Understanding Variation in State Policy and Politics of Food Environments

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ABSTRACT

Measures of food environment quality seek to capture availability, accessibility, affordability, accommodation, and acceptability of food available to residents. At present time, measures of food security and food access play an important role in quantifying the affordability, accessibility, and availability aspects of food environment quality. Existing research has thoroughly explored the relationship between state-level food policy and food security, food access, and food environments. We add to this field of study by examining the relationship between state-level partisan politics that lead to such policies and the resulting variation in food environment quality across states. We use both mixed-effects and logistic regression analysis to explore common measures of food security and food access as well as two new measures of food environment quality. Ultimately, we find that political partisanship of governors, state-funded food financing, certain SNAP policies, and minimum wage laws are associated with variation in food environment quality across states.

KEYWORDS

Food environment; Food access; Food security; Food policy; Politics

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1 INTRODUCTION

Within international research on food security, food access is a component of food security as an indicator of general food availability (Leroy et al., 2015). In the United States, however, defining food access has evolved a much more nuanced availability of full-service retail food stores that offer a variety of affordable, healthy food items (which often means large grocery stores and supermarkets). Despite its economic success, the United States experiences disparities in both food security (Gibb et al., 2021; Ma et al., 2021; Vacarro and Huffman, 2017) and food access (Beaulac et al., 2009; Elbel et al., 2019; Walker, Keane, and Burke, 2010), particularly in low-income and marginalized communities.

In many cases, low-quality food environments are believed to be associated with poor health outcomes (Drewnowski et al., 2012; Rose et al., 2010), with certain exceptions in rural communities where supermarkets have been found to be positively associated with poor health outcomes (Ahern, Brown, and Dukas, 2011). Nonetheless, researchers have yet to find a irrefutable causal relationship between food environments and health impacts (Walker, Keane, and Burke, 2010; White, 2007). While there is strong evidence that has shown food security is improved with financial and nutrition interventions (Mabli et al., 2013; Nord and Golla, 2009), there are mixed results on whether food access can be improved with retail interventions (Rose et al., 2010; Wrigley, Warm, and Margetts, 2003). As a result, state variation in public policy that seeks to improve the quality of local food environments has shown differences in socioeconomic and public health outcomes, which can provide lessons for future food policy recommendations. At the same

time, state politics has the power to influence whether sound public policy has been or can be realistically implemented (Campbell, 2002; May, 1986; Oliver, 2006).

We contribute to this body of burgeoning literature by examining the combination of state policies and politics that are associated with variation in food environment quality as expressed by both food security and food access characteristics. In this study we seek to answer the following questions: (1) What is the relationship between a state's rate of food security and its public policies and political partisanship? (2) What is the relationship between food access and states' public policies and political partisanship? (3) What is the relationship between overall food environment quality and states' public policies and political partisanship?

First, we explore the term *food environment* along with the food security and food access characteristics it is comprised of. We also explore the state policies and politics that are often associated with food environment quality. Next, we discuss our novel panel dataset of state-level factors associated with food environment quality and the creation of two unique food environment indexes. Subsequently, we use mixed-effect regression analysis to find that Democratic governorship is associated with increased food insecurity, state-funded food financing is associated with increased food access, and increased minimum wages are associated with food environment quality. We provide a supplementary examination of the latent growth factors of food security and food access as the key components of food environment quality. Lastly, we conclude that there are likely opportunities to use public policy as a tool for improving food environments, regardless of political partisanship.

2 BACKGROUND

Benninger et al. (2021) believe that systems thinking can help with understanding the complexity of food systems, particularly given the racialized issues of food insecurity, limited food access, and low-quality food environments.

2.1 Food Environments

According to the U.S. Centers for Disease Control and Prevention (CDC), food environment is defined as "the physical presence of food that affects a person's diet" (CDC, 2014). A broader definition of food environment can include factors such as an individual's proximity to food stores, the distribution of those food stores, food prices, household income, food and nutrition assistance, and other household and community characteristics that provide food access (CDC, 2014; University of Wisconsin Population Health Institute, 2022; USDA ERS, 2020). In an effort to capture a more robust measure of food environment that includes both the availability of food stores and income-related ability to afford food purchases, University of Wisconsin Population Health Institute (2022) developed the "Food Environment Index" that equally weights food access and food security. The index has a scale of 0 to 10, representing lowest to highest quality food environments. Although the index is updated intermittently because the underlying data is updated at different frequencies, the index showed that the average county had a score of 7.6 in 2022.

The two components of food environment – food security and food access – also have an array of factors that define them. Food security is most often defined as having enough food to always meet dietary needs for a productive and healthy life through both physical and economic access (USAID, 2022). The U.S. Department of Agriculture's Economic Research Service (USDA ERS) more specifically defines food security to instances in which individuals reports little to no reduced

quality, variety, and desirability in their diet (USDA ERS, 2022). Additionally, USDA ERS defined food access as the accessibility to sources of healthy food, as measured by proximity to food stores or density of food stores (USDA ERS, 2021). In the United States, food access is most often associated with retail food stores and can include individual factors (e.g., household income, private transportation) and community factors (e.g., median household income, public transportation) that influence retail access. USDA ERS also produces a "Food Environment Atlas" that maps grocery proximity, store availability, restaurant availability, food assistance, food security, food prices and taxes, local foods, health and physical activity, and socioeconomic trends (USDA ERS, 2023).

Studies on food environment often pertain to the relationship between diet and public health in the context of neighborhood, work, school, and home food environments (Caspi et al., 2012; Ding et al., 2012; Holsten, 2009; Morland and Evenson, 2009). Much of this public health literature on food environments stems from Penchansky and Thomas (1981) who defined healthcare access as having five dimensions: availability, accessibility, affordability, accommodation, and acceptability. In public health research, meta-analysis of literature on food environments has found that food environment measures most often use geographic analysis, and only a fraction of existing studies on food access used a longitudinal technique or captured affordability, accommodation, and acceptability as access dimensions as defined by Penchansky and Thomas (Caspi et al. 2012; Lytle and Sokol, 2017; Lytle, 2009; McKinnon et al., 2009).

In an effort to capture additional dimensions of access with a more robust description of food environment, there is a recent literature on an expanded definition of food environment that includes measurements of both food security and food access, including the University of

Wisconsin's Population Health Institute's food environment index (University of Wisconsin Population Health Institute, 2022).

2.1.1 Food Security

As of December 2020, 10.5 percent of U.S. households struggled with food insecurity, which was unchanged from the share of the population that struggled with food insecurity prior to the COVID-19 pandemic (Coleman-Jensen et al., 2021). Given the persistent nature of food insecurity, the federal government has designed several food and nutrition programs to provide increased food security for low-income U.S. households. In 2020, about 55 percent of food insecure households participated in federal food and nutrition assistance programs, such as SNAP (Supplemental Nutrition Assistance Program), WIC (Special Supplemental Nutrition Program for Women, Infants, and Children), or NSLP (National School Lunch Program) (Coleman-Jensen et al., 2021).

The consequences of food insecurity are widely documented. Food insecurity is associated with compromised aspects of human development, including psychological and social functioning (Arenas et al. 2019; Gundersen and Ziliak, 2015; Hamelin, Habicht, and Beaudry, 1999; Olson, 1999 Rose, 1999). Moreover, causal links between food insecurity and health outcomes have been established and the situation results in increased healthcare spending for low-income households (Gundersen and Ziliak, 2018).

2.1.2 Food Access

According to the 2019 Food Access Research Atlas, approximately 12.8 percent of census tracts into the United States were identified as low income and experienced limited food access at the 1-mile threshold in urban communities and a 10-mile threshold in rural communities (USDA ERS, 2022). This figure on communities impacted by limited food access included over 14 million

residents who identified as racial minorities as well as 7.5 million residents who identified as Hispanic.

Food access can be measured along a variety of different parameters, including in-store availability of healthy foods (Donkin et al., 1999; Rose et al. 2010; Zhen, 2021). Nevertheless, there persists differences in analysis food access. Full-service grocery has been defined in a variety of ways by researchers: as supercenters with a food department in addition to non-food departments (e.g., home goods, electronics) (Campo and Gijsbrechts, 2004), as supermarkets with many food departments (e.g., bakery, deli) (Chrisinger et al., 2018), and as supercenters, supermarkets, and grocery stores (Ware et al., 2021). A popular access measure of in-store availability, price, and quality is the Nutrition Environment Measures Survey (NEMS) (Glanz et al., 2007), and there are many iterations and modifications to this survey for restaurants, convenience stores, etc.

For the most part, studies show that low-income households tend to shop where prices are lowest, particularly larger grocery stores and supermarkets often located in suburban neighborhoods (Alwitt and Donley, 1997; Ver Ploeg et al., 2009). Given this information, it has been difficult for researchers to determine if living in a community with limited food access means a household has inadequate food access, even for low-income, minority residents (Donkin et al., 1999). Nevertheless, studies find that households' lack of access to retail grocers can be a barrier to healthy eating (Chen et al., 2010; Drewnowski et al., 2012). Additionally, unhealthy product availability has been associated with unhealthy diets and increased obesity (Ball, Timperio, and Crawford, 2009; Rose et al., 2010).

2.2 State Food Environment Policy

Although the federal government provides national policies and programs to ameliorate issues of food insecurity and lack of food access, state-level policy pertaining to food environments can take a variety of forms. State governments make policy decisions regarding their administration of federal food and nutrition programs, including SNAP and WIC. State governments also make policy decisions related to the food programs they directly fund through their own budgets, including supplement nutrition programs and financing of grocery retailers.

Researchers have begun examination of the spillover effects of food security and food access policies on food environment quality. Cuffey and Beatty (2021), for example, study the effect of food financing policies that subsidize grocery stores to find an increase in grocery store shopping among SNAP participants, particularly those in close proximity to the new store.

2.2.1 State Food Security Policy

The USDA Food and Nutrition Service (FNS) administers federal expenditure of SNAP, WIC, NSLP, the National School Breakfast Program (SBP), and other program funds to state governments, and in some cases local governments, tribal organizations, and U.S. territories.

A variety of different quantitative studies examine the influence of policy factors that are correlated with food system outcomes based on states' administration of federal food assistance programs. Researchers have studied the effects of food assistance policies on program participation with the understanding that program participation, in fact, improves food security (Ratcliffe, McKernan, Finegold, 2008). These researchers have examined the influence of a variety of state food assistance policy impacting food security directly or indirectly (i.e., through program participation), particularly eligibility requirements (e.g., vehicle exemption, immigrant eligibility),

outreach funding, use of biometric technology (e.g., fingerprinting, blood sample), program benefits available through electronic benefits transfer (EBT), recertification periods, administrative reporting frequency, etc. Additional state policies on SNAP administration include raising or eliminating asset limits, expanding categorical eligibility, allowing phone interviews, extending recertification periods, lenient reporting requirements, and expanded marketing and outreach.

In addition to federal food and nutrition assistance, state governments may also provide food assistance to their residents, particularly in cases where a state's residents may not qualify for federal programs. Six states offer state-funded food and nutritional assistance to immigrants who are ineligible for federal assistance (National Immigration Law Center, 2022). Currently, California, Connecticut, Illinois, Maine, Minnesota, and Washington offer this supplementary assistance (National Immigration Law Center, 2022). For example, California provides the California Food Assistance Program to legal permanent resident non-citizens who lost benefits under the 1996 Personal Responsibility and Work Opportunity Reconciliation Act (PRWORA) due to their immigration status, non-citizens who are the victims of abuse or battery, and non-citizens who are no longer federally eligible due to the federal seven-year eligibility time limit (California Department of Social Services, 2022).

2.2.2 State Food Access Policy

Federal food financing initiatives (FFI) to increase food access began in 2011 with the U.S. Department of Health & Human Services (HHS), which funded over $50 million in retail grocery projects between 2011-2016 (HHS, 2019. The additional federal FFI policy authorized $125 million by the 2014 Farm Bill within USDA and reauthorized by the 2018 Farm Bill (USDA Rural

Development, 2022). Other federal community development funds are available to states, including New Market Tax Credit through the U.S. Department of Treasury.

Nevertheless, food financing policy efforts started with states. State-funded FFIs began in 2004 with Pennsylvania's Fresh Food Financing Initiative. The primary goals of most FFIs are to provide financing to developers, retail grocers, and corner store owners to offer additional access to affordable, healthy foods in underserved communities with the hopes of improving public health outcomes. The Pennsylvania effort was the result of Philadelphia being identified as having as a city with the one of the lowest densities of grocery stores in the United States (The Food Trust, 2022; The Reinvestment Fund, 2022).

In addition to Pennsylvania, other states and cities have provided varying levels of funding and had varying levels of success with their FFIs. Although Pennsylvania's FFI temporarily ended in 2010 when all the original funds were awarded, it restarted in 2018 with new capital investment. North Carolina, for example, only ever enacted a temporary healthy corner store pilot program, which lasted just 2016-2017 (PolicyLink, 2022).

2.3 State Politics Influencing Food Environments

Food policy researchers argue that partisan politics is a key contributor to these food policy trends and, in certain cases, have inhibited benefits of federal food programs (Nestle, 2019). Federal, state, and local policymakers are forced to find balance between improving social welfare and appeasing rent-seeking political coalitions (Swinnen, 2018). The omnibus Farm Bill continually contains both agricultural policy and food environment policy to appease both rural conservative and urban liberal politicians, respectively (Coppess, 2018; Gritter, 2015). Nevertheless, this political phenomenon is not unique to the United States nor to food and agricultural issues.

The United States poses an interesting political case study because of its style of *American Federalism*. The Tenth Amendment of the U.S. Constitution gives the power to states (or to the people) on all matters not prohibited or expressly given to the federal government. Additionally, states are granted police powers – the power to make laws and regulations for the benefit of their communities regarding health, education, welfare, and morals. These provisions outline American Federalism, where the federal government acts on issues delegated to it while "power and authority reside with the States, or with the people themselves" (Waxman, 2002). Included in this system of government are *concurrent powers*, which are powers exercised by both the federal and state government to collect taxes, establish courts, and regulate interstate commerce. The state government is tasked with overseeing the public welfare and safety and, as a result, residents are more likely to come into contact with state and local law enforcement and regulators than federal officials. Thus, state laws and politics often have a stronger effect on citizens' day-to-day lives relative to federal law and politics.

The latest evolution of American Federalism latest occurred in the 1980s with an increasing devolution of federal power back to states under the conservative Reagan administration. The main characteristics of this "New Federalism" era are the advent of block grants, revenue sharing, and the federal government's increased inability to limit discretionary state spending. This evolution empowered states to innovate and increase the dissimilarity in standards for policy areas under their jurisdiction. After this, there begins dynamic variation in the content and implementation of state food policy. For example, even within the federal guidelines for SNAP eligibility, there is a large variation in state SNAP policy and requirements for SNAP eligibility depending on the state's political climate, which leads to marked differences in participation.

3 DATA & METHODS

Although there is considerable research on the politics of SNAP implementation, we examine the full spectrum of political and social policy infrastructure influencing local food systems. We believe that a local community's political infrastructure relies heavily on state government politics as well. As a result, we have collected state-level data on food security, food access, public policy, and partisan politics and used regression modeling to understand the relationships among food environment characteristics.

3.1 Data

We have created a novel panel dataset on food environments, food policy, and state politics from a variety of sources. General state policy data come from Michigan State University Institute for Public Policy and Social Research's Correlates of State Policy Project (CSPR) v2.4.1 (Grossman et al., 2021), which is a compilation of variables from various data sources. SNAP policy data come from the USDA Economic Research Service, which provides a source for state-level data on factors that influence SNAP participation (USDA ERS, 2019). WIC data focus on the uptake of EBT (electronic benefits transfer) overtime, which derived from USDA Food and Nutrition Services reporting on statewide use of EBT use for dispersal WIC benefits (USDA FNS, 2022). County business pattern data come from the U.S. Census (2021) and were aggregated to the state-level for our purposes. State-funded food assistance data was constructed from information collected by the National Immigration Law Center (2020). State-funded food financing initiatives (FFI) data was largely derived from the Healthy Food Access Portal (Healthy Food Access Portal, 2022). Legislative partisanship data come from the National Conference of State Legislatures and reports on annual legislative control, governor's political party, and state control (NCSL, 2021).

Household demographic information comes from the U.S. Census via NHGIS (Mason et al. 2021), where we replicate the decennial census data for the span of each decade rather than use American Community Survey estimates for the intra-decennial time periods.

The dependent variables are state-level measures of food insecurity, grocery store density as a proxy for food access, and a food environment index that incorporates both food security and grocery store density. Food insecurity measures come from the CSPR and taken from University of Kentucky National Welfare Data (Grossman et al., 2021). It is the proportion of individuals who answered "yes" to at least three questions from the Core Food Security Model of the U.S. Census Current Population Survey. Unfortunately, more comprehensive census tract-level data on food access, such as USDA's Food Access Research Atlas, are not available in a panel data format for the time period of interest. As a result, we use U.S. Census County Business Pattern data of supermarkets and grocery stores (NAICS 4451) and specialty food stores (NAICS 4452) (U.S. Census, 2021), in combination with CSPR figures for total population taken from U.S. Census and American Community Survey estimates (Grossman et al., 2021), to create a new state-level grocery density variable to represent food access.[1] Our calculated food environment index is the product of food insecurity and grocery store density, scaled by 100. The density method of quantifying food environment is one of the two most common methods of spatial approaches in examining food environment, with the other being the proximity method (Charreire et al., 2010).

[1] We include establishments classified as NAICS 445110 (supermarket) but exclude establishments classified as NAICS 452210 (department store). For example, the Target corporation's stores are likely classified as a NAICS 445110 supermarket and the Walmart corporation's stores are likely classified as a NAICS 452210 department store (NAICS Association, 2022a; NAICS Association, 2022b).

We use these various data sources to explore the decade between 2005 and 2014. During this period, summary statistics show that both food security and grocery density declined on average across U.S. states and the District of Columbia (see Table 1). Additionally, as the average population increased, the population share of SNAP and school breakfast participation increased while the population share of Temporary Assistance for Needy Families (TANF) and school lunch participation decreased. The population of Supplemental Security Income (SSI) and WIC participation remained statistically unchanged.

Table 1. Summary of State Food Environment and Socioeconomic Conditions in 2005 and 2014

Characteristic	2005	2014	P-value
Food Security Rate	87.9 (3.1)	85.0 (3.2)	<0.001
Grocery Density	42 (11)	35 (12)	0.001
Weighted Food Environment Index	0.00 (0.80)	0.00 (0.77)	>0.9
Threshold Food Environment Index	32 (63%)	33 (65%)	0.8
State Population (Million)	5.80 (6.53)	6.25 (7.12)	0.6
Share Female	50.86 (0.82)	50.70 (0.80)	0.2
Average Median Age	35.52 (1.89)	37.50 (2.31)	<0.001
Share Bachelor's Degree	15.6 (3.3)	18.8 (4.1)	<0.001
Unemployment Rate	2.79 (0.59)	4.34 (0.92)	<0.001
Poverty Rate	12.3 (3.2)	14.1 (3.9)	0.025
Share HH Income <$10k	9.70 (2.68)	7.09 (1.65)	<0.001
Share SSI Participants	2.19 (0.87)	2.41 (0.85)	0.11
Share TANF Participants	0.61 (0.41)	0.46 (0.35)	0.003
Share SNAP Participants	3.91 (1.43)	7.07 (2.11)	<0.001
Share NSLP Participants	10.19 (1.95)	9.54 (1.88)	0.077
Share SBP Participants	3.09 (1.26)	4.07 (1.38)	<0.001
Share WIC Participants	2.51 (0.59)	2.31 (0.45)	0.11
Share Black	11 (12)	11 (11)	0.7
Share Latino	8 (9)	11 (10)	0.017
Share Asian	6.5 (8.3)	8.1 (8.1)	0.05
Share Foreign Born	7.3 (5.7)	8.8 (6.1)	0.085
Share without Documentation	2.75 (1.87)	2.66 (1.58)	>0.9

Mean (SD); n (%)

Wilcoxon rank sum test; Pearson's Chi-squared test

3.1.1 Food Environment Indexes: Weighted & Binary

We develop a state-level food environment index based that includes information on both food security and food access. We use existing general methods to construct composite indicators to compare state food environment quality. We do this because it is easier for policymakers and the general public to identify common trends in both food security and food access without confusing or conflating the use of a single measure. As with the case of food security and food access, we develop a new set of food environment indexes to evaluate and explore a higher level of food

system complexity across states each year. In order to create these new indexes, we first normalize both the food security and food access measures, then aggregate the normalized measures (Joint Research Centre - European Commission, 2008).

The weighted food environment index weighs standardized food security and food access measures. First, we standardize both annual measures to a common scale with a mean of zero and a standard deviation of one for each study year. Using this method, extreme value will have a greater effect on the composite index. Second, we equally weigh and sum the annual standardized measure to create the equally weighted composite index.

$$Weighted\ Index_{s,y} = \sum_{m} w_m * \left(\frac{x_{m,s,y} - \underline{x}_{m,y}}{\sigma_{m,y}} \right)$$

where w is the weight, x is the measure's statistic, $\underline{x}$ is the mean, σ is the standard deviation, m is the measure of interest, s is the state, and y is the year. In the case of equally weighing measure, w_m is 0.5 for both m measures.[2]

The binary food environment index indicates whether states have food security or food access measures that are at or above the mean for each year. We transform both annual food access or food security measures such that the values receive a 1 if either are at or above the mean and a 0 if they both are below the mean. Using this method, extreme values will not have an outsized effect on the composite index.

[2] We envision states and local governments may decide to give greater weight to one issue over another. Therefore, instead of simply equally weighting food security and food access, a future index may decide to assign weights differently to food security and food access.

$$Binary\ Index_{s,y} = \begin{cases} 1 & if \quad x_{m,s,y} \geq \bar{x}_{m,y} \quad \forall\, m \\ 0 & if \quad x_{m,s,y} < \bar{x}_{m,y} \quad \forall\, m \end{cases}$$

where x is the measure's statistic and $\bar{x}$ is the mean m is the measure of interest, s is the state, and y is the year. If the indicator ratio is at or above the mean the threshold indicator receives a value of 1. If the indicator ratio is below the mean, the threshold indicator receives a value of 0. As a result, the binary index holds a value of 0 or 1, where 0 indicates both food security and food access measures are below the annual mean and where 1 indicates either or both food security and food access measures are at or above the annual mean.[3]

3.1.2 State Policy Data

During the 2005-2014 period, the following summary statistics show that states implemented a variety of policies to provide support for food insecure households and organizations seeking to expand food access (see Table 2). The average state minimum wage increased to an average of $7.60 by 2014. SNAP policies largely improved the ease of application and increased eligibility. Additionally, the use of EBT for WIC benefits increased to ten states by 2014.

[3] We envision states and local governments may be interested in a threshold different than simply above or below the mean. Therefore, a future binary index may decide to assign threshold differently (e.g., median) for food security and/or food access.

Table 2. Summary of State Policy Implementation in 2005 and 2014

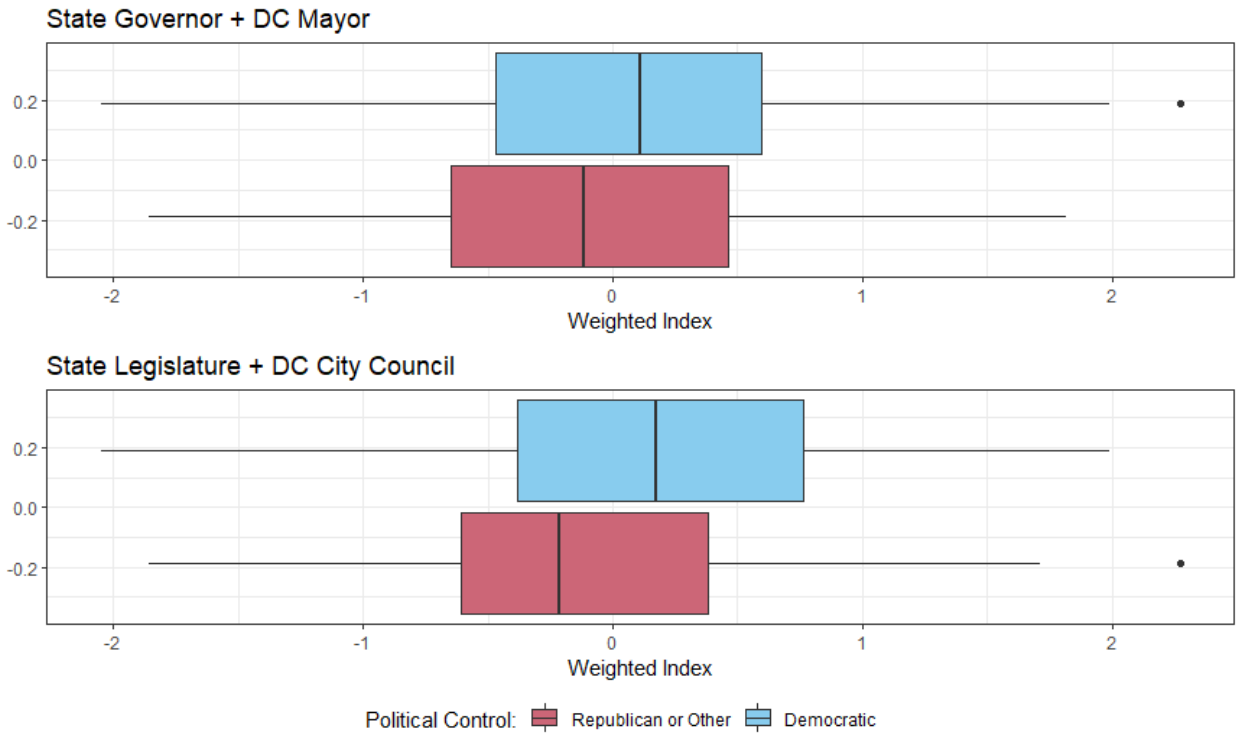
Characteristic	2005	2014	P-value
State Minimum Wage	5.57 (0.88)	7.60 (0.81)	<0.001
SNAP: Broad-based Categorical Eligibility	11 (22%)	40 (78%)	<0.001
SNAP: Share Requiring 1-3mo Recertification	0.039 (0.122)	0.004 (0.008)	<0.001
SNAP: Phone Interview	1 (2.0%)	45 (88%)	<0.001
SNAP: Fingerprinting	4 (7.8%)	1 (2.0%)	0.4
SNAP: Assistance Eligibility for Legal Non-citizens	6 (12%)	3 (5.9%)	0.5
SNAP: Online Application	9 (18%)	43 (84%)	<0.001
SNAP: All Vehicles Excluded from Asset Test	29 (57%)	43 (84%)	0.002
WIC: EBT Implemented	1 (2.0%)	10 (20%)	0.004
State-funded Food Assistance	6 (12%)	6 (12%)	>0.9
State-funded Food Financing	1 (2.0%)	6 (12%)	0.11

Mean (SD); n (%)
Wilcoxon rank sum test; Pearson's Chi-squared test; Fisher's exact test

3.1.3 State Politics Data

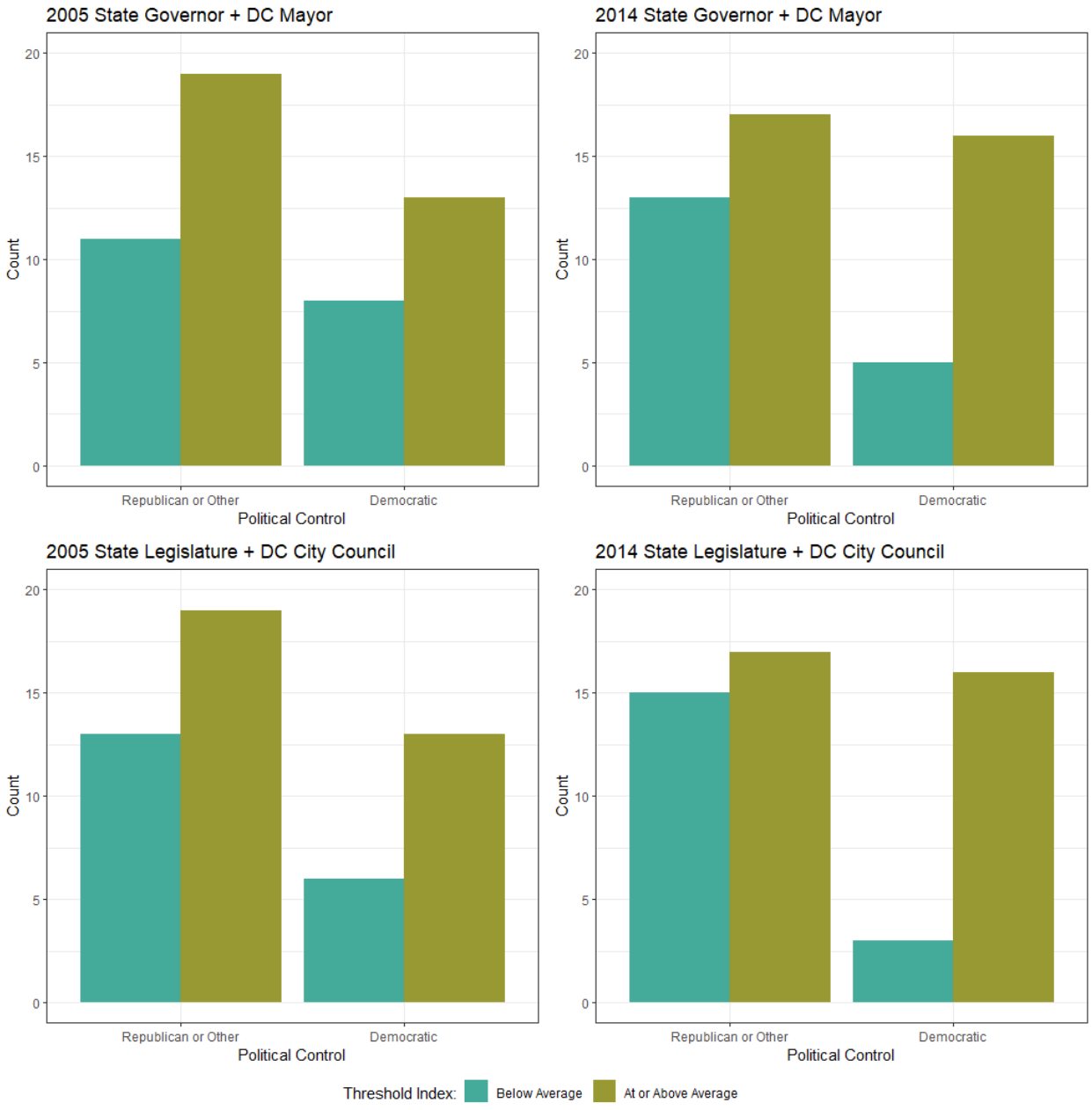
The summary statistics show that states with democratic legislatures and governors had higher overall food environment quality using the weighted index between 2005-2014, as seen in Figure 1.

Figure 1. Weighted Food Environment Index, by Political Control from 2005-2014



Using the threshold Index, we find that the number of states with democratic political control and above average food environments increased between 2005-2014, as seen in Figure 2. The number of states with non-democratic political control and above average food environments declined between the same time period.

Figure 2. Threshold Food Environment Index, by Political Control in 2005 and 2014



3.2 Methods

Existing literature has established relationships between: (1) household characteristics, socioeconomic conditions, state food policy, and *food security*, (2) household characteristics, socioeconomic conditions, and *food access*, and (3) socioeconomic conditions and *food*

environment quality. Nevertheless, we contribute to the discourse by utilizing a novel dataset with a wider array of state food policies (e.g., state-funded food assistance, state-funded food financing) and with state political partisanship to examine food security, food access, and two new measures of food environment quality.

3.2.1 Food Security & Food Access

In order to explore state-level food security and food access as food system outcomes, we use the following mixed model with a random effect for the intercept and fixed slopes:

$$y_{st} = x'_{st}\beta + z'_{st}\gamma + q'_{st}\delta + \mu_s + \varepsilon_{st}$$

where s is a state, t is a year, x is a set of political partisanship covariates, z is a set of food policy covariates, q is a set of socioeconomic covariates, μ is state random effect, and ε is an error term.

Socioeconomic control variables include the U.S. region (Midwest, Northeast, South, and West), log of total population, the state population's share of TANF participants, SNAP participants, WIC participants, NSLP participants, SBP participants, and SSI recipients, poverty rate, unemployment rate, share of households with annual income less than $10,000, share of female residents, median age, share of adult residents with at least a bachelor's degree, share of Asian residents, Black residents, and Latino residents, share of foreign-born residents, and share of immigrants without documentation.

3.2.2 Food Environment Quality

In an examination of food environment quality, we use the previous mixed model to explain the relationship between the weighted index of food environment quality and the political, food policy, and socioeconomic sets of covariates:

$$y_{st} = x'_{st}\beta + z'_{st}\gamma + q'_{st}\delta + \mu_s + \varepsilon_{st}$$

where s is a state, t is a year, x is a set of political partisanship covariates, z is a set of food policy covariates, q is a set of socioeconomic covariates, μ is state random effect, and ε is an error term.

Our binary index of food environment quality uses the following logistic regression model to predict the relationship between a state's food environment being above the national average based on the same sets of covariates:

$$\log\left(\frac{p_{st}}{1-p_{st}}\right) = x'_{st}\beta + z'_{st}\gamma + q'_{st}\delta + \varepsilon_{st}$$

where p is the probability that the binary index measure is equal to 1 (i.e., the food environment quality is above average), s is a state, t is a year, x is a set of political partisanship covariates, z is a set of food policy covariates, q is a set of socioeconomic covariates, and ε is an error term.

In the Appendix, we use bivariate latent growth modeling (BLGM) to examine the trajectories of food security and food access as the components of our food environment indexes. This analysis allows us to understand the food security and food access changes in the same time period and evaluate the correlations between their levels and change parameters.

3.2.3 Hypotheses

In considering our research questions, we hypothesize the following:

- States with lower minimum wages, restrictive SNAP policies (e.g., limited BBCE, mandatory fingerprinting), delayed implementation of EBT for WIC, and a lack of state-funded food assistance will be associated with higher rates of food insecurity.

- States with state-funded food financing initiatives will be associated with higher grocery store density, perhaps as the inequity of existing food access is apparent across the state's geography.
- States with democratic state legislatures and governors will be associated with higher food security and higher grocery density.

4 RESULTS

We find that state SNAP policies are not significantly significant predictors of the state's food security rate, after controlling for socioeconomic conditions across states, as seen in Table 3. Democratic governorship is, however, found to be negatively associated with food security.

State-funded food financing initiatives (FFI) are found to be positively associated with food access, which confirms our hypothesis of states that prioritize food access have higher grocery density rates. It is important to note that in this analysis we are unable to comment on the geographic inequity of the existing food access across states. Although we consider food assistance policies to be most relevant in explaining the relationship with food security, we do find that fingerprinting SNAP applicants is negatively associated with food access.

Table 3. Mixed Model Results for Food Security and Food Access

	Food Security		Food Access	
	Partial	Full	Partial	Full
State Minimum Wage	-0.518 **	-0.320	-0.362 *	-0.256
	(0.158)	(0.174)	(0.171)	(0.162)
SNAP: Broad-based Categorical Eligibility	-0.722 *	-0.232	-0.077	0.178
	(0.303)	(0.337)	(0.330)	(0.312)
SNAP: Share Requiring 1-3mo Recertification	-0.600	-0.042	2.771 ***	0.722
	(0.727)	(1.780)	(0.781)	(1.576)
SNAP: Phone Interview	-0.938 ***	-0.424	0.757 *	-0.338
	(0.283)	(0.305)	(0.301)	(0.254)
SNAP: Fingerprinting	-0.699	0.060	-4.244 ***	-2.933 ***
	(0.688)	(0.762)	(0.782)	(0.714)
SNAP: Eligibility for Legal Non-citizens	0.592	0.464	-0.502	0.388
	(0.563)	(0.711)	(0.641)	(0.684)
SNAP: Online Application	-0.046	0.121	0.487	0.002
	(0.273)	(0.301)	(0.293)	(0.270)
SNAP: Vehicles Excluded from Asset Test	0.271	0.008	0.625	-0.032
	(0.297)	(0.357)	(0.324)	(0.328)
WIC: EBT Implemented	0.018	0.763	-0.335	-0.636
	(0.465)	(0.508)	(0.506)	(0.454)
State-funded Food Assistance	-0.062	-0.655	-0.842 *	-0.164
	(0.382)	(0.711)	(0.417)	(0.754)
State-funded Food Financing	1.049	1.109	3.027 ***	2.211 ***
	(0.574)	(0.640)	(0.626)	(0.589)
Democrat Legislature	-0.069	-0.047	1.455 ***	0.463
	(0.268)	(0.348)	(0.293)	(0.307)
Democrat Governor	-0.590 **	-0.815 ***	0.175	-0.026
	(0.199)	(0.246)	(0.213)	(0.210)
Socioeconomic controls	No	Yes	No	Yes
N	700	500	700	500
logLik	-1574.477	-1087.068	-1677.633	-1052.104
AIC	3184.954	2250.135	3391.267	2180.209

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

We find that state minimum wage is positively associated with our weighted food environment index, which is a measure of food environment quality that equally weighs a state's food security rate and grocery density.

Table 4. Mixed Model Results for Weighted Food Environment Index

	Weighted Food Environment Index	
	Partial	Full
State Minimum Wage	0.025	0.060 *
	(0.025)	(0.028)
SNAP: Broad-based Categorical Eligibility	-0.104 *	-0.006
	(0.048)	(0.055)
SNAP: Share Requiring 1-3mo Recertification	0.016	-0.175
	(0.115)	(0.286)
SNAP: Phone Interview	-0.005	-0.005
	(0.044)	(0.048)
SNAP: Fingerprinting	-0.274 *	-0.170
	(0.113)	(0.126)
SNAP: Eligibility for Legal Non-citizens	0.042	0.063
	(0.093)	(0.120)
SNAP: Online Application	-0.007	0.017
	(0.043)	(0.048)
SNAP: Vehicles Excluded from Asset Test	0.114 *	0.042
	(0.048)	(0.058)
WIC: EBT Implemented	-0.026	0.054
	(0.074)	(0.082)
State-funded Food Assistance	-0.021	-0.136
	(0.061)	(0.125)
State-funded Food Financing	0.185 *	0.161
	(0.092)	(0.104)
Democrat Legislature	0.069	0.025
	(0.043)	(0.056)
Democrat Governor	-0.045	-0.056
	(0.031)	(0.039)
Socioeconomic controls	No	Yes
N	700	500
logLik	-333.187	-235.576
AIC	702.373	547.151

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

We also find that state minimum wage is positively associated with our threshold food environment index, which measures whether a state's food security or food access rates are above the national average. The threshold index is also positively associated with the opportunity

to conduct a phone interview as a requirement of the SNAP application (as opposed to an in-person interview).

Table 5. Odds Ratios for Threshold Food Environment Index

	Threshold Food Environment Index	
	Partial	Full
State Minimum Wage	0.679 ***	0.500 *
	(0.417 - 0.955)	(0.042 - 1.021)
SNAP: Broad-based Categorical Eligibility	0.625 **	0.328
	(0.172 - 1.084)	(-0.473 - 1.153)
SNAP: Share Requiring 1-3mo Recertification	-2.229 **	-1.190
	(-3.658 - -0.859)	(-4.979 - 2.731)
SNAP: Phone Interview	0.369	1.055 *
	(-0.215 - 0.955)	(0.049 - 2.079)
SNAP: Fingerprinting	-1.603 ***	-1.514
	(-2.404 - -0.845)	(-5.078 - 1.085)
SNAP: Assistance Eligibility for Legal Non-citizens	-0.294	-0.124
	(-1.141 - 0.575)	(-1.963 - 1.892)
SNAP: Online Application	0.982 ***	0.242
	(0.489 - 1.486)	(-0.574 - 1.075)
SNAP: Vehicles Excluded from Asset Test	-0.439 *	-0.542
	(-0.880 - -0.003)	(-1.500 - 0.385)
WIC: EBT Implemented	-0.415	0.818
	(-1.117 - 0.281)	(-0.536 - 2.230)
State-funded Food Assistance	1.371 ***	0.472
	(0.671 - 2.117)	(-1.353 - 2.672)
State-funded Food Financing	2.268 ***	1.608
	(1.092 - 3.785)	(-1.336 - 5.047)
Democrat Legislature	-0.150	0.385
	(-0.552 - 0.250)	(-0.531 - 1.330)
Democrat Governor	-0.044	-0.193
	(-0.419 - 0.331)	(-0.968 - 0.575)
Socioeconomic controls	No	Yes
N	700	500
logLik	-370.507	-153.269
AIC	773.014	378.538

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

5 POLICY (AND POLITICAL) IMPLICATIONS

We reiterate that this analysis purely shows the correlation, not causation, between Democratic governorship and increased food insecurity. Nonetheless, our findings highlight the opportunity for Democratic governors to be mindful that their states struggle with food insecurity at higher rates and seek opportunities to use public policy as a tool to combat the issue. This study builds upon existing research to show that certain SNAP policies are associated with improved food security. Our analysis used a dataset that spans 2005-2014, which includes Arizona being the last state to end the use of fingerprinting in the SNAP application process. By 2011, most state and local SNAP administrators had ceased the use of fingerprinting applicants because it was expensive and slowed the application process (Cournoyer, 2011). This is an example where state-level policy can make food assistance programs more fiscally efficient and easily accessible.

In that we find that state-funded food financing is positively associated with increased food access, states governments that prioritize healthy food access might look further into public financing solutions to limited food access. Fleischhacker, Flournoy, and Moore (2013) offer a framework for "meaningful, measurable, and manageable approaches" to evaluating food financing initiatives through short- and long-term case studies, longitudinal analysis, and randomized controlled trials each with a comparison group. The authors also argue that additional research funding should be provided to conduct these studies without impacting programmatic funds.

Most importantly, we believe our study of food environment quality adds to food system research that seeks to avoid the confusion between and conflation of food access and food security by exploring the combination of both phenomena as measured by food environment quality. This concept follows the framework from existing research that seeks to understand the relationship

and synergies between food security and food access (Bonanno and Li, 2015; Courtemanche et al., 2019). In this area, we find that food environment quality is associated with an increased minimum wage and the opportunity to conduct SNAP initial application and recertification interviews via telephone. Although state minimum wage policy has been shown to have little to no redistribution impacts on U.S. households (Sabia and Nielsen 2015), there is a future opportunity to explore the political situation that leads to such state policy and its significance in the food system.

6 CONCLUSION

We believe our primary contribution is an examination of food environment quality as a robust measure of a food system. In this analysis, we examine a state-level food system to find that political partisanship, state-funded food financing, SNAP policies, and minimum wage laws are associated variation in food environment quality across states. As a result, we state government's seeking to improve food environment quality might consider revisiting their policies on minimum wages, food financing, and certain aspects of the SNAP application process.

Nevertheless, there are limitations with publicly available food environment data. We recognize that the use of our current food environment indexes is not ideal given that it gives no indication where grocery stores are located across a state's geography at a finer scale. This omission will obviously exclude discussion of equity for low-income communities that struggle with food access. We also excluded Walmart stores from our analysis given that they were coded as department stores in U.S. Census data. Additionally, we recognize the data limitations of self-reporting participation in SNAP and other federal assistance programs, which leads to known misreporting (Kreider et al., 2012; Mittag, 2019; Parker, 2011).

In future research, we would like to explore the variation in FFIs, comparing the policies and politics of states that were early adopters before federal FFIs (i.e., Pennsylvania, New Jersey, and New York), late adopters, and those that never adopted state-funded FFI. Additionally, we would like to examine the share of SNAP and WIC retailers among the state's grocers to understand more about the stores that create food access for both benefits recipients and the broader community. A further examination of state-funded food policy and partisan politics may help policymakers and advocates achieve healthy, sustainable food environments.

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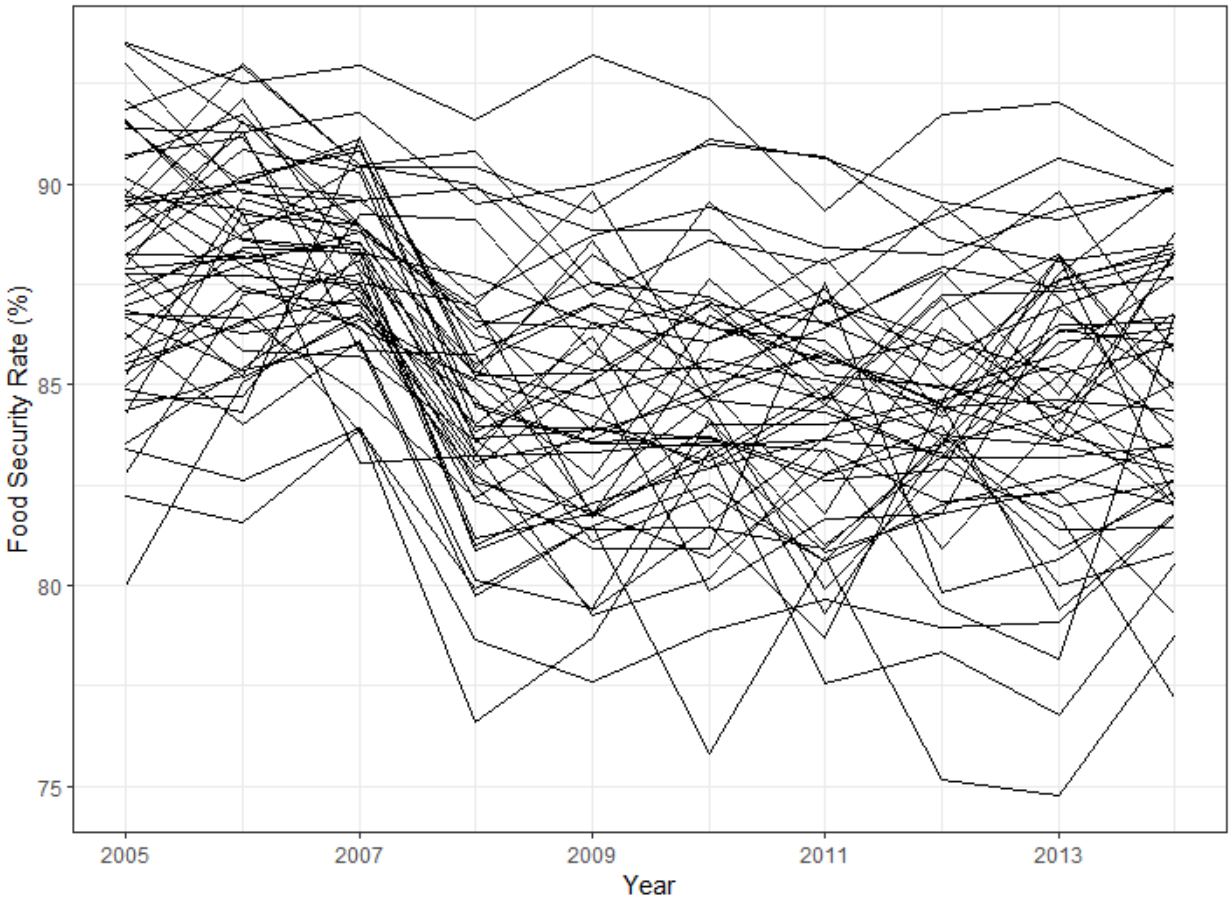
8 APPENDIX

In an effort to understand the unobservable relationship between food security and food access, we use bivariate latent growth modeling (BLGM) to examine the trajectories of food security and food access as the components of our food environment indexes.

8.1 Data

Our panel dataset includes measures of both food security and food access between 2005-2014. The food insecurity measure comes from the Correlates of State Policy Project (CSPR) based on University of Kentucky National Welfare Data (Grossman et al., 2021). It is the proportion of individuals who answered "yes" to at least three questions from the Core Food Security Model of the U.S. Census Current Population Survey. Figure A1 shows that there is a trend of declining food security during the period. There is also significant variation in state rates of food security and this variability increased following the start of the Great Recession in 2007.

Figure A1. Food Security Rate, by State from 2005-2014

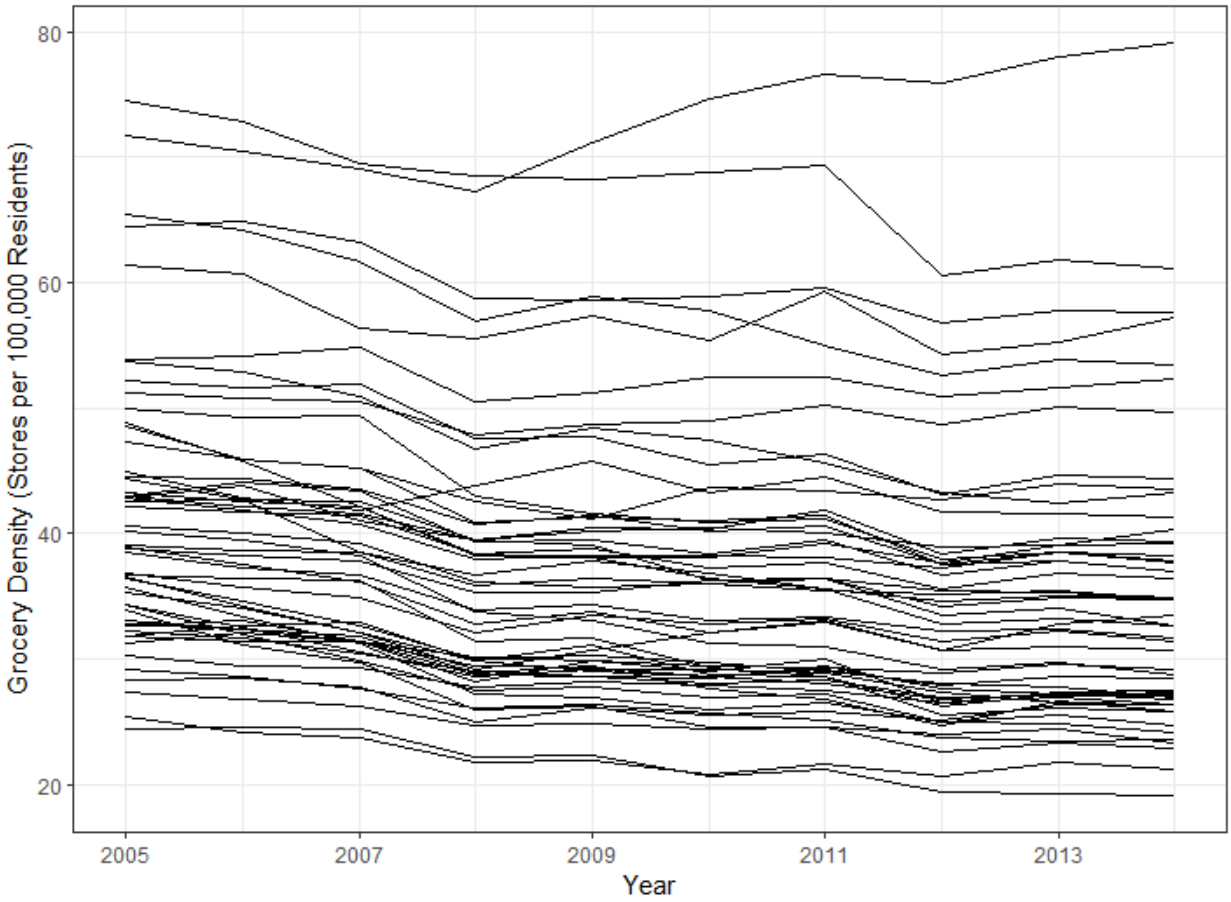


Note: Figure includes all 50 states and the District of Columbia (DC). Source: Grossman et al., 2021

The food access measure is calculated grocery density. We use U.S. Census County Business Pattern data of supermarkets, grocery stores, and specialty food stores (U.S. Census, 2021), in combination with total population taken from CSPR's U.S. Census and American Community Survey estimates (Grossman et al., 2021), to create a state-level grocery density measure. Figure

A2 shows a trend of declining grocery density across many states and the District of Columbia (DC).

Figure A2. Food Access Rate, by State from 2005-2014



Note: Figure includes all 50 states and the District of Columbia (DC). Source: Grossman et al., 2021; U.S. Census, 2021

8.2 Method

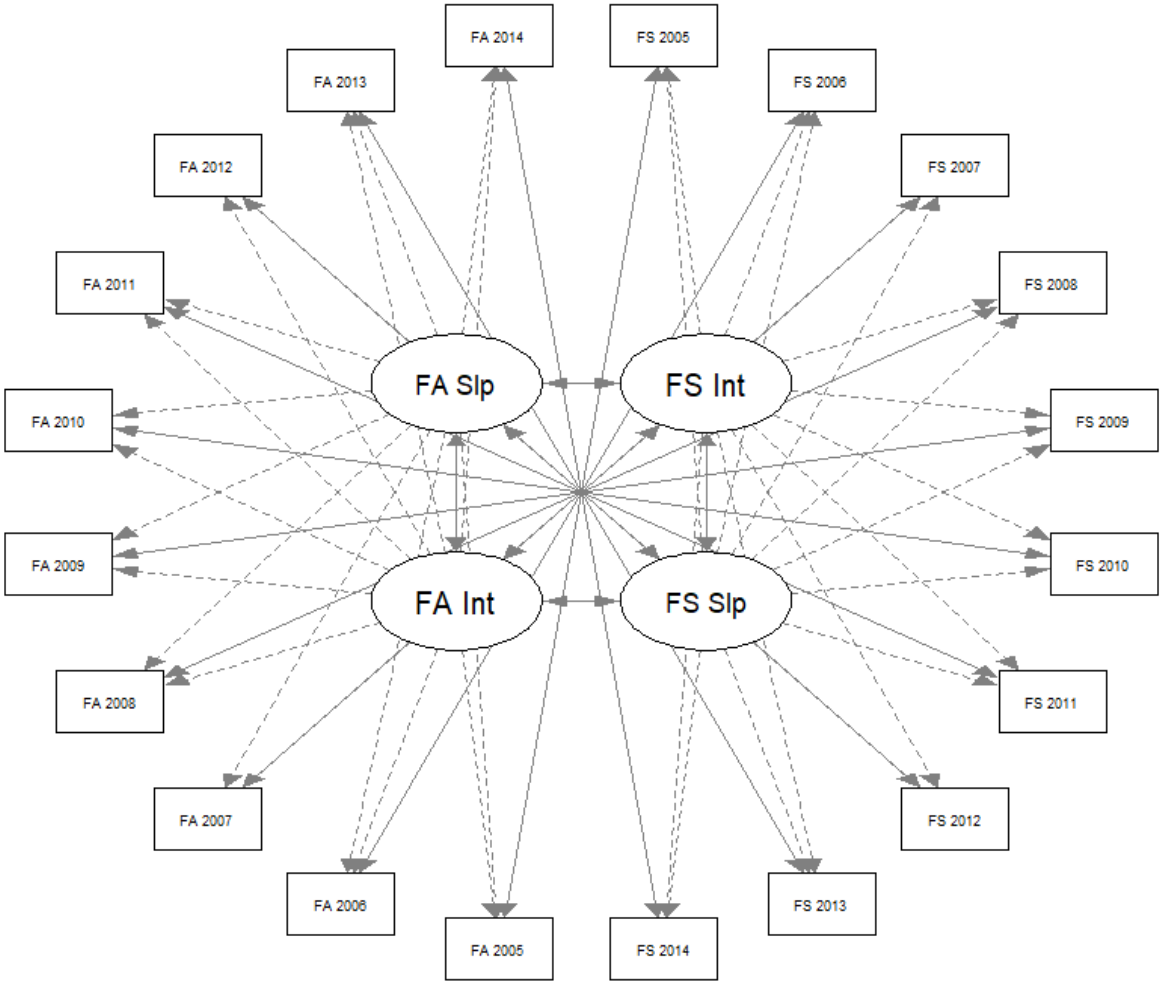
We use bivariate latent growth modeling (BLGM, also known as parallel process modeling) uses structural equation modeling to understand the relationship between food security and food access across states over time. BLGM allows for simultaneous estimation of food security and food access trajectories beyond the observed socioeconomic, public policy, and political partisanship variables we included in our mixed models. BLGM permits examination of annual residuals of each outcome after accounting for each outcome's within-state change. Modeling annual residuals allows us to capture the within-state changes in both outcomes, which can be the result of many unexplained factors happening during the same period (Muniz-Terrera et al., 2017). The BLGM is expressed as:

$$x_{st} = \beta_{0s} + \beta_{1s} y_{st} + \delta_{st}$$

where the latent outcome of interest x_{st} is a function of the endogenous indicator y_{st} and an error term δ_{st}. Therefore, β_{0s} is the expected response given $y_{st} = 0$ (i.e., the intercept) and β_{1s} is the expected change in the outcome per year (i.e., the slope) in state s at time t. The model estimates two sets of intercepts and slopes (along with the covariances of each); one set for each repeatedly measured outcomes.

We hypothesize that there is no relationship between the change in food security and the change in food access during the period of interest. Figure A3 illustrates the latent relationship between food security and food access.

Figure A3. BLGM Diagram of Food Security (FS) and Food Access (FA)



Note: *FS* refers to food security. *FA* refers to food access. *Int* refers to intercept. *Slp* refers to slope. The circle symbolizes a latent variable. The rectangle symbolizes an observed variable. The solid line symbolizes a factor loading (i.e., the path between an observed variable and a latent variable), while the dashed line symbolizes a factor loading for a fixed parameter. Residuals are not represented in this figure for simplicity.

8.3 Results

The results of Table A1 show that the predicted food security rate in 2005 is 87.57 percent and for every year the rate is expected to decline by 0.43 points. The expected food access rate is a grocery density of 40.79 grocery stores per 100,000 residents in 2005 and for every year the rate is expected to decline by 0.73 points.

Table A1. BLGM Estimates

	Estimate	Std. Error	Z	p-value
	Latent Intercepts			
Food Security - Intercept	87.57	0.34	259.29	0.000
Food Security - Slope	-0.43	0.03	-12.16	0.000
Food Access - Intercept	40.79	1.54	26.4	0.000
Food Access - Slope	-0.72	0.07	-11.01	0.000
	Latent Variances			
Food Security - Intercept	4.24	1.16	3.67	0.000
Food Security - Slope	0.01	0.01	0.56	0.574
Food Access - Intercept	121.14	24.1	5.03	0.000
Food Access - Slope	0.2	0.04	4.6	0.000
	Latent Covariances			
FS Intercept – FS Slope	0.16	0.09	1.78	0.075
FS Intercept – FA Intercept	9.39	3.97	2.37	0.018
FS Intercept – FA Slope	-0.02	0.16	-0.11	0.914
FS Slope – FA Intercept	0.09	0.39	0.24	0.812
FS Slope – FA Slope	0.00	0.02	0.02	0.982
FA Intercept – FA Slope	-0.24	0.73	-0.33	0.741
	Fit Indices			
Chi-squared	948.23			0.000
Degrees of freedom	213			
CFI	0.74			
TLI	0.77			
RMSEA	0.26			

Note: CFI is the Comparative Fit Index where values over 0.90 indicate a good model fit. TLI is the Tucker Lewis Index values over 0.90 indicate a good model fit. RMSEA is the Root Mean Square Error of Approximation, where values over 0.10 indicate a poor model fit.

The estimated covariances imply that there is positive relationship between the intercept and slope of food security, which indicates the higher the starting food security rate, the stronger the change in food security over time. There is a positive relationship between the slope of food security and the intercept of food access, which indicates that the higher the starting food access rate, the

stronger the change in food security. Additionally, we find that there is no significant relationship between the slope of food security and the slope of food access.

8.4 Conclusion

Our BLGM results show a decreasing trajectory for both food security and food access between 2005-2014. Nevertheless, we do not find a correlation between the trajectories of food security and food access during this period. We believe this finding warrants the use of food environment indexes that are a combination of food security and food access to represent a robust measure of food environment quality.

There are limitations to our BLGM specification, as we do not include covariates. At present, the current BLGM specification indicates that there is room to improve the model's fit. In future research, we plan to add mean values of the socioeconomic, public policy, and political partisanship variables used in the mixed models to increase statistical power and improve the model's fit.