a). *Chart book: Snap helps struggling families put food on the table.* https://www.cbpp.org/research/food-assistance/chart-book-snap-helps-struggling-families-put-food-on-the-table. (Accessed: 2021-9-11)

Center on Budget and Policy Priorities. (2019b). *Policy basics: The supplemental nutrition assistance program (snap).* https://www.cbpp.org/research/food-assistance/the-supplemental-nutrition-assistance-program-snap. (Accessed: 2021-11-24)

Centers for Disease Control and Prevention. (2017). *Only 1 in 10 adults get enough fruits or vegetables.* https://www.cdc.gov/media/releases/2017/p1116-fruit-vegetable-consumption.html#:~:text=Depending%20on%20their%20age%20and,of%20a%20healthy%20eating%20pattern. (Accessed: 2021-6-15)

Centers for Disease Control and Prevention. (2021). *Poor nutrition.* https://www.cdc.gov/chronicdisease/resources/publications/factsheets/nutrition.htm. (Accessed: 2021-6-02)

Cerulli, G. (2015). ctreatreg: Command for fitting dose–response models under exogenous and endogenous treatment. *The Stata Journal*, *15*(4), 1019–1045.

Choe, C., Flores-Lagunes, A., & Lee, S.-J. (2015). Do dropouts with longer training exposure benefit from training programs? korean evidence employing methods for continuous treatments. *Empirical Economics*, *48*(2), 849–881.

Cleary, R., Bonanno, A., Ghazaryan, A., Bellows, L., & McCloskey, M. (2020). School meals and quality of household food acquisitions. *Applied Economic Perspectives and Policy*.

Coleman-Jensen, A., Gregory, C., & Singh, A. (2019). Household food security in the united states in 2018. *USDA-ERS Economic Research Report*(270).

Coleman-Jensen, A., Gregory, C., & Singh, A. (2020). Household food security in the united states in 2019. *USDA-ERS Economic Research Report*(275).

Council on Food, Agricultural, and Resource Economics. (2021). *The implications of the proposed changes to snap.* https://www.cfare.org/new-blog/the-implications-of-the-proposed-changes-to-snap. (Accessed: 2021-3-27)

Davis, G. C., & You, W. (2010a, apr). The Thrifty Food Plan Is Not Thrifty When Labor Cost Is Considered. *The Journal of Nutrition*, *140*(4), 854–857. doi: 10.3945/jn.109.119594

Davis, G. C., & You, W. (2010b, June 4). The time cost of food at home: General and food stamp participant profiles. *Applied Economics*, *42*(20), 2537–2552. doi: 10.1080/00036840801964468

Davis, G. C., & You, W. (2011). Not enough money or not enough time to satisfy the thrifty food plan? a cost difference approach for estimating a money–time threshold. *Food Policy*, *36*(2), 101–107.

Davis, G. C., & You, W. (2013). Estimates of returns to scale, elasticity of substitution, and the thrifty food plan meal poverty rate from a direct household meal production function. *Food Policy*, *43*, 204–212.

Deaton, A., & Muellbauer, J. (1980). An Almost Ideal Demand System. *The American Economic Review*, *70*(3), 312–326.

Devine, C. M., Farrell, T. J., Blake, C. E., Jastran, M., Wethington, E., & Bisogni, C. A. (2009). Work conditions and the food choice coping strategies of employed parents. *Journal of nutrition education and behavior*, *41*(5), 365–370.

Di Daniele, N. (2019). *The role of preventive nutrition in chronic non-communicable diseases* (Vol. 11) (No. 5). Multidisciplinary Digital Publishing Institute.

Economic Researach Service. (2019). *Foodaps national household food acquisition and purchase survey.* https://www.ers.usda.gov/data-products/foodaps-national-household-food-acquisition-and-purchase-survey.aspx. (Accessed: 2020-5-13)

Economic Research Service. (2019). *Food security status of u.s. households in 2018.* https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/key-statistics-graphics.aspx#householdtype. (Accessed: 2019-10-30)

Feeding America. (2021). *Understand food insecurity.* https://hungerandhealth.feedingamerica.org/understand-food-insecurity/. (Accessed: 2021-11-24)

Filippetti, A., & Cerulli, G. (2018). Are local public services better delivered in more autonomous regions? evidence from european regions using a dose-response approach. *Papers in Regional Science*, *97*(3), 801–826.

Firpo, S., Fortin, N. M., & Lemieux, T. (2009). Unconditional quantile regressions. *Econometrica*, *77*(3), 953–973.

Food and Nutrition Service. (2017). *Global strategy on diet, physical activity and health.* https://www.fns.usda.gov/pressrelease/2012/012012. (Accessed: 2020-6-15)

Food and Nutrition Service. (2020). *Healthy eating index.* https://www.fns.usda.gov/healthy-eating-index-hei. (Accessed: 2022-4-23)

Gronau, R. (1980). Home Production–A Forgotten Industry Author. *The Review of Economics and Statistics*, *62*(3), 408–416.

Gronau, R. (1986). Home production—a survey. *Handbook of labor economics*, *1*, 273–304.

Guenther, P. M., Kirkpatrick, S. I., Reedy, J., Krebs-Smith, S. M., Buckman, D. W., Dodd, K. W., … Carroll, R. J. (2014). The healthy eating index-2010 is a valid and reliable measure of diet quality according to the 2010 dietary guidelines for americans. *The Journal of nutrition*, *144*(3), 399–407.

Hamermesh, D. S. (2008). Direct estimates of household production. *Economics Letters*, *98*(1), 31–34.

Harris, B. (2006). Tetrachoric correlation coefficient. *Encyclopedia of statistical sciences*.

Holben, D. H., & Marshall, M. B. (2017). Position of the academy of nutrition and dietetics: food insecurity in the united states. *Journal of the Academy of Nutrition and Dietetics*, *117*(12), 1991–2002.

Holland, J. H., Thompson, O. M., Godwin, H. H., Pavlovich, N. M., & Stewart, K. B. (2015). Farm-to-school programming in south carolina: An economic impact projection analysis. *Journal of Hunger & Environmental Nutrition*, *10*(4), 526–538.

Huffman, W. E. (2011). Household production and the demand for food and other inputs: Us evidence. *Journal of Agricultural and Resource Economics*, 465–487.

James Jr, H. S. (1996). The valuation of household production: How different are the opportunity cost and market price valuation methods?

Joshi, A., Azuma, A. M., & Feenstra, G. (2008). Do farm-to-school programs make a difference? findings and future research needs. *Journal of Hunger & Environmental Nutrition*, *3*(2-3), 229–246.

Joshi, A., Kalb, M., & Beery, M. (2006). *Going local: Paths to success for farm to school programs.* Los Angeles: occidental college and community Food security coalition.

Kerkhofs, M., & Kooreman, P. (2003). Identification and estimation of a class of household production models. *Journal of Applied Econometrics*, *18*(3), 337–369.

Khitarishvili, T., Rios-Avila, F., & Kim, K. (2015). Direct estimates of food and eating production function parameters for 2004–12 using an atus/ce synthetic dataset. *Levy Economics Institute, Working Papers Series*(836).

Kiker, B. F., & de Oliveira, M. (1990). Estimation and valuation of non-leisure time. *Oxford Bulletin of Economics and Statistics*, *52*(2), 115–141.

Kirkpatrick, S., & Tarasuk, V. (2003). The relationship between low income and household food expenditure patterns in canada. *Public health nutrition*, *6*(6), 589–597.

Kuhn, M. A. (2018). Who feels the calorie crunch and when? the impact of school meals on cyclical food insecurity. *Journal of Public Economics*, *166*, 27–38.

Lakkakula, A., Geaghan, J., Zanovec, M., Pierce, S., & Tuuri, G. (2010). Repeated taste exposure increases liking for vegetables by low-income elementary school children. *Appetite*, *55*(2), 226–231.

Lewbel, A. (1985). A Unified Approach to Incorporating Demographic or Other Effects into Demand Systems. *The Review of Economic Studies*, *52*(1), 1–18.

Lewbel, A., & Pendakur, K. (2009). Tricks with Hicks : The EASI Demand System. *American Economic Review*, *99*(3), 827–863.

Lopez, J. A. (2011). A comparison of price imputation methods under large samples and different levels of censoring. presented at 2011 AAEA & NAREA Joint Annual Meeting, Pittsburgh, Pennsylvania.

Lyson, H. C. (2016). National policy and state dynamics: A state-level analysis of the factors influencing the prevalence of farm to school programs in the united states. *Food Policy*, *63*, 23–35.

Mancino, L., & Gregory, C. A. (2012). *Does more cooking mean better eating? estimating the relationship between time spent in food preparation and diet quality* (Tech. Rep.).

Mancino, L., & Newman, C. (2007). *Who has time to cook? how family resources influence food preparation* (Tech. Rep.). USDA ERS No. 1477-2016-121080.

McDonald, J. F., & Moffitt, R. A. (1980). The uses of tobit analysis. *The review of economics and statistics*, 318–321.

Monsivais, P., Aggarwal, A., & Drewnowski, A. (2014). Time spent on home food preparation and indicators of healthy eating. *American journal of preventive medicine*, *47*(6), 796–802.

Moore, L. V., & Thompson, F. E. (2015). Adults meeting fruit and vegetable intake recommendations—united states, 2013. *MMWR. Morbidity and mortality weekly report*, *64*(26), 709.

Moss, A., Smith, S., Null, D., Long Roth, S., & Tragoudas, U. (2013). Farm to school and nutrition education: positively affecting elementary school-aged children's nutrition knowledge and consumption behavior. *Childhood obesity*, *9*(1), 51–56.

Murphy, M. (1978). The value of nonmarket household production: opportunity cost versus market cost estimates. *Review of Income and Wealth*, *24*(3), 243–255.

Muth, M. K., Sweitzer, M., Brown, D., Capogrossi, K., Karns, S. A., Levin, D., … Zhen, C. (2016). *Understanding iri household-based and store-based scanner data* (Tech. Rep.).

National Cancer Institute. (2014). *Usual dietary intakes: U.s. population, 2007–2010.* https://epi.grants.cancer.gov/diet/usualintakes/national-data-usual-dietary-intakes-2007-to-2010.pdf. (Accessed: 2020-6-15)

National Cancer Institute. (2022). *Steps for calculating hei scores.* https://epi.grants.cancer.gov/hei/calculating-hei-scores.html. (Accessed: 2022-5-12)

National Farm to School Network. (2020a). *Usda announces 2020 farm to school grant recipients.* http://www.farmtoschool.org/news-and-articles/usda-announces-2020-farm-to-school-grant-recipients. (Accessed: 2020-6-15)

National Farm to School Network. (2020b). *What is farm to school?* http://www.farmtoschool.org/about. (Accessed: 2020-6-15)

Park, J. L., Holcomb, R. B., Raper, K. C., & Capps Jr, O. (1996). A demand systems analysis of food commodities by us households segmented by income. *American Journal of Agricultural Economics*, *78*(2), 290–300.

Pendakur, K. (2009). Easi made easier. *Quantifying Consumer Preferences*, 179–206.

Rogus, S. (2018). Examining the influence of perceived and objective time constraints on the quality of household food purchases. *Appetite*, *130*, 268–273.

Scharadin, B., & Jaenicke, E. C. (2020). Time spent on childcare and the household healthy eating index. *Review of Economics of the Household*, 1–30.

Schmidt, M. C., Kolodinsky, J., & Symans, C. (2006). The burlington school food project, final evaluation report. *Burlington, VT: A Report for the Center for Rural Studies*.

Shonkwiler, J. S., & Yen, S. T. (1999). Two-step estimation of a censored system of equations. *American Journal of Agricultural Economics*, *81*(4), 972–982.

Smith, T. A. (2017). Do school food programs improve child dietary quality? *American Journal of Agricultural Economics*, *99*(2), 339–356.

Somerset, S., & Markwell, K. (2009). Impact of a school-based food garden on attitudes and identification skills regarding vegetables and fruit: a 12-month intervention trial. *Public Health Nutrition*, *12*(2), 214–221.

Stewart, H., Blisard, N., Bhuyan, S., & Nayga Jr, R. M. (2004). *The demand for food away from home: Full-service or fast food?* (Tech. Rep.). USDA AER No. 829.

Taylor, J., & Johnson, R. (2013). F arm to s chool as a strategy to increase children's fruit and vegetable consumption in the u nited s tates: Research and recommendations. *Nutrition Bulletin*, *38*(1), 70–79.

The White House. (2010). *Child nutrition reauthorization.* obamawhitehouse.archives.gov/sites/default/files/Child_Nutrition_Fact_Sheet_12_10_10.pdf. (Accessed: 2020-7-8)

Thompson, B., & Amoroso, L. (2011). *Combating micronutrient deficiencies: food-based approaches*. CABI.

Tobin, J. (1958). Estimation of relationships for limited dependent variables. *Econometrica: journal of the Econometric Society*, 24–36.

United Stated Department of Agriculture. (2020a). *Scientific report of the 2020 dietary guidelines advisory committee.* https://www.dietaryguidelines.gov/sites/default/files/2020

-07/ScientificReport_of_the_2020DietaryGuidelinesAdvisoryCommittee_first-print.pdf. (Accessed: 2021-6-02)

United Stated Department of Agriculture. (2020b). *Usda nutrition assistance programs.* https://www.nal.usda.gov/fnic/usda-nutrition-assistance-programs. (Accessed: 2021-6-02)

U.S. Department of Agriculture and U.S. Department of Health and Human Services. (2020). *Dietary guidelines for americans 2020-2025.* https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf. (Accessed: 2021-6-02)

USDA. (2013). *Healthy hunger-free kids act.* fns.usda.gov/school-meals/healthy-hunger-free-kids-act. (Accessed: 2020-7-8)

USDA. (2015). *Food environment atlas. united states department of agriculture - economic research service.* www.ers.usda.gov/data-products/food-environment-atlas/data-access-and-documentation-downloads/. (Accessed: 2017-11-23)

USDA Center for Nutrition Policy and Promotion. (2006). *Thrifty food plan 2006.* https://www.fns.usda.gov/thrifty-food-plan-2006-report. (Accessed: 2021-9-11)

USDA Center for Nutrition Policy and Promotion. (2020). *Ta quick guide to snap eligibility and benefits.* https://www.cbpp.org/research/food-assistance/a-quick-guide-to-snap-eligibility-and-benefits. (Accessed: 2021-9-11)

USDA Food and Nutrition Service. (2019). *Facts about snap.* https://www.fns.usda.gov/snap/facts. (Accessed: 2021-9-11)

Vadiveloo, M. K., Parker, H. W., Juul, F., & Parekh, N. (2020). Sociodemographic differences in the dietary quality of food-at-home acquisitions and purchases among participants in the us nationally representative food acquisition and purchase survey (foodaps). *Nutrients*, *12*(8), 2354.

Vernon, V. (2005). Food expenditure, food preparation time and household economies of scale. *Food Preparation Time and Household Economies of Scale (February 2005)*.

Ver Ploeg, M. (2009). Do benefits of us food assistance programs for children spillover to older children in the same household? *Journal of Family and Economic Issues*, *30*(4), 412.

Vidoni, M. L., Reininger, B. M., & Lee, M. (2019). A comparison of mean-based and quantile regression methods for analyzing self-report dietary intake data. *Journal of Probability and Statistics*, *2019*.

Wardle, J., Herrera, M. L., Cooke, L., & Gibson, E. L. (2003). Modifying children's food preferences: the effects of exposure and reward on acceptance of an unfamiliar vegetable. *European journal of clinical nutrition*, *57*(2), 341–348.

Wilde, P. E., & Llobrera, J. (2009). Using the thrifty food plan to assess the cost of a nutritious diet. *Journal of Consumer Affairs*, *43*(2), 274–304.

Wolfson, J. A., & Bleich, S. N. (2015). Is cooking at home associated with better diet quality or weight-loss intention? *Public health nutrition*, *18*(8), 1397–1406.

World Health Organization. (2002). *Global strategy on diet, physical activity and health.* https://www.who.int/dietphysicalactivity/strategy/eb11344/strategy_english_web.pdf. (Accessed: 2020-6-15)

You, W., & Davis, G. C. (2019). Estimating dual headed time in food production with implications for snap benefit adequacy. *Review of Economics of the Household*, *17*(1), 249–266.

Zellner, A. (1962). An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias. *Journal of the American statistical Association*, *57*(298), 348–368.

Zhen, C., Finkelstein, E. A., Nonnemaker, J. M., Karns, S. A., & Todd, J. E. (2014). Predicting the effects of sugar-sweetened beverage taxes on food and beverage demand in a large demand system. *American journal of agricultural economics*, *96*(1), 1–25.

**Table A.1.** Correlation matrix of food-related activities

**(a)** Correlation matrix of food-related activities of SNAP participating households

| | eat drink | FAFH purchase | FAFH travel | FAFH waiting | grocery shopping | grocery travel | food preparar-tion | food pre-sentation | kitchen clean-up |
|---|---|---|---|---|---|---|---|---|---|
| eat drink | 1 | | | | | | | | |
| FAFH purchase | 0.2600 | 1 | | | | | | | |
| FAFH travel | 0.2938 | 0.7888 | 1 | | | | | | |
| FAFH waiting | 0.2070 | 0.2517 | 0.3516 | 1 | | | | | |
| grocery shopping | 0.2365 | 0.2571 | 0.2982 | 0.2231 | 1 | | | | |
| grocery travel | 0.2783 | 0.2758 | 0.3391 | 0.2694 | 0.6301 | 1 | | | |
| food preparartion | 0.1820 | 0.1322 | 0.1957 | 0.2575 | 0.3267 | 0.3060 | 1 | | |
| food presentation | 0.2139 | 0.2056 | 0.2207 | 0.1484 | 0.2081 | 0.2637 | 0.4122 | 1 | |
| kitchen clean-up | 0.2649 | 0.1856 | 0.2542 | 0.2482 | 0.3485 | 0.3518 | 0.4901 | 0.4676 | 1 |

**(b)** Correlation matrix of food-related activities of SNAP-eligible nonparticipating households

| | eat drink | FAFH purchase | FAFH travel | FAFH waiting | grocery shopping | grocery travel | food preparar-tion | food pre-sentation | kitchen clean-up |
|---|---|---|---|---|---|---|---|---|---|
| eat drink | 1 | | | | | | | | |
| FAFH purchase | 0.2334 | 1 | | | | | | | |
| FAFH travel | 0.2834 | 0.7822 | 1 | | | | | | |
| FAFH waiting | 0.2297 | 0.2196 | 0.3194 | 1 | | | | | |
| grocery shopping | 0.2136 | 0.2651 | 0.3127 | 0.1947 | 1 | | | | |
| grocery travel | 0.2653 | 0.3115 | 0.3438 | 0.243 | 0.6344 | 1 | | | |
| food preparartion | 0.2444 | 0.1269 | 0.1782 | 0.2322 | 0.348 | 0.4196 | 1 | | |
| food presentation | 0.1854 | 0.1519 | 0.1775 | 0.1119 | 0.2098 | 0.2128 | 0.3704 | 1 | |
| kitchen clean-up | 0.2522 | 0.0999 | 0.1514 | 0.3163 | 0.3391 | 0.3097 | 0.4684 | 0.4901 | 1 |

**(c)** Correlation matrix of food-related activities of SNAP ineligible households

| | eat drink | FAFH purchase | FAFH travel | FAFH waiting | grocery shopping | grocery travel | food preparar-tion | food pre-sentation | kitchen clean-up |
|---|---|---|---|---|---|---|---|---|---|
| eat drink | 1 | | | | | | | | |
| FAFH purchase | 0.1369 | 1 | | | | | | | |
| FAFH travel | 0.1842 | 0.6564 | 1 | | | | | | |
| FAFH waiting | 0.2007 | 0.1914 | 0.2504 | 1 | | | | | |
| grocery shopping | 0.2644 | 0.1647 | 0.2204 | 0.2304 | 1 | | | | |
| grocery travel | 0.2936 | 0.2378 | 0.2991 | 0.2842 | 0.6511 | 1 | | | |
| food preparartion | 0.1746 | 0.1020 | 0.1680 | 0.2384 | 0.3149 | 0.3461 | 1 | | |
| food presentation | 0.1310 | 0.2058 | 0.2183 | 0.2152 | 0.2009 | 0.2031 | 0.4215 | 1 | |
| kitchen clean-up | 0.2139 | 0.1383 | 0.1726 | 0.3059 | 0.3092 | 0.3118 | 0.4585 | 0.5443 | 1 |

**Table A.2.** Estimated OLS and UQR coefficients for SNAP participant households. Panel (a) Specification 1; Panel (b) Specification 2; and Panel (c) Specification 3.

**(a)** Estimated OLS and UQR coefficients for Specification 1.

| | OLS | RIF Regressions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 15 | 25 | 50 | 75 | 85 | 95 |
| food preparartion | 0.014 | 0.129 | -0.089 | 0.021 | 0.179 | -0.215 | -0.035 | -0.305 |
| | (0.154) | (0.284) | (0.213) | (0.197) | (0.213) | (0.226) | (0.263) | (0.318) |
| food presentation | -1.584 | -37.450 | 13.018 | 11.570 | -16.347 | 12.067 | 2.633 | 58.606 |
| | (20.220) | (51.222) | (28.530) | (26.130) | (29.443) | (28.381) | (29.884) | (47.534) |
| kitchen clean-up | -0.756 | -0.607 | 0.587 | -1.281 | -1.389 | -1.004 | -0.902 | -0.027 |
| | (0.726) | (1.323) | (0.917) | (0.923) | (1.080) | (0.948) | (1.039) | (1.721) |
| grocery shopping | 1.185 | -1.550 | 2.256 | -0.536 | -0.705 | 3.354 | 1.569 | 4.673 |
| | (1.538) | (2.389) | (1.834) | (1.706) | (2.153) | (2.434) | (3.335) | (4.942) |
| grocery travel | 1.703 | 4.100 | -4.318 | 1.648 | 5.792 | 3.549 | 8.890 | -5.512 |
| | (3.867) | (3.924) | (5.939) | (4.513) | (5.382) | (5.431) | (7.981) | (10.719) |
| FAFH purchase | 6.902 | 4.770 | 10.106 | 5.442 | 2.179 | 11.229 | 15.975 | -11.011 |
| | (11.973) | (19.387) | (11.563) | (13.955) | (18.846) | (19.276) | (24.128) | (32.730) |
| FAFH waiting | -79.776 | 103.885 | -103.211 | -82.464 | -137.341 | -119.094 | -152.506 | -66.414 |
| | (65.055) | (109.036) | (88.083) | (83.834) | (87.068) | (86.418) | (92.896) | (127.330) |
| FAFH travel | -0.263 | 10.060 | 3.064 | 6.278 | 0.159 | -1.947 | -11.718 | -4.900 |
| | (7.157) | (12.848) | (7.921) | (7.641) | (12.314) | (10.935) | (12.023) | (20.703) |
| eat drink | -0.017 | 0.058 | -0.092 | -0.031 | -0.071 | -0.028 | 0.046 | -0.024 |
| | (0.063) | (0.135) | (0.094) | (0.080) | (0.088) | (0.097) | (0.116) | (0.172) |
| exercise | -0.264 | -0.868 | -0.405 | 0.116 | 0.492 | -0.605 | -0.528 | -0.085 |
| | (0.419) | (0.990) | (0.700) | (0.475) | (0.635) | (0.480) | (0.566) | (0.939) |
| Hisp HH | 1.817 | 2.333 | 3.044 * | 3.121 ** | 0.978 | 1.277 | 2.689 | 1.804 |
| | (1.142) | (2.497) | (1.707) | (1.441) | (1.737) | (1.737) | (2.032) | (2.861) |
| Black HH | -0.432 | -0.204 | 1.502 | 2.175 | -2.462 | -1.953 | -1.324 | -1.563 |
| | (1.077) | (2.384) | (1.645) | (1.334) | (1.556) | (1.483) | (1.718) | (2.056) |
| Asian HH | 7.316 * | 4.917 ** | 6.552 * | 4.580 | 3.240 | 12.990 * | 4.235 | 16.835 |
| | (3.897) | (2.482) | (3.477) | (3.531) | (5.648) | (6.635) | (7.993) | (18.068) |
| Other HH | -0.697 | -3.082 | 0.420 | 0.959 | 0.056 | 0.538 | -0.693 | 0.198 |
| | (1.151) | (2.794) | (1.459) | (1.334) | (1.581) | (1.864) | (1.940) | (3.076) |
| HH size | -0.159 | 1.101 * | 0.118 | -0.141 | -0.289 | -0.286 | -0.717 | -0.773 |
| | (0.287) | (0.599) | (0.413) | (0.360) | (0.437) | (0.475) | (0.507) | (0.649) |
| Children | -0.656 | -2.461 | -1.337 | -1.522 | -0.262 | -1.880 | 0.150 | 0.082 |
| | (1.032) | (2.024) | (1.420) | (1.290) | (1.480) | (1.509) | (1.687) | (2.800) |
| Working | -0.010 | -1.432 | -0.081 | 0.368 | 0.740 | 0.530 | -0.087 | -0.583 |
| | (0.517) | (0.886) | (0.686) | (0.667) | (0.728) | (0.752) | (0.915) | (1.257) |
| Vehicle | 0.119 | -0.415 | -0.158 | -0.013 | 0.833 | -0.097 | -1.021 | 0.064 |
| | (0.767) | (1.247) | (0.961) | (0.933) | (1.028) | (1.147) | (1.295) | (1.687) |
| Own Home | -2.266 *** | -1.283 | -2.360 ** | -1.650 | -3.154 ** | -1.228 | -1.632 | -3.840 * |
| | (0.864) | (1.490) | (1.082) | (1.088) | (1.305) | (1.207) | (1.412) | (2.292) |
| Oth HomeOwn | 1.364 | 0.011 | -0.982 | 1.002 | 1.163 | 1.582 | 1.259 | -0.629 |
| | (1.841) | (3.178) | (2.353) | (2.210) | (2.687) | (2.689) | (3.186) | (4.220) |
| High School | -1.427 | -3.083 | -1.574 | -2.193 | -1.513 | -0.505 | -1.619 | 1.829 |
| | (1.138) | (2.003) | (1.595) | (1.435) | (1.561) | (1.519) | (2.087) | (2.524) |
| College | -0.360 | -2.702 | -1.245 | -1.142 | -0.917 | 1.462 | 0.936 | 0.697 |
| | (1.146) | (2.143) | (1.652) | (1.458) | (1.694) | (1.603) | (2.064) | (3.071) |
| Bachelors | 4.043 ** | -0.804 | 2.600 | 2.488 | 4.596 ** | 4.631 ** | 7.136 ** | 10.023 ** |
| | (1.564) | (2.416) | (1.832) | (1.804) | (2.306) | (2.317) | (3.432) | (4.916) |
| Postgraguate | 5.894 ** | 1.517 | 0.345 | 1.299 | 1.234 | 8.220 * | 14.496 ** | 25.165 ** |
| | (2.613) | (2.213) | (2.990) | (2.637) | (3.465) | (4.471) | (6.468) | (12.178) |
| Income | 0.138 | 0.231 | 0.175 | 0.143 | -0.019 | 0.082 | 0.130 | 0.356 |
| | (0.119) | (0.259) | (0.201) | (0.153) | (0.257) | (0.283) | (0.353) | (0.675) |
| Nonmetro | -0.950 | -1.184 | 0.357 | -0.372 | -1.934 | 0.044 | -0.532 | -2.351 |
| | (1.702) | (3.562) | (2.655) | (2.231) | (2.472) | (2.603) | (2.950) | (4.062) |
| Constant | 46.727 *** | 28.100 *** | 30.956 *** | 34.964 *** | 42.555 *** | 51.741 *** | 60.132 *** | 84.733 *** |
| | (4.354) | (6.990) | (6.309) | (5.552) | (6.228) | (5.635) | (7.499) | (13.972) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively.

**(b)** Estimated OLS and UQR coefficients for Specification 2.

| | OLS | RIF Regressions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 15 | 25 | 50 | 75 | 85 | 95 |
| stt1 | -0.017 | -0.027 | -0.002 | -0.047 | -0.041 | -0.021 | 0.013 | 0.038 |
| | (0.029) | (0.058) | (0.041) | (0.037) | (0.039) | (0.039) | (0.052) | (0.058) |
| stt2 | 0.022 | 0.133 * | 0.027 | 0.051 | -0.017 | 0.042 | -0.005 | -0.091 |
| | (0.038) | (0.073) | (0.048) | (0.041) | (0.055) | (0.055) | (0.065) | (0.094) |
| exercise | -0.233 | -0.889 | -0.519 | 0.090 | 0.446 | -0.472 | -0.315 | 0.080 |
| | (0.405) | (1.003) | (0.627) | (0.412) | (0.571) | (0.424) | (0.541) | (0.978) |
| Hisp HH | 1.701 | 2.363 | 2.988 ** | 2.951 ** | 0.732 | 1.146 | 2.414 | 1.882 |
| | (1.135) | (2.366) | (1.514) | (1.305) | (1.618) | (1.570) | (1.974) | (2.591) |
| Black HH | -0.482 | -0.179 | 1.467 | 2.133 | -2.558 | -2.016 | -1.496 | -1.502 |
| | (1.073) | (2.458) | (1.615) | (1.374) | (1.603) | (1.414) | (1.543) | (2.036) |
| Asian HH | 7.167 * | 5.502 ** | 6.153 * | 4.457 | 3.320 | 12.367 ** | 3.619 | 16.021 |
| | (3.877) | (2.470) | (3.347) | (3.214) | (5.014) | (5.955) | (8.525) | (17.203) |
| Other HH | -1.121 | -2.613 | 0.030 | 0.448 | -0.505 | -0.255 | -1.762 | -0.246 |
| | (1.099) | (2.813) | (1.350) | (1.332) | (1.658) | (1.646) | (1.867) | (2.770) |
| HH size | -0.220 | 1.100 * | 0.118 | -0.143 | -0.368 | -0.425 | -0.876 * | -0.816 |
| | (0.283) | (0.636) | (0.401) | (0.335) | (0.426) | (0.449) | (0.487) | (0.671) |
| Children | -0.570 | -2.730 | -1.156 | -1.399 | -0.248 | -1.571 | 0.395 | 0.489 |
| | (1.023) | (2.196) | (1.542) | (1.268) | (1.460) | (1.501) | (1.779) | (2.566) |
| Working | 0.042 | -1.365 | -0.116 | 0.431 | 0.876 | 0.584 | -0.010 | -0.645 |
| | (0.514) | (0.839) | (0.714) | (0.641) | (0.723) | (0.764) | (0.907) | (1.153) |
| Vehicle | 0.100 | -0.318 | -0.277 | -0.012 | 0.833 | -0.164 | -1.087 | 0.010 |
| | (0.764) | (1.216) | (0.992) | (0.944) | (1.004) | (1.132) | (1.205) | (1.719) |
| Own Home | -2.248 *** | -1.224 | -2.373 ** | -1.657 | -3.106 *** | -1.214 | -1.650 | -3.872 * |
| | (0.862) | (1.414) | (1.159) | (1.039) | (1.176) | (1.258) | (1.492) | (2.138) |
| Oth HomeOwn | 1.280 | -0.069 | -0.914 | 1.023 | 0.989 | 1.520 | 0.982 | -0.390 |
| | (1.832) | (3.105) | (2.597) | (2.211) | (2.385) | (2.427) | (2.944) | (4.724) |
| High School | -1.196 | -3.091 | -1.393 | -2.070 | -1.087 | -0.116 | -1.168 | 1.776 |
| | (1.125) | (1.921) | (1.417) | (1.358) | (1.576) | (1.696) | (1.714) | (2.527) |
| College | -0.159 | -2.808 | -1.016 | -1.074 | -0.639 | 1.878 | 1.344 | 0.835 |
| | (1.136) | (1.836) | (1.410) | (1.295) | (1.664) | (1.743) | (1.987) | (2.493) |
| Bachelors | 4.354 *** | -0.915 | 2.743 | 2.600 | 5.002 ** | 5.210 ** | 7.924 ** | 10.155 ** |
| | (1.550) | (2.241) | (1.768) | (1.690) | (2.129) | (2.457) | (3.163) | (4.519) |
| Postgraguate | 6.137 ** | 1.514 | 0.549 | 1.606 | 1.594 | 8.677 ** | 14.579 ** | 25.635 ** |
| | (2.587) | (1.938) | (2.703) | (2.747) | (3.830) | (3.987) | (6.285) | (10.687) |
| Income | 0.136 | 0.218 | 0.184 | 0.146 | -0.028 | 0.088 | 0.125 | 0.378 |
| | (0.119) | (0.270) | (0.207) | (0.177) | (0.277) | (0.284) | (0.356) | (0.655) |
| Nonmetro | -1.007 | -1.013 | 0.229 | -0.520 | -1.986 | 0.001 | -0.729 | -2.405 |
| | (1.691) | (3.653) | (2.789) | (2.468) | (2.364) | (2.604) | (3.001) | (4.199) |
| Constant | 46.785 *** | 29.088 *** | 30.897 *** | 35.306 *** | 42.664 *** | 51.658 *** | 60.174 *** | 83.675 *** |
| | (4.330) | (6.269) | (6.043) | (6.014) | (6.107) | (6.863) | (7.196) | (13.120) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively.

**(c)** Estimated OLS and UQR coefficients for Specification 3.

| | OLS | RIF Regressions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **5** | **15** | **25** | **50** | **75** | **85** | **95** |
| T_FAHprep | -0.147 | -0.117 | -0.101 | -0.227 * | -0.145 | -0.274 ** | -0.137 | 0.000 |
| | (0.090) | (0.204) | (0.140) | (0.136) | (0.139) | (0.126) | (0.143) | (0.233) |
| T_ShopFAHhathh | 0.284 | -0.894 | 0.651 | -0.827 | -0.530 | 1.607 | 1.278 | 1.492 |
| | (1.012) | (2.078) | (1.298) | (1.175) | (1.440) | (1.400) | (1.966) | (2.578) |
| T_FAFHhathh | 0.933 | 6.590 | 3.765 | 3.848 | 0.575 | 0.439 | -2.763 | -7.004 |
| | (2.433) | (4.491) | (2.976) | (2.875) | (3.787) | (3.638) | (3.967) | (5.689) |
| eat drink | -0.014 | 0.083 | -0.087 | -0.025 | -0.082 | -0.019 | 0.049 | -0.025 |
| | (0.062) | (0.131) | (0.093) | (0.074) | (0.085) | (0.087) | (0.124) | (0.174) |
| exercise | -0.232 | -0.822 | -0.431 | 0.149 | 0.498 | -0.515 | -0.438 | 0.013 |
| | (0.418) | (1.007) | (0.653) | (0.468) | (0.587) | (0.455) | (0.548) | (1.055) |
| Hisp HH | 1.716 | 2.529 | 2.964 ** | 3.020 ** | 0.714 | 1.143 | 2.405 | 1.785 |
| | (1.135) | (2.466) | (1.453) | (1.437) | (1.740) | (1.655) | (1.923) | (2.800) |
| Black HH | -0.486 | -0.145 | 1.433 | 2.120 | -2.596 * | -2.017 | -1.470 | -1.504 |
| | (1.073) | (2.168) | (1.426) | (1.433) | (1.515) | (1.472) | (1.634) | (2.131) |
| Asian HH | 7.093 * | 5.500 ** | 5.953 * | 4.323 | 3.195 | 12.285 * | 3.626 | 15.907 |
| | (3.878) | (2.496) | (3.209) | (3.490) | (4.386) | (6.967) | (8.376) | (18.686) |
| Other HH | -1.104 | -2.335 | -0.027 | 0.506 | -0.606 | -0.227 | -1.717 | -0.373 |
| | (1.098) | (2.559) | (1.561) | (1.233) | (1.614) | (1.701) | (1.908) | (3.134) |
| HH size | -0.182 | 1.089 * | 0.166 | -0.127 | -0.361 | -0.326 | -0.797 * | -0.734 |
| | (0.283) | (0.610) | (0.405) | (0.359) | (0.418) | (0.446) | (0.471) | (0.675) |
| Children | -0.606 | -2.678 | -1.196 | -1.415 | -0.284 | -1.675 | 0.336 | 0.451 |
| | (1.024) | (2.107) | (1.460) | (1.274) | (1.545) | (1.537) | (1.639) | (2.380) |
| Working | 0.026 | -1.347 | -0.189 | 0.405 | 0.852 | 0.562 | -0.012 | -0.647 |
| | (0.514) | (0.905) | (0.680) | (0.567) | (0.846) | (0.866) | (0.955) | (1.313) |
| Vehicle | 0.168 | -0.213 | -0.216 | 0.099 | 0.879 | -0.044 | -1.030 | 0.008 |
| | (0.764) | (1.217) | (1.045) | (0.985) | (1.129) | (1.186) | (1.191) | (1.791) |
| Own Home | -2.295 *** | -1.152 | -2.464 ** | -1.684 | -3.156 ** | -1.331 | -1.717 | -3.956 |
| | (0.863) | (1.582) | (1.199) | (1.037) | (1.248) | (1.330) | (1.429) | (2.422) |
| Oth HomeOwn | 1.165 | -0.297 | -1.122 | 0.784 | 0.893 | 1.351 | 0.964 | -0.221 |
| | (1.835) | (3.244) | (2.466) | (2.103) | (2.963) | (2.634) | (3.049) | (4.446) |
| High School | -1.233 | -2.915 | -1.531 | -2.052 | -1.167 | -0.243 | -1.191 | 1.660 |
| | (1.129) | (1.857) | (1.303) | (1.336) | (1.621) | (1.516) | (1.841) | (2.607) |
| College | -0.207 | -2.644 | -1.190 | -1.100 | -0.739 | 1.768 | 1.317 | 0.733 |
| | (1.137) | (1.953) | (1.380) | (1.290) | (1.605) | (1.731) | (1.975) | (2.797) |
| Bachelors | 4.318 *** | -0.735 | 2.685 | 2.667 | 5.006 ** | 5.053 ** | 7.767 *** | 9.964 ** |
| | (1.553) | (2.198) | (1.877) | (1.832) | (2.202) | (2.562) | (2.873) | (4.866) |
| Postgraguate | 5.988 ** | 1.373 | 0.047 | 1.332 | 1.424 | 8.417 * | 14.629 ** | 25.904 ** |
| | (2.604) | (1.915) | (3.000) | (2.598) | (3.816) | (4.417) | (6.086) | (12.045) |
| Income | 0.132 | 0.216 | 0.179 | 0.138 | -0.034 | 0.082 | 0.123 | 0.378 |
| | (0.119) | (0.261) | (0.224) | (0.152) | (0.289) | (0.296) | (0.345) | (0.659) |
| Nonmetro | -1.071 | -0.872 | 0.009 | -0.552 | -2.092 | -0.167 | -0.751 | -2.508 |
| | (1.694) | (3.670) | (2.818) | (2.491) | (2.329) | (2.538) | (2.504) | (4.442) |
| Constant | 46.939 *** | 28.691 *** | 30.978 *** | 35.413 *** | 42.935 *** | 51.947 *** | 60.469 *** | 84.310 *** |
| | (4.338) | (6.720) | (6.043) | (5.750) | (5.907) | (6.239) | (6.817) | (16.271) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively.

**Table A.3.** Estimated OLS and UQR coefficients for SNAP-eligible nonparticipant households. Panel (a) Specification 1; Panel (b) Specification 2; and Panel (c) Specification 3.

**(a)** Estimated OLS and UQR coefficients for Specification 1.

| | OLS | RIF Regressions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 15 | 25 | 50 | 75 | 85 | 95 |
| food preparartion | 0.160 | -0.265 | -0.152 | -0.091 | 0.348 | 0.122 | 0.414 | 0.462 |
| | (0.201) | (0.360) | (0.254) | (0.297) | (0.292) | (0.295) | (0.367) | (0.474) |
| food presentation | -24.413 | -39.419 | 22.819 | -51.934 | -48.705 | 36.578 | -57.834 | 18.026 |
| | (30.883) | (55.719) | (37.444) | (39.734) | (40.032) | (50.088) | (50.732) | (58.923) |
| kitchen clean-up | 0.673 | 3.367 * | 1.557 | 1.850 | 0.944 | -1.195 | -0.841 | -1.218 |
| | (1.018) | (2.014) | (1.518) | (1.412) | (1.356) | (1.574) | (1.757) | (1.690) |
| grocery shopping | 0.410 | 1.076 | 1.308 | 3.960 * | 0.334 | -1.284 | -3.330 | -7.627 * |
| | (1.960) | (2.872) | (2.499) | (2.273) | (2.624) | (3.634) | (3.404) | (4.167) |
| grocery travel | -2.131 | 8.781 | -2.041 | -7.651 | -3.464 | -0.157 | 3.340 | 1.850 |
| | (4.840) | (6.923) | (7.377) | (6.248) | (6.591) | (7.497) | (10.325) | (13.957) |
| FAFH purchase | 2.141 | -3.848 | -33.390 | -2.381 | 5.726 | 0.188 | 6.238 | 32.473 |
| | (14.436) | (26.514) | (21.576) | (21.445) | (21.367) | (22.524) | (20.888) | (31.390) |
| FAFH waiting | -74.174 | -31.549 | 30.540 | -85.170 | -116.257 | -93.159 | -105.310 | -184.836 |
| | (80.803) | (155.656) | (99.114) | (100.173) | (109.656) | (144.886) | (154.685) | (153.126) |
| FAFH travel | -7.139 | -1.050 | 7.709 | -8.170 | -0.169 | -15.752 | -21.822 | -17.970 |
| | (8.664) | (15.323) | (13.289) | (14.318) | (13.552) | (14.589) | (14.182) | (17.147) |
| eat drink | -0.047 | -0.064 | -0.034 | 0.046 | -0.055 | -0.003 | -0.041 | 0.066 |
| | (0.069) | (0.112) | (0.088) | (0.090) | (0.082) | (0.100) | (0.120) | (0.172) |
| exercise | -0.313 | -2.474 * | -0.844 | -0.506 | -0.448 | 0.306 | 0.017 | 0.918 |
| | (0.399) | (1.466) | (0.714) | (0.593) | (0.473) | (0.597) | (0.645) | (0.998) |
| Hisp HH | 4.428 *** | 3.915 | 1.800 | 4.095 ** | 7.181 *** | 4.740 * | 5.113 | 2.339 |
| | (1.535) | (2.460) | (2.038) | (1.883) | (2.127) | (2.437) | (3.271) | (4.158) |
| Black HH | -1.957 | -2.589 | -4.577 * | -1.616 | -0.130 | -2.887 | -2.418 | -3.979 |
| | (1.584) | (3.644) | (2.408) | (2.163) | (2.047) | (2.223) | (2.662) | (3.386) |
| Asian HH | 5.342 ** | 7.125 * | 1.824 | 2.429 | 7.441 ** | 6.013 | 7.696 | 2.363 |
| | (2.318) | (3.695) | (2.525) | (2.563) | (2.985) | (3.674) | (4.772) | (6.963) |
| Other HH | -1.031 | -2.418 | -0.567 | -0.747 | -0.642 | -0.748 | -3.493 | -1.689 |
| | (1.687) | (3.030) | (2.315) | (2.418) | (2.332) | (2.698) | (3.166) | (3.519) |
| HH size | -0.455 | 0.485 | 0.822 | 0.424 | -0.511 | -1.313 | -1.253 | -1.902 ** |
| | (0.453) | (0.911) | (0.585) | (0.606) | (0.644) | (0.821) | (0.930) | (0.860) |
| Children | 1.421 | 1.714 | -2.619 | -1.286 | 2.187 | 3.513 | 3.194 | 4.073 |
| | (1.443) | (2.876) | (2.045) | (1.868) | (1.768) | (2.446) | (2.886) | (2.983) |
| Working | -0.683 | -0.233 | -1.703 ** | -1.947 ** | -0.963 | -0.076 | -0.132 | 0.643 |
| | (0.626) | (1.200) | (0.847) | (0.851) | (0.831) | (1.026) | (1.143) | (1.448) |
| Vehicle | 0.885 | -0.525 | 1.547 | 0.829 | 0.890 | 1.232 | 0.960 | -1.720 |
| | (1.106) | (2.463) | (1.685) | (1.500) | (1.424) | (1.748) | (1.981) | (2.016) |
| Own Home | -2.967 *** | -4.417 * | -3.404 *** | -2.721 * | -2.745 * | -2.746 | -1.136 | -1.546 |
| | (1.059) | (2.541) | (1.263) | (1.439) | (1.462) | (1.720) | (1.914) | (2.181) |
| Oth HomeOwn | -0.633 | -3.826 | -4.059 | 2.381 | 1.418 | 2.929 | -0.155 | -3.465 |
| | (2.894) | (7.137) | (3.891) | (3.538) | (3.495) | (4.552) | (4.634) | (5.511) |
| High School | 1.540 | -1.722 | 0.768 | 1.753 | 4.471 ** | 2.875 | -0.296 | 1.777 |
| | (1.674) | (3.536) | (2.222) | (2.403) | (2.222) | (2.487) | (2.717) | (2.915) |
| College | 2.773 | 1.734 | 0.694 | 1.198 | 5.387 ** | 3.623 | 2.818 | 4.057 |
| | (1.689) | (3.497) | (2.334) | (2.261) | (2.235) | (2.623) | (2.661) | (3.211) |
| Bachelors | 5.375 *** | -0.848 | 1.355 | 3.722 | 7.603 *** | 9.667 *** | 8.688 ** | 12.175 ** |
| | (1.914) | (4.119) | (2.852) | (2.490) | (2.760) | (2.964) | (3.909) | (5.116) |
| Postgraguate | 8.799 *** | -1.396 | 4.949 * | 6.725 ** | 10.426 *** | 12.614 *** | 12.433 *** | 20.558 *** |
| | (2.299) | (5.470) | (2.781) | (2.878) | (3.199) | (4.000) | (4.603) | (6.167) |
| Income | 0.259 | 0.286 | 0.230 | 0.137 | 0.115 | 0.567 | 0.711 | -0.035 |
| | (0.235) | (0.296) | (0.227) | (0.250) | (0.336) | (0.491) | (0.641) | (0.547) |
| Nonmetro | -3.628 | -1.019 | -1.245 | -3.143 | -3.076 | -6.950 * | -7.626 ** | -5.965 * |
| | (2.284) | (4.209) | (2.930) | (2.793) | (3.115) | (3.614) | (2.981) | (3.391) |
| Constant | 51.476 *** | 29.325 *** | 38.685 *** | 44.664 *** | 44.593 *** | 60.342 *** | 68.722 *** | 75.195 *** |
| | (4.539) | (8.188) | (6.041) | (6.419) | (6.218) | (7.593) | (7.314) | (7.345) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively.

**(b)** Estimated OLS and UQR coefficients for Specification 2.

| | OLS | RIF Regressions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 15 | 25 | 50 | 75 | 85 | 95 |
| stpc1 | 0.010 | 0.106 | 0.083 | 0.022 | 0.005 | -0.011 | -0.056 | -0.070 |
| | (0.043) | (0.085) | (0.061) | (0.057) | (0.057) | (0.066) | (0.067) | (0.087) |
| stpc2 | -0.067 | -0.015 | -0.099 | -0.070 | -0.018 | -0.132 ** | -0.142 ** | -0.061 |
| | (0.045) | (0.075) | (0.061) | (0.065) | (0.056) | (0.064) | (0.068) | (0.093) |
| exercise | -0.316 | -2.453 * | -0.880 | -0.459 | -0.468 | 0.316 | 0.096 | 0.916 |
| | (0.395) | (1.371) | (0.603) | (0.570) | (0.465) | (0.574) | (0.572) | (0.979) |
| Hisp HH | 4.187 *** | 3.470 | 1.834 | 3.709 ** | 6.729 *** | 4.669 * | 4.944 | 2.050 |
| | (1.500) | (2.694) | (1.996) | (1.766) | (2.181) | (2.442) | (3.076) | (4.083) |
| Black HH | -2.065 | -2.784 | -4.534 * | -2.117 | -0.259 | -2.955 | -2.367 | -4.114 |
| | (1.566) | (3.709) | (2.670) | (2.204) | (2.113) | (2.240) | (2.743) | (3.360) |
| Asian HH | 5.153 ** | 6.698 * | 1.916 | 1.858 | 7.171 ** | 5.911 | 7.477 | 2.287 |
| | (2.294) | (3.907) | (2.445) | (2.640) | (3.109) | (3.877) | (5.369) | (6.941) |
| Other HH | -1.068 | -1.583 | 0.196 | -0.503 | -0.660 | -1.846 | -3.984 | -3.618 |
| | (1.579) | (2.882) | (2.042) | (2.037) | (2.162) | (2.693) | (2.956) | (3.241) |
| HH size | -0.500 | 0.307 | 0.822 | 0.346 | -0.542 | -1.272 * | -1.354 * | -1.664 ** |
| | (0.445) | (0.822) | (0.603) | (0.572) | (0.581) | (0.691) | (0.822) | (0.684) |
| Children | 1.361 | 1.625 | -2.480 | -1.517 | 2.134 | 3.506 | 2.945 | 3.990 |
| | (1.434) | (2.687) | (1.958) | (1.691) | (1.827) | (2.400) | (2.754) | (2.902) |
| Working | -0.719 | -0.239 | -1.628 * | -2.173 *** | -0.998 | -0.082 | -0.212 | 0.557 |
| | (0.616) | (1.202) | (0.885) | (0.830) | (0.841) | (0.843) | (1.124) | (1.373) |
| Vehicle | 0.911 | -0.687 | 1.525 | 0.888 | 0.967 | 1.211 | 0.957 | -1.635 |
| | (1.100) | (2.509) | (1.639) | (1.525) | (1.367) | (1.608) | (1.756) | (1.919) |
| Own Home | -2.887 *** | -4.287 * | -3.321 ** | -2.560 * | -2.638 * | -2.769 | -1.343 | -1.662 |
| | (1.049) | (2.404) | (1.392) | (1.472) | (1.415) | (1.791) | (1.982) | (2.300) |
| Oth HomeOwn | -0.544 | -4.748 | -4.386 | 2.143 | 1.727 | 3.218 | 0.284 | -2.913 |
| | (2.869) | (6.254) | (4.032) | (3.213) | (3.870) | (4.472) | (4.644) | (5.101) |
| High School | 1.698 | -1.160 | 0.767 | 1.743 | 4.757 ** | 2.636 | 0.109 | 1.641 |
| | (1.654) | (3.485) | (2.399) | (2.223) | (2.197) | (2.423) | (2.744) | (2.959) |
| College | 2.759 | 2.201 | 0.771 | 1.228 | 5.298 ** | 3.500 | 2.829 | 3.869 |
| | (1.679) | (3.593) | (2.439) | (2.210) | (2.181) | (2.471) | (2.766) | (3.456) |
| Bachelors | 5.415 *** | -0.269 | 1.402 | 3.703 | 7.584 *** | 9.523 *** | 8.794 ** | 11.983 ** |
| | (1.900) | (4.189) | (2.445) | (2.514) | (2.612) | (3.256) | (3.638) | (5.416) |
| Postgraguate | 8.693 *** | -0.844 | 5.087 * | 6.784 ** | 10.113 *** | 12.460 *** | 12.385 *** | 19.979 *** |
| | (2.283) | (5.025) | (2.955) | (2.869) | (3.073) | (3.893) | (4.746) | (6.230) |
| Income | 0.260 | 0.309 | 0.250 | 0.173 | 0.123 | 0.548 | 0.707 | -0.089 |
| | (0.234) | (0.319) | (0.237) | (0.245) | (0.340) | (0.492) | (0.578) | (0.668) |
| Nonmetro | -3.710 | -0.988 | -1.098 | -3.005 | -3.299 | -7.068 ** | -7.904 *** | -6.534 ** |
| | (2.273) | (4.030) | (3.058) | (3.201) | (2.957) | (3.397) | (2.841) | (3.016) |
| Constant | 51.150 *** | 29.685 *** | 38.037 *** | 44.330 *** | 44.513 *** | 59.694 *** | 68.779 *** | 75.561 *** |
| | (4.485) | (9.856) | (6.609) | (5.563) | (6.172) | (6.713) | (6.314) | (6.614) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively.

**(c)** Estimated OLS and UQR coefficients for Specification 3.

| | OLS | RIF Regressions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **5** | **15** | **25** | **50** | **75** | **85** | **95** |
| T_FAHprep | -0.045 | -0.299 | -0.109 | -0.175 | -0.082 | -0.012 | 0.073 | 0.343 |
| | (0.118) | (0.250) | (0.167) | (0.155) | (0.150) | (0.172) | (0.200) | (0.317) |
| T_ShopFAHhathh | 0.404 | 4.475 ** | 1.081 | 1.250 | 0.539 | -1.030 | -2.066 | -5.315 ** |
| | (1.258) | (1.773) | (1.552) | (1.627) | (1.793) | (2.130) | (2.076) | (2.400) |
| T_FAFHhathh | -4.939 * | -0.623 | -3.941 | -8.013 ** | -2.596 | -8.952 ** | -9.427 * | -2.196 |
| | (2.946) | (4.604) | (4.904) | (3.949) | (4.212) | (4.206) | (5.238) | (5.762) |
| eat drink | -0.043 | -0.023 | -0.005 | 0.053 | -0.038 | -0.016 | -0.062 | 0.028 |
| | (0.067) | (0.124) | (0.089) | (0.079) | (0.088) | (0.107) | (0.120) | (0.164) |
| exercise | -0.325 | -2.572 * | -1.001 | -0.517 | -0.429 | 0.276 | 0.101 | 0.981 |
| | (0.394) | (1.449) | (0.641) | (0.572) | (0.478) | (0.634) | (0.558) | (0.963) |
| Hisp HH | 4.116 *** | 3.431 | 1.667 | 3.618 * | 6.707 *** | 4.501 * | 4.787 | 1.966 |
| | (1.500) | (2.376) | (1.767) | (1.912) | (1.938) | (2.293) | (3.165) | (4.304) |
| Black HH | -2.190 | -3.078 | -4.816 ** | -2.152 | -0.392 | -3.042 | -2.405 | -3.954 |
| | (1.569) | (3.919) | (2.292) | (2.140) | (1.991) | (2.137) | (2.601) | (3.382) |
| Asian HH | 5.105 ** | 6.975 ** | 1.856 | 2.028 | 7.127 ** | 5.779 | 7.252 | 1.831 |
| | (2.302) | (3.490) | (2.609) | (2.702) | (3.367) | (3.812) | (5.208) | (6.906) |
| Other HH | -1.182 | -1.426 | 0.261 | -0.375 | -0.673 | -2.009 | -4.353 | -3.769 |
| | (1.581) | (2.573) | (2.043) | (2.026) | (2.191) | (2.436) | (2.845) | (3.240) |
| HH size | -0.430 | 0.646 | 1.012 * | 0.433 | -0.451 | -1.280 * | -1.448 * | -1.970 *** |
| | (0.445) | (0.809) | (0.561) | (0.590) | (0.572) | (0.716) | (0.743) | (0.746) |
| Children | 1.402 | 1.633 | -2.511 | -1.290 | 2.217 | 3.572 | 2.958 | 3.949 |
| | (1.437) | (2.852) | (1.837) | (1.909) | (1.930) | (2.372) | (2.286) | (3.175) |
| Working | -0.733 | -0.394 | -1.770 ** | -2.046 ** | -1.000 | -0.042 | -0.162 | 0.641 |
| | (0.619) | (1.114) | (0.841) | (0.832) | (0.889) | (0.913) | (1.042) | (1.494) |
| Vehicle | 0.921 | -0.502 | 1.582 | 0.895 | 0.993 | 1.150 | 0.856 | -1.841 |
| | (1.101) | (2.546) | (1.747) | (1.544) | (1.634) | (1.652) | (1.712) | (1.964) |
| Own Home | -2.938 *** | -4.342 ** | -3.342 ** | -2.551 ** | -2.715 * | -2.781 * | -1.371 | -1.606 |
| | (1.051) | (2.174) | (1.473) | (1.274) | (1.474) | (1.625) | (1.746) | (2.287) |
| Oth HomeOwn | -0.394 | -4.715 | -4.273 | 2.401 | 1.834 | 3.483 | 0.555 | -2.876 |
| | (2.872) | (6.019) | (3.874) | (3.733) | (3.543) | (4.764) | (4.648) | (5.437) |
| High School | 1.672 | -1.152 | 0.716 | 1.916 | 4.747 ** | 2.637 | 0.047 | 1.578 |
| | (1.657) | (3.264) | (2.150) | (2.091) | (1.999) | (2.302) | (2.570) | (2.916) |
| College | 2.711 | 1.915 | 0.445 | 1.216 | 5.294 ** | 3.446 | 2.866 | 3.980 |
| | (1.675) | (3.339) | (2.216) | (2.366) | (2.185) | (2.513) | (2.761) | (3.405) |
| Bachelors | 5.318 *** | -0.676 | 1.029 | 3.695 | 7.548 *** | 9.449 *** | 8.791 ** | 12.228 ** |
| | (1.897) | (3.684) | (2.501) | (2.343) | (2.194) | (3.024) | (3.563) | (5.278) |
| Postgraguate | 8.623 *** | -1.333 | 4.748 | 6.598 ** | 10.134 *** | 12.366 *** | 12.405 *** | 20.393 *** |
| | (2.283) | (5.285) | (2.888) | (2.978) | (2.585) | (3.616) | (4.502) | (6.125) |
| Income | 0.261 | 0.258 | 0.232 | 0.150 | 0.129 | 0.552 | 0.728 | -0.030 |
| | (0.235) | (0.329) | (0.268) | (0.243) | (0.361) | (0.444) | (0.572) | (0.608) |
| Nonmetro | -3.731 | -1.134 | -1.124 | -3.095 | -3.317 | -7.076 ** | -7.887 *** | -6.340 ** |
| | (2.274) | (4.261) | (2.940) | (3.442) | (2.917) | (3.354) | (2.775) | (2.878) |
| Constant | 51.660 *** | 29.746 *** | 38.439 *** | 44.556 *** | 45.064 *** | 60.304 *** | 69.518 *** | 75.839 *** |
| | (4.518) | (9.439) | (7.247) | (6.090) | (5.985) | (7.689) | (7.273) | (7.338) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively.

**Table A.4.** Estimated OLS and UQR coefficients for SNAP ineligible households. Panel (a) Specification 1; Panel (b) Specification 2; and Panel (c) Specification 3.

**(a)** Estimated OLS and UQR coefficients for Specification 1.

| | OLS | RIF Regressions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 15 | 25 | 50 | 75 | 85 | 95 |
| food preparartion | 0.019 | -0.149 | -0.088 | -0.228 | 0.011 | 0.196 | 0.218 | 0.209 |
| | (0.146) | (0.234) | (0.201) | (0.220) | (0.185) | (0.211) | (0.254) | (0.387) |
| food presentation | -4.219 | 26.629 | 47.002 | 27.524 | -14.686 | -48.431 | -63.373 * | -71.403 * |
| | (23.694) | (43.429) | (36.040) | (37.301) | (31.715) | (31.817) | (36.816) | (37.140) |
| kitchen clean-up | 0.174 | 0.071 | -0.893 | 0.317 | 0.341 | 0.813 | 1.766 | -0.028 |
| | (0.777) | (1.034) | (1.041) | (1.257) | (1.104) | (1.164) | (1.536) | (2.056) |
| grocery shopping | 0.283 | 1.144 | 2.897 * | 0.071 | -0.072 | -2.043 | -1.718 | 1.602 |
| | (1.317) | (1.838) | (1.615) | (1.793) | (1.748) | (1.809) | (2.312) | (3.275) |
| grocery travel | 2.935 | 2.322 | -0.552 | -0.352 | 1.617 | 7.363 * | 7.022 | 7.045 |
| | (3.063) | (4.873) | (4.656) | (4.111) | (4.016) | (4.288) | (5.394) | (8.520) |
| FAFH purchase | -11.691 * | 10.248 | -11.441 | -13.021 | -18.851 ** | -7.837 | -7.709 | -33.554 ** |
| | (6.928) | (7.815) | (13.557) | (10.369) | (9.229) | (8.048) | (12.192) | (13.488) |
| FAFH waiting | 25.412 | 0.082 | 88.415 | 80.805 | 83.105 | 96.194 | -91.003 | -212.433 * |
| | (66.078) | (115.789) | (94.171) | (102.344) | (94.061) | (102.392) | (105.356) | (115.096) |
| FAFH travel | 6.568 | -2.655 | 1.648 | 4.620 | 7.085 | 4.167 | 10.195 | 31.085 ** |
| | (4.577) | (6.605) | (8.859) | (7.496) | (6.984) | (6.391) | (8.770) | (15.377) |
| eat drink | 0.112 ** | 0.081 | 0.111 * | 0.137 ** | 0.182 *** | 0.117 * | 0.098 | -0.020 |
| | (0.046) | (0.062) | (0.067) | (0.063) | (0.061) | (0.069) | (0.073) | (0.096) |
| exercise | 0.158 | -0.668 | -0.230 | 0.334 | 0.257 | 0.423 | 0.367 | 1.601 * |
| | (0.285) | (0.569) | (0.402) | (0.378) | (0.370) | (0.403) | (0.494) | (0.877) |
| Hisp HH | 1.787 | -0.024 | 2.662 | 1.892 | 2.377 | 3.058 * | 0.101 | 0.903 |
| | (1.212) | (2.261) | (1.828) | (1.706) | (1.717) | (1.728) | (1.806) | (1.937) |
| Black HH | -1.556 | -1.224 | -5.014 ** | -3.514 * | 1.045 | 0.406 | 0.528 | 3.726 |
| | (1.349) | (3.085) | (2.408) | (2.051) | (1.818) | (1.887) | (1.911) | (2.850) |
| Asian HH | 1.710 | -0.445 | -0.803 | 0.245 | 2.481 | 4.908 | 3.988 | 2.156 |
| | (1.821) | (3.033) | (2.664) | (2.645) | (2.424) | (2.989) | (3.629) | (4.969) |
| Other HH | -0.661 | -2.492 | -1.314 | -0.323 | -0.203 | -0.314 | 1.154 | -0.452 |
| | (1.267) | (2.587) | (2.151) | (1.954) | (1.957) | (1.833) | (1.936) | (1.971) |
| HH size | -1.500 *** | 0.674 | -1.370 ** | -1.214 * | -2.191 *** | -2.003 *** | -1.632 *** | -1.170 * |
| | (0.399) | (0.717) | (0.668) | (0.646) | (0.553) | (0.552) | (0.547) | (0.626) |
| Children | 1.032 | -2.211 | 1.683 | 1.851 | 2.079 | 0.710 | 0.133 | -0.380 |
| | (1.031) | (1.965) | (1.655) | (1.621) | (1.462) | (1.446) | (1.534) | (1.834) |
| Working | 0.102 | 0.553 | 0.737 | 0.094 | 0.414 | -0.303 | -0.288 | -0.590 |
| | (0.448) | (0.736) | (0.711) | (0.691) | (0.620) | (0.659) | (0.707) | (0.752) |
| Vehicle | 1.304 | -0.644 | 0.551 | 0.945 | 1.086 | 1.431 | 1.665 | 2.330 |
| | (0.970) | (1.898) | (1.676) | (1.436) | (1.448) | (1.360) | (1.406) | (1.904) |
| Own Home | -3.499 *** | -4.481 *** | -5.602 *** | -4.904 *** | -4.019 *** | -2.134 * | -2.603 ** | -2.937 * |
| | (0.821) | (1.512) | (1.276) | (1.300) | (1.058) | (1.202) | (1.199) | (1.649) |
| Oth HomeOwn | -0.648 | 1.468 | -3.878 | -2.112 | -1.789 | -0.796 | 1.331 | 4.815 |
| | (2.803) | (4.784) | (4.456) | (4.340) | (3.647) | (3.384) | (4.189) | (7.998) |
| High School | -0.312 | 1.330 | 2.328 | 3.242 | 0.296 | 0.675 | -2.109 | -5.500 |
| | (1.988) | (4.519) | (3.831) | (3.232) | (2.646) | (2.495) | (2.814) | (4.252) |
| College | 2.222 | 2.109 | 4.812 | 4.572 | 4.265 | 4.171 * | 0.136 | -4.931 |
| | (1.925) | (4.417) | (3.754) | (3.270) | (2.673) | (2.435) | (2.695) | (4.163) |
| Bachelors | 5.018 ** | 3.272 | 6.722 * | 7.262 ** | 7.922 *** | 7.757 *** | 4.152 | -1.549 |
| | (1.987) | (4.416) | (3.819) | (3.127) | (2.621) | (2.559) | (2.908) | (4.249) |
| Postgraguate | 9.061 *** | 5.308 | 10.307 *** | 12.341 *** | 10.678 *** | 11.508 *** | 7.676 ** | 5.192 |
| | (2.100) | (4.876) | (3.926) | (3.302) | (2.850) | (2.888) | (3.228) | (4.645) |
| Income | -0.064 | -0.413 ** | -0.205 | -0.077 | 0.076 | 0.056 | 0.166 | -0.195 |
| | (0.085) | (0.202) | (0.151) | (0.123) | (0.125) | (0.125) | (0.182) | (0.200) |
| Nonmetro | -0.663 | -4.001 | -0.299 | -0.442 | 0.580 | -1.385 | 0.421 | -2.407 |
| | (1.705) | (3.621) | (2.688) | (2.762) | (2.316) | (2.099) | (2.362) | (2.592) |
| Constant | 48.443 *** | 30.024 *** | 30.423 *** | 34.025 *** | 44.175 *** | 54.483 *** | 66.857 *** | 83.641 *** |
| | (3.537) | (6.200) | (5.748) | (5.322) | (5.294) | (4.990) | (5.770) | (7.285) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively.

**(b)** Estimated OLS and UQR coefficients for Specification 2.

| | OLS | RIF Regressions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 15 | 25 | 50 | 75 | 85 | 95 |
| st1 | 0.135 *** | 0.096 | 0.148 *** | 0.068 | 0.157 *** | 0.168 ** | 0.146 * | 0.201 |
| | (0.048) | (0.063) | (0.054) | (0.063) | (0.060) | (0.073) | (0.088) | (0.134) |
| st2 | 0.003 | 0.008 | 0.018 | 0.017 | 0.000 | 0.005 | 0.002 | -0.079 |
| | (0.029) | (0.049) | (0.038) | (0.040) | (0.037) | (0.042) | (0.048) | (0.063) |
| st3 | -0.007 | 0.060 | -0.039 | -0.015 | -0.045 | -0.005 | 0.027 | 0.038 |
| | (0.046) | (0.083) | (0.077) | (0.076) | (0.060) | (0.066) | (0.077) | (0.125) |
| exercise | 0.184 | -0.661 | -0.238 | 0.362 | 0.307 | 0.490 | 0.419 | 1.569 ** |
| | (0.284) | (0.599) | (0.410) | (0.363) | (0.390) | (0.422) | (0.451) | (0.743) |
| Hisp HH | 1.694 | -0.113 | 2.731 | 1.946 | 2.386 | 3.125 * | -0.266 | 0.274 |
| | (1.198) | (2.086) | (1.842) | (1.801) | (1.645) | (1.626) | (1.835) | (2.187) |
| Black HH | -1.545 | -1.394 | -4.979 ** | -3.511 * | 1.145 | 0.671 | 0.384 | 3.517 |
| | (1.340) | (2.711) | (2.507) | (2.098) | (2.152) | (1.928) | (2.019) | (2.834) |
| Asian HH | 1.602 | -0.464 | -0.828 | 0.180 | 2.410 | 5.010 * | 3.734 | 1.487 |
| | (1.817) | (3.531) | (2.650) | (2.528) | (2.419) | (2.821) | (3.551) | (4.883) |
| Other HH | -0.589 | -2.726 | -1.124 | -0.073 | 0.130 | 0.026 | 0.883 | -0.865 |
| | (1.241) | (2.634) | (2.128) | (1.728) | (1.755) | (1.700) | (1.977) | (2.151) |
| HH size | -1.456 *** | 0.708 | -1.302 ** | -1.144 * | -2.111 *** | -1.991 *** | -1.624 *** | -1.214 * |
| | (0.398) | (0.786) | (0.608) | (0.597) | (0.515) | (0.518) | (0.594) | (0.638) |
| Children | 0.972 | -2.145 | 1.648 | 1.725 | 1.842 | 0.480 | 0.107 | -0.070 |
| | (1.024) | (2.118) | (1.495) | (1.492) | (1.405) | (1.252) | (1.783) | (1.761) |
| Working | 0.077 | 0.437 | 0.671 | -0.021 | 0.366 | -0.271 | -0.263 | -0.376 |
| | (0.445) | (0.803) | (0.699) | (0.696) | (0.644) | (0.580) | (0.738) | (0.816) |
| Vehicle | 1.401 | -0.668 | 0.511 | 1.011 | 1.226 | 1.565 | 1.909 | 2.604 |
| | (0.969) | (1.871) | (1.841) | (1.467) | (1.423) | (1.483) | (1.574) | (2.134) |
| Own Home | -3.543 *** | -4.510 *** | -5.597 *** | -5.030 *** | -4.161 *** | -2.266 * | -2.674 ** | -2.703 |
| | (0.818) | (1.420) | (1.376) | (1.175) | (1.147) | (1.200) | (1.259) | (1.758) |
| Oth HomeOwn | -0.778 | 1.597 | -3.872 | -2.258 | -2.153 | -1.295 | 1.178 | 5.123 |
| | (2.798) | (4.232) | (4.610) | (4.275) | (4.124) | (3.645) | (4.375) | (7.725) |
| High School | -0.478 | 1.252 | 1.990 | 2.892 | -0.051 | 0.627 | -1.992 | -5.260 |
| | (1.985) | (4.233) | (3.548) | (3.118) | (2.767) | (2.588) | (2.900) | (4.321) |
| College | 2.097 | 2.073 | 4.590 | 4.383 | 3.994 | 4.010 | 0.207 | -4.622 |
| | (1.921) | (4.165) | (3.107) | (3.172) | (2.842) | (2.609) | (2.680) | (4.153) |
| Bachelors | 4.865 ** | 3.354 | 6.604 ** | 7.147 ** | 7.615 ** | 7.464 *** | 4.048 | -1.545 |
| | (1.983) | (4.178) | (3.349) | (3.114) | (2.959) | (2.661) | (3.112) | (4.335) |
| Postgraguate | 8.981 *** | 5.269 | 10.247 *** | 12.312 *** | 10.537 *** | 11.435 *** | 7.562 ** | 5.211 |
| | (2.097) | (4.358) | (3.525) | (3.289) | (3.035) | (2.904) | (3.329) | (4.700) |
| Income | -0.058 | -0.409 ** | -0.196 | -0.066 | 0.084 | 0.057 | 0.164 | -0.197 |
| | (0.085) | (0.193) | (0.168) | (0.115) | (0.130) | (0.122) | (0.174) | (0.192) |
| Nonmetro | -0.680 | -4.031 | -0.241 | -0.290 | 0.755 | -1.132 | 0.203 | -3.256 |
| | (1.695) | (3.195) | (2.890) | (2.681) | (2.377) | (2.066) | (2.306) | (2.803) |
| Constant | 49.235 *** | 30.240 *** | 31.003 *** | 34.735 *** | 45.326 *** | 55.530 *** | 67.776 *** | 84.569 *** |
| | (3.516) | (6.466) | (5.815) | (5.880) | (5.527) | (4.797) | (5.796) | (7.409) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively.

**(c)** Estimated OLS and UQR coefficients for Specification 3.

| | OLS | RIF Regressions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 15 | 25 | 50 | 75 | 85 | 95 |
| T_FAHprep | -0.011 | -0.094 | -0.007 | -0.126 | -0.001 | 0.102 | 0.113 | -0.104 |
| | (0.095) | (0.169) | (0.131) | (0.127) | (0.124) | (0.127) | (0.171) | (0.189) |
| T_ShopFAHhathh | 1.536 * | 1.576 | 2.197 ** | 0.986 | 0.801 | 2.124 | 1.146 | 2.237 |
| | (0.894) | (1.076) | (1.005) | (1.077) | (1.108) | (1.379) | (1.597) | (2.573) |
| T_FAFHhathh | -0.373 | -0.231 | -1.325 | -0.963 | -0.722 | -1.183 | 1.454 | 4.518 |
| | (2.123) | (4.044) | (3.812) | (3.593) | (3.508) | (2.715) | (3.510) | (5.958) |
| eat drink | 0.115 ** | 0.087 | 0.110 * | 0.140 ** | 0.190 *** | 0.121 * | 0.105 | -0.018 |
| | (0.046) | (0.060) | (0.063) | (0.070) | (0.062) | (0.064) | (0.081) | (0.101) |
| exercise | 0.159 | -0.639 | -0.289 | 0.273 | 0.247 | 0.474 | 0.429 | 1.661 ** |
| | (0.284) | (0.564) | (0.403) | (0.376) | (0.390) | (0.399) | (0.480) | (0.749) |
| Hisp HH | 1.783 | -0.078 | 2.795 | 2.012 | 2.567 | 3.213 * | -0.123 | 0.304 |
| | (1.199) | (2.212) | (1.852) | (1.718) | (1.588) | (1.883) | (1.813) | (2.090) |
| Black HH | -1.448 | -1.216 | -4.873 * | -3.357 | 1.234 | 0.795 | 0.443 | 3.356 |
| | (1.339) | (2.811) | (2.563) | (2.074) | (2.042) | (1.663) | (1.919) | (2.580) |
| Asian HH | 1.635 | -0.402 | -0.777 | 0.308 | 2.453 | 5.038 | 3.732 | 1.278 |
| | (1.815) | (3.219) | (2.667) | (2.342) | (2.400) | (3.075) | (3.411) | (5.076) |
| Other HH | -0.499 | -2.644 | -1.001 | 0.078 | 0.257 | 0.119 | 0.964 | -1.024 |
| | (1.240) | (2.735) | (1.964) | (1.728) | (1.783) | (1.937) | (1.921) | (2.088) |
| HH size | -1.498 *** | 0.764 | -1.310 * | -1.106 * | -2.206 *** | -2.091 *** | -1.725 *** | -1.364 ** |
| | (0.395) | (0.742) | (0.709) | (0.628) | (0.538) | (0.525) | (0.597) | (0.675) |
| Children | 1.069 | -1.894 | 1.730 | 1.880 | 1.912 | 0.594 | 0.172 | -0.233 |
| | (1.022) | (2.008) | (1.665) | (1.590) | (1.412) | (1.394) | (1.596) | (1.747) |
| Working | 0.129 | 0.593 | 0.677 | 0.033 | 0.399 | -0.173 | -0.206 | -0.438 |
| | (0.442) | (0.668) | (0.735) | (0.679) | (0.634) | (0.637) | (0.734) | (0.815) |
| Vehicle | 1.366 | -0.658 | 0.486 | 0.974 | 1.157 | 1.499 | 1.866 | 2.633 |
| | (0.968) | (1.789) | (1.765) | (1.451) | (1.389) | (1.330) | (1.664) | (1.965) |
| Own Home | -3.533 *** | -4.540 *** | -5.598 *** | -4.965 *** | -4.101 *** | -2.220 ** | -2.674 ** | -2.910 * |
| | (0.818) | (1.490) | (1.366) | (1.314) | (1.110) | (1.125) | (1.258) | (1.746) |
| Oth HomeOwn | -0.777 | 1.489 | -3.854 | -2.108 | -2.016 | -1.290 | 1.165 | 4.651 |
| | (2.796) | (4.034) | (4.531) | (4.155) | (3.657) | (3.350) | (4.396) | (7.248) |
| High School | -0.467 | 1.222 | 1.918 | 2.993 | 0.152 | 0.610 | -1.946 | -5.582 |
| | (1.989) | (3.998) | (3.375) | (3.600) | (2.673) | (2.363) | (3.064) | (4.557) |
| College | 2.071 | 1.994 | 4.446 | 4.368 | 4.162 | 3.987 * | 0.269 | -4.893 |
| | (1.926) | (4.029) | (3.228) | (3.710) | (2.598) | (2.257) | (2.902) | (4.489) |
| Bachelors | 4.799 ** | 3.313 | 6.406 ** | 7.054 * | 7.689 *** | 7.435 *** | 4.118 | -1.912 |
| | (1.990) | (3.933) | (3.229) | (3.654) | (2.720) | (2.398) | (3.240) | (4.643) |
| Postgraguate | 8.917 *** | 5.200 | 10.025 *** | 12.170 *** | 10.650 *** | 11.414 *** | 7.670 ** | 4.925 |
| | (2.106) | (4.115) | (3.337) | (3.679) | (2.915) | (2.526) | (3.392) | (4.894) |
| Income | -0.060 | -0.398 * | -0.198 | -0.071 | 0.075 | 0.057 | 0.164 | -0.198 |
| | (0.085) | (0.221) | (0.147) | (0.125) | (0.125) | (0.124) | (0.167) | (0.178) |
| Nonmetro | -0.617 | -3.869 | -0.160 | -0.309 | 0.702 | -0.990 | 0.275 | -3.147 |
| | (1.695) | (3.280) | (2.716) | (2.733) | (2.596) | (2.005) | (2.405) | (2.787) |
| Constant | 48.792 *** | 30.578 *** | 30.390 *** | 34.081 *** | 44.392 *** | 55.048 *** | 67.409 *** | 84.619 *** |
| | (3.523) | (5.794) | (5.579) | (5.571) | (4.979) | (4.682) | (6.155) | (7.906) |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively.

**Table A.5.** TabTetrachoric correlation matrix of FTSP activities

| | Serve Local | Taste Demos | Food Coach | School Garden | Serve Garden | Taste Garden | Field Trip | Farmer Visit | Themed Promo | Promote Local | Media Cover | Hosted Events | F2S Month | Curriculum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Serve Local | 1 | | | | | | | | | | | | | |
| Taste Demos | 0.8498 | 1 | | | | | | | | | | | | |
| Food Coach | 0.7747 | 0.7224 | 1 | | | | | | | | | | | |
| School Garden | 0.615 | 0.6101 | 0.5782 | 1 | | | | | | | | | | |
| Serve Garden | 0.7337 | 0.6011 | 0.5327 | 0.7452 | 1 | | | | | | | | | |
| Taste Garden | 0.6704 | 0.7639 | 0.586 | 0.7875 | 0.7793 | 1 | | | | | | | | |
| Field Trip | 0.6963 | 0.5668 | 0.4648 | 0.5887 | 0.5741 | 0.498 | 1 | | | | | | | |
| Farmer Visit | 0.6882 | 0.7291 | 0.5717 | 0.5643 | 0.5184 | 0.5859 | 0.695 | 1 | | | | | | |
| Themed Promo | 0.8556 | 0.7659 | 0.6675 | 0.5161 | 0.5404 | 0.5626 | 0.4819 | 0.6376 | 1 | | | | | |
| Promote Local | 0.9119 | 0.7522 | 0.731 | 0.5482 | 0.6079 | 0.5748 | 0.5542 | 0.6791 | 0.8403 | 1 | | | | |
| Media Cover | 0.8189 | 0.7446 | 0.684 | 0.5886 | 0.6 | 0.6076 | 0.6023 | 0.7769 | 0.7402 | 0.838 | 1 | | | |
| Hosted Events | 0.633 | 0.6827 | 0.666 | 0.6147 | 0.5481 | 0.5993 | 0.5733 | 0.6884 | 0.5892 | 0.6078 | 0.7321 | 1 | | |
| F2S Month | 0.7798 | 0.6805 | 0.613 | 0.4292 | 0.5084 | 0.4933 | 0.4416 | 0.6486 | 0.7309 | 0.757 | 0.6689 | 0.5554 | 1 | |
| Curriculum | 0.6516 | 0.6246 | 0.578 | 0.7264 | 0.7168 | 0.7069 | 0.6373 | 0.6188 | 0.5426 | 0.6133 | 0.6656 | 0.687 | 0.5398 | 1 |

**Table A.6.** Estimated Tobit Coefficients of Control Variables for Specifications 3, 4 and 5 – Dependent Variables are Monthly FV Expenditure Shares (FVSh) and FV expenditure (FVExp)

| Control Variable | Specification 3 | | | | Specification 4 | | | | Specification 5 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FVExp | | FVSh | | FVExp | | FVSh | | FVExp | | FVSh | |
| **Household-level Control Variables** | | | | | | | | | | | | |
| HH Size | 0.765 | *** | -0.402 | *** | 0.763 | *** | -0.403 | *** | 0.765 | *** | -0.402 | *** |
| | (0.096) | | (0.031) | | (0.096) | | (0.031) | | (0.096) | | (0.031) | |
| HH Income | 0.057 | *** | 0.015 | *** | 0.057 | *** | 0.015 | *** | 0.057 | *** | 0.015 | *** |
| | (0.002) | | (0.001) | | (0.002) | | (0.001) | | (0.002) | | (0.001) | |
| Hisp HH | -3.260 | *** | -0.205 | | -3.275 | *** | -0.205 | | -3.278 | *** | -0.207 | * |
| | (0.392) | | (0.125) | | (0.392) | | (0.125) | | (0.392) | | (0.125) | |
| Black HH | -3.690 | *** | 0.163 | | -3.754 | *** | 0.150 | | -3.745 | *** | 0.156 | |
| | (0.359) | | (0.114) | | (0.359) | | (0.114) | | (0.359) | | (0.114) | |
| Asian HH | -3.998 | *** | 1.068 | *** | -4.057 | *** | 1.052 | *** | -4.053 | *** | 1.050 | *** |
| | (0.508) | | (0.162) | | (0.507) | | (0.162) | | (0.507) | | (0.162) | |
| Others HH | 0.114 | | 0.438 | *** | -0.050 | | 0.382 | *** | -0.033 | | 0.391 | *** |
| | (0.461) | | (0.147) | | (0.461) | | (0.147) | | (0.461) | | (0.147) | |
| Child 0-6 | -3.189 | *** | -0.271 | *** | -3.148 | *** | -0.260 | *** | -3.146 | *** | -0.259 | *** |
| | (0.266) | | (0.085) | | (0.266) | | (0.085) | | (0.266) | | (0.085) | |
| Child 6-13 | -0.672 | ** | 0.251 | *** | -0.685 | ** | 0.249 | *** | -0.685 | ** | 0.250 | *** |
| | (0.265) | | (0.085) | | (0.265) | | (0.085) | | (0.265) | | (0.085) | |
| Child 13-18 | 0.695 | ** | -0.272 | *** | 0.682 | ** | -0.276 | *** | 0.685 | ** | -0.275 | *** |
| | (0.281) | | (0.090) | | (0.280) | | (0.090) | | (0.280) | | (0.090) | |
| Widow HH | -4.011 | *** | 0.114 | | -4.006 | *** | 0.122 | | -4.000 | *** | 0.122 | |
| | (0.735) | | (0.235) | | (0.735) | | (0.235) | | (0.734) | | (0.235) | |
| Separated HH | -6.557 | *** | -1.159 | *** | -6.512 | *** | -1.149 | *** | -6.516 | *** | -1.152 | *** |
| | (0.339) | | (0.108) | | (0.339) | | (0.108) | | (0.339) | | (0.108) | |
| Single HH | -9.382 | *** | -1.725 | *** | -9.295 | *** | -1.699 | *** | -9.312 | *** | -1.714 | *** |
| | (0.450) | | (0.143) | | (0.450) | | (0.143) | | (0.449) | | (0.143) | |
| Head Edu | 3.753 | *** | 1.406 | *** | 3.714 | *** | 1.392 | *** | 3.712 | *** | 1.389 | *** |
| | (0.244) | | (0.078) | | (0.244) | | (0.078) | | (0.244) | | (0.078) | |
| Rent Home | -5.380 | *** | -1.738 | *** | -5.342 | *** | -1.726 | *** | -5.344 | *** | -1.727 | *** |
| | (0.255) | | (0.081) | | (0.255) | | (0.081) | | (0.255) | | (0.081) | |
| Oth HomeOwner | -4.437 | *** | -1.297 | *** | -4.496 | *** | -1.327 | *** | -4.499 | *** | -1.330 | *** |
| | (0.677) | | (0.216) | | (0.677) | | (0.216) | | (0.677) | | (0.216) | |
| **Local Food Supply Chain Control Variables** | | | | | | | | | | | | |
| FarmInc | -0.142 | | -0.968 | *** | -0.109 | | -0.915 | *** | -0.097 | | -0.912 | *** |
| | (0.923) | | (0.296) | | (0.921) | | (0.295) | | (0.921) | | (0.295) | |
| %Direct | 0.743 | *** | 0.159 | *** | 0.742 | *** | 0.167 | *** | 0.733 | *** | 0.160 | *** |
| | (0.093) | | (0.030) | | (0.093) | | (0.030) | | (0.093) | | (0.030) | |
| Foodhubs | -1.712 | *** | -0.316 | * | -1.588 | *** | -0.271 | | -1.616 | *** | -0.288 | * |
| | (0.537) | | (0.172) | | (0.537) | | (0.172) | | (0.537) | | (0.172) | |
| PCFM | -1.196 | ** | 0.158 | | -1.300 | *** | 0.139 | | -1.296 | *** | 0.139 | |
| | (0.462) | | (0.148) | | (0.462) | | (0.148) | | (0.462) | | (0.148) | |
| Milkprice | -4.510 | *** | -0.444 | | -5.055 | *** | -0.672 | | -4.983 | *** | -0.606 | |
| | (1.563) | | (0.500) | | (1.556) | | (0.498) | | (1.557) | | (0.498) | |
| Constant | 12.774 | *** | 6.193 | *** | 8.199 | *** | 4.455 | *** | 13.180 | *** | 6.395 | *** |
| | (1.787) | | (0.572) | | (1.917) | | (0.614) | | (1.783) | | (0.571) | |

Note: Standard errors in parentheses. ***, ** and * denote coefficients statistically significant at the 1%, 5% and 10% probability level, respectively. Coefficients for RUCCs, Month, Year, and State-level fixed-effects are omitted for brevity.