Socioeconomic, Demographic and Geographic Factors Affecting Household Food Purchase and Acquisition Decisions in the United States as a Complex Economic System

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Selected Paper prepared for presentation at the 2016 Agricultural & Applied Economics Association Annual Meeting, Boston, Massachusetts, July 31-August 2

The findings and conclusions reported in this paper do not necessarily represent views of the U.S. Department of Agriculture Economic Research Service and Texas A&M University.

Data used in this preliminary paper were obtained by several public sources such as the USDA Food Environment Atlas, United States Census Bureau, and United States Bureau of Labor and Statistics.

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Abstract

Socioeconomic, demographic and geographic factors affecting food purchase and acquisition decisions by the individuals and households in the United States are complex. Twenty two variables associated with socioeconomic, demographic and geographic factors affecting food purchase and acquisition decisions are studied in an algorithm that involve machine learning and causality structures to uncover complex causality patterns associated with such variables. Several publically available data sets as well as most recently collected USDA data, Food APS are used in this study. Preliminary analyses show that unemployment, poverty and race are direct causes of food insecurity, while income causes food insecurity via poverty. Unemployment is a common cause for both food insecurity and poverty. This modeling effort will help improve the nation's path for effective nutrition and health-related policy interventions as stipulated by USDA-Economic Research Service Strategic Goals.

Keywords: Food purchase, food acquisition, food insecurity, food assistance, poverty, obesity, directed acyclic graphs, Food APS data

JEL Classification: C40, D83, D85, I18

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Research Question and Policy Relevance:

There is increasing interest in understanding how a community's food environment factors influence food purchase and acquisition decisions and diet quality (USDA-ERS, 2013). Important factors contributing to the food environment include myriad of socioeconomic, demographic and geographic indicators. More specifically, they include geographic factors such as distance to the nearest grocery store (accessibility to food stores), the number and type of food stores and restaurants, availability of local foods, and the availability of recreational facilities such as gyms and fitness centers. Socioeconomic-demographic factors affecting food purchase and acquisition decisions include factors such as food prices, shopping behavior, expenditures on food away from home (fast foods and non-fast food restaurants such as fast casual and full-service restaurants), food and beverage taxes, income, poverty status, participation in food and nutrition assistance programs, and food security (insecurity) rate. These aforementioned food environment factors may have substantial impacts on diet, nutrition, and health outcomes.

Even though several studies in the extant literature have addressed issues related to food insecurity, food deserts, food assistance, health, and other factors of food environment, these studies have considered limited numbers of variables in piecemeal fashion, hence not giving the holistic picture of the complex economics of the food environment (see Wolf and Coldtiz, 1998; Casey *et al*., 2001; Jyoti *et al*., 2005; Casey *et al*., 2006; Dubois *et al*., 2006; Yen *et al*., 2008; Finkelstine *et al*., 2009; Nord and Golla, 2009; Dixon, 2010; Cawley and Meyerhoefer, 2010; Gundersen *et al*., 2011; Tiehen *et al*., 2012). A recent notable exception to this trend is

the study by Dharmasena *et al*., (2016), where they looked at sixteen socio-economic-demographic variables consisting of the food environment of the United States to ascertain the causality structure underlying food insecurity, food assistance, obesity and poverty. However, Dharmasena et al., (2016) used aggregate state level data spanning over the period 2008-2010 in uncovering causality patterns among food insecurity, food assistance, poverty and obesity variables, which obviously gave rise to limited information learned at the individual and/or household level decision making. Therefore, as proposed by this study, use of FoodAPS data in modeling causality patterns among key food policy variables in the United States help overcome such limitations in modeling and inferences at individual as well as at the household level. As a result, given the complexity of the interaction among the aforementioned variables at more micro level (individual or household level), more research is necessary to identify causal relationships among these factors at micro levels. This effort will help improve the nation's path for effective nutrition and health-related policy interventions as stipulated by USDA-Economic Research Service Strategic Goal Number 4 (USDA-ERS, 2012 and 2013).

This study has two specific objectives. They are (1) to model socioeconomic, demographic and geographic factors influencing food purchase and acquisition decisions in the United States using causality (exogenous versus endogenous status) structures developed through economic theory and artificial intelligence at micro level (individual and/or households level) and (2) to conduct policy analysis with respect to national-priority policy variables, namely food security, poverty, food assistance, and obesity as they relate to individual's (or household's) food purchase and acquisition decisions.

Data and Methodology:

There is a rich literature on theoretical and empirical relationships among many of the variables deemed important in the US Food Consumption-Diet Quality-Policy complex. We plan to use nationally representative data from National Household Food Acquisition and Purchase Survey (FoodAPS) which documented household's at-home as well as away from home food acquisitions, along with factors that influence household food choices. This data consists of 4,826 households including low-income households who participated in the supplemental nutrition assistance program (SNAP), low-income households who did not participate in SNAP program, and high-income households. The FoodAPS survey data will be supplemented with the FoodAPS geographic component (FoodAPS-GC), IRI market research data, and data from Food Environment Atlas where necessary in this paper. Data with regards to twenty two socioeconomic-demographic and geographic variables will be used in this study. They are, number of food stores by type, distance to nearest food store, retailer location, measures of access to retailer, SNAP household, SNAP eligible nonparticipating household, per capita expenditure at fast-food restaurants, per capita expenditure at full-service restaurants, per capita expenditure on fruits and vegetables, median household income, percentage of Whites, Blacks, Hispanics, Asians, unemployment rate, percentage of food insecure households, percentage of obese adults, health status, food security, diet and nutrition knowledge, and food price.

The causal relationships between food environment and diet and health outcomes variables will be studied using methods developed recently in computer science field (Pearl, 1995; Pearl, 2000; Spirtes, *et al,* 2000). Detailed description of such methods is explained in

Dharmasena *et al*., (2016). Beginning with a set of variables defined by *ceteris paribus* theory; we will investigate the exogenous and endogenous structures present in the observed data. These methods will, as well, identify proper instrumental variable status, if such are present in the set of measured variables. Further, the methods used will offer insights on the possible presence of latent or unobserved variables. We explicitly account for the possibility that each variable under study is endogenous by following the work of Pearl (2009) and Spirtes, *et al.,* (2000), in representing causal structures in graphical form and using separation (conditional independence relations) notions to help identify causal flows.

Key to our method of analysis is differences in conditional independence conditions present in a set of theoretically related variables. If data are generated as a causal chain X→Y→Z or a fork X← Y→Z, the conditional independence relations between X and Z given Y will be different from those on data held together by inverted forks X→Y←Z. Search for the latter (causal inverted forks) amongst the set of theory motivated variables drives these algorithms. Research advances in these methods (Pearl 2009; Spirtes *et al.,* 2000) have found a rich set of applications across the wide expanse of data-based science (Hoover, 2005; Bryant *et al.*, 2009; and Pearl, 2014). A key point these studies make is when working with observational (non-experimental) data, it is vital that the underlying causal structure be identified before one consider appropriate estimation methods. The machine learning literature applies minimum conditions for finding (if possible) the underlying causal structure that generates important literature relevant data. This work has clear utility in modeling complex systems.

Expected Results and Policy:

Two sets of findings will result from this study. The first is the set of estimated causal relationships between food environment, food purchase and acquisition and policy-relevant factors (food security, poverty, food assistance and obesity). The second set of findings is based on the identified causal graph between variables. There we estimate the effect of changes in food environment and food acquisition factors on four policy-relevant variables using standard econometric techniques. This modeling exercise followed by graphical causality structure is called the structural equation modeling (SEM) as identified by Pearl, (2000). This will not only allow one to develop structural parameters associated with variables, but also to perform policy scenarios. For example, we will be able to say effects of changes on obesity rates on food purchase and acquisition decisions or effects of changes in food purchase and acquisition decisions on obesity rates. The underlying exogenous and endogenous structure is identified in the graph. This resulting complex causality structure in food purchase and acquisition decisions reveals that policy variables cannot be treated independently of their rich causal structure. Government agencies responsible for designing policies for food assistance, poverty, food insecurity and obesity need to consider the interrelationships among these variables. Preliminary analyses show that unemployment, poverty and race are direct causes of food insecurity, while income causes food insecurity via poverty. Unemployment is a common cause for both food insecurity and poverty.

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