



Food environment in the United States as a complex economic system



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ABSTRACT

The food environment in the United States is complex. Sixteen socio-economic-demographic variables from various public data sources are studied with a machine learning algorithm to ascertain the causality structure associated with the food environment in the United States. High levels of unemployment and poverty are direct causes of high levels of food insecurity, while low income causes high levels of food insecurity via increased levels of poverty. Unemployment is a common cause for both increased levels of food insecurity and poverty. We find that food insecurity and participation in Supplemental Nutrition Assistance Program (SNAP) are related, yet no direct causality is observed. Contrary to past studies which find that SNAP participation decreased the occurrences of poverty, in contemporaneous time, we find that poverty and SNAP participation are related through several back-door paths, via food insecurity, unemployment, race and food taxes. Obesity and SNAP participation are indirectly related via several back-door paths, namely, race income, poverty and food insecurity and unemployment. Also, food insecurity and obesity are related by several back-door paths. Low income, high food taxes, and race (being Black and non-Hispanic) are direct causes of obesity. The complex causality structure in the US food environment reveals that policy variables cannot be treated independently of their rich causal structure. Government agencies responsible for designing policies for food assistance, poverty alleviation, combating food insecurity and obesity need to consider the interrelationships among these variables.

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1. Background information

The food environment is complex. According to the Economic Research Service of the United States Department of Agriculture, food choices, health and well-being as well as community characteristics and various factors affecting these as a whole are defined as the food environment (USDA, 2014). It includes all physical and social aspects that influence what, where, how, and when we consume our food as well as government policies influencing food production, food prices, food taxes, and food marketing. The food environment also is affected by other economic factors such as income, unemployment, poverty, food insecurity, and food assistance programs. Nutrition and obesity also are contributory factors to the food environment (Capps, 2009).

Food environment factors such as proximity to stores/restaurants, food prices, food and nutrition assistance programs, and community characteristics interact to influence food choices and diet quality (USDA, 2014). More specifically, indicators of food choices such as access to and proximity of a grocery store, number

of food stores and restaurants, expenditures on food away from home, participation in food and nutrition assistance programs, food prices, food taxes and availability of local foods are important factors contributing to the food environment. As far as the health and well-being of a community's food environment is concerned, food insecurity, presence of food deserts, adult and childhood obesity and physical activity levels are of great concern (USDA, 2014). Additionally, there may be other characteristics such as demographic composition, income, poverty status, and availability of recreation and fitness centers that may impact the food environment. In addition to the aforementioned factors affecting the food environment, other factors such as macroeconomic shocks (unemployment, interest rates, inflation, mortgage crises, divorce or separation, disability), asset availability and liquidity, food prices and government support programs for agricultural commodities may influence the food environment of communities (Dharmasena et al., 2014a).

Research is beginning to emerge documenting the complexity and interaction of factors affecting the food environment. However, given the complexity of the interaction among the aforementioned variables, more research is necessary to identify causal relationships among these factors, thereby providing the paths for effective policy interventions (USDA, 2014). Even though we find several studies in the extant literature addressing issues

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related to food insecurity, food deserts, food assistance, health and other factors of food environment, these studies have considered only few variables at a time in piecemeal fashion, hence not giving the holistic picture of the complex economics of the food environment (see for example, Wolf and Colditz, 1998; Casey et al., 2001, 2006; Jyoti et al., 2005; Dubois et al., 2006; Yen et al., 2008; Finkelstein et al., 2009; Nord and Golla, 2009; Dixon, 2010; Cawley and Meyerhoefer, 2012; Gundersen et al., 2011a; Tiehen et al., 2012). As a result, in the absence of complete picture pertaining to factors affecting the food environment, the design of appropriate food and nutrition policies can be adversely affected.

We discuss several studies addressing different components or variables of the food environment in the United States, centering attention on four food and nutrition policies. They are food security (or insecurity), food assistance (Supplemental Nutrition Assistance Program, SNAP), poverty and obesity. The articles are chosen with regard to addressing various food environment-related variables that are affecting or affected by aforementioned four policy variables. This selected literature provides a representation of food environment-related issues albeit not an exhaustive treatment.

1.1. Food insecurity and food assistance programs

Coleman-Jensen et al. (2012) reported that in 2011, 14.9% of U.S. households were food insecure, and 5.4% households had very low food security. Furthermore, 57% of food-insecure households reported that they received assistance from one or more of the three largest Federal food and nutrition assistance programs (the Supplemental Nutritional Assistance Program, SNAP; the National School Lunch Program, NSLP; and the Supplemental Nutrition Assistance Program for Women, Infants and Children, WIC). Also, they found that food insecurity varied among households with different economic and demographic characteristics, such as the prevalence of high food insecurity with households with low income, all households with children and specifically those with children under six years of age, households with children headed by a single woman, and Black and Hispanic households.

Wilde and Nord (2005) showed that higher incomes reduced food insecurity as expected; however they did not find clear evidence to support the notion that households' participation in food assistance programs decreased food insecurity. Gundersen et al. (2011a,b) reported that information beyond poverty status is important for understanding food insecurity. Other factors possibly determining food insecurity are unemployment rate, income, race and ethnic origin. Gundersen and Gruber (2001) and Leete and Bania (2010) found that households with no liquid assets were substantially more likely to be food insecure compared to those with liquid assets.

There are numerous consequences of food insecurity in the United States. A large body of literature has focused on correlational relationships rather than on causal relationships of food insecurity in attempting to explain various outcomes (Gundersen et al., 2011a). Gundersen et al. (2011a, p. 289) provided an extensive review of correlational studies relating food insecurity to health outcomes. Furthermore, Gundersen et al. (2011a) stated that, while food insecurity may cause health problems, the host of potential unobserved variables between food insecurity and poor health could be a problem trying to model causality effects of food insecurity and health outcomes. For example, food insecurity itself may not be directly contributing to worse health outcomes; however, other factors associated with households such as low income may be a contributory factor to worse health outcomes along with food insecurity. Also Gundersen et al. (2011a) explained possible effects of SNAP and NSLP in dealing with food insecurity in the United States. Economists have suggested that participation in the SNAP is likely to be endogenous, hence regressing food insecurity

on SNAP, not controlling for unobserved variables, potentially would lead to spurious empirical results. Identification of proper instruments for SNAP participation has been challenging; however, Gundersen and Oliveira (2001) were able to take care of this endogeneity issue, identifying variables that control the selection into SNAP and food insecurity. The participation in the NSLP in alleviating food insecurity faces similar problems associated with endogeneity of selection into and participation in this program. However, after controlling for selection and measurement error problems, Gundersen et al. (2012) found evidence that the NSLP substantially affects reducing food insecurity. Furthermore, acting on the premise that SNAP decreases food insecurity, Gundersen et al. (2009) found that increases in participation in SNAP decreased the relative well-being of program participants.

Yen et al. (2008) estimated the relationship between SNAP participation and household food insecurity to find that participation in SNAP reduces the severity of food insecurity. Nord and Golla (2009) measured U.S. household food insecurity before and after participation in the SNAP to discover that food insecurity declines with household's participation in the SNAP (households self-select into SNAP when they are severely food insecure). Although all income-poor households did not participate in food assistance programs (self-selection issues), D. Ribar and Hamrick (2003) and D.C. Ribar and Hamrick (2003) found that income-poverty had a direct negative relationship with food sufficiency. For the same reason, Bartfeld and Dunifon (2006) concluded that it was difficult to document the relationship between food assistance programs and their impact on food security, although a decline in food insecurity was observed when such programs are in place.

Jensen (2002) discussed similar effects and relationships between income and food security (insecurity) as well as between food expenditure of low-income households and its relation to poverty. Furthermore, Jensen (2002) discussed household participation in U.S government food assistance programs (like SNAP) and its relationship to food insecurity. Another extensive body of literature, represented by Gundersen and Kreider (2008), Bhattacharya et al. (2004), Bitler et al. (2005), Borjas (2004), Furness et al. (2004), Gundersen (2008), Gundersen et al. (2003), Laraia et al. (2006), D. Ribar and Hamrick (2003), D.C. Ribar and Hamrick (2003), Van Hook and Balistreri (2006), found that participation in food assistance programs decreased food insecurity, particularly in adults, but not in children as found by Bhattacharya et al. (2004). Olson et al. (2004) investigated factors contributing to food insecurity especially centering attention on rural communities of the United States.

1.2. Food assistance programs and poverty

Tiehen et al. (2012) found on average a 4.4% decline in the prevalence of poverty as a result of SNAP, while the decline in depth and severity of poverty was on average 10.3% and 13.2% respectively. They concluded that the SNAP significantly improved the welfare of low-income households. Additionally, Bitler and Haider (2011) explained the linkage between low income and food assistance and the role of food assistance in alleviating problems associated with such low incomes. Case et al. (2002) explained the relationship of household income to health, more specifically with respect to children's health, finding that children from lower-income households with chronic conditions had worse health outcomes than did those from higher-income households.

1.3. Obesity and food insecurity

Finkelstein et al. (2005) discussed economic causes and consequences of the obesity epidemic in the United States. According to them, reduction of body energy expenditure (as a result of

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