Spatial Attributes Impact on SNAP Participation Rates

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Abstract

The Supplemental Nutrition Assistance Program (SNAP) is among the most participated in public assistance programs in the United States. In 2023, 12.6% of the United States participated in the program (USDA, 2025). Research on the varying participation rates across U.S. states has largely been limited to local study areas and identifying influential demographic and economic characteristics. By applying these findings from past studies, this study intends to expand the work of spatially analyzing SNAP participation rates by testing two different spatial attributes' influence on SNAP participation rates in the state of North Carolina. This study hypothesizes that North Carolina counties with low population density and fewer mileage of paved interstate will reflect a lower participation rate in SNAP. These spatial attributes were chosen because of their indication of accessibility and ruralness. Accessibility does not have a universally agreed upon definition, but this paper will understand accessibility as "people's overall ability to reach desired services and activities" (Litman, 2024). Similarly, ruralness does not have a set definition but this study will understand it through population density as it "serves as a better general definition for rural areas in North Carolina and better captures the county-centric identities many North Carolinians hold" (NC RuralCenter, 2025). Using these attributes, a linear regression analysis will be conducted to find the statistical significance of this group of variables in participation rates. To inform this model, data from the North Carolina Rural Center, Democratic Party, and Office of State Budget and Management will be used. To fully understand the concentration of these variables across North Carolina, this paper will produce three choropleth maps that visualize the population density, SNAP participation rates, and miles of interstate per North Carolina county. In addition to this set of choropleth maps, this study will conduct an optimized hot spot analysis in ArcGIS Pro to visualize statistically significant hot

spots of SNAP participation rates. Finally, to test the hypothesis set forth by this study, I will run linear regressions to find out if population density or miles of paved interstate have a statistically significant or insignificant relationship between SNAP participation.

Background

In 1939, as a response to the food surplus and unemployment fostered by the Great Depression, the first version of what is now known as the Supplemental Nutrition Assistance Program was put forth as the Food Stamp Program. This program aimed to distribute the agricultural surpluses of the time to improve domestic consumption and serve as unemployment relief. The program was an immediate success and saw the service of 4,000,000 people a month at its peak. After agricultural surpluses diminished and in the face of World War II, the program was later ended but formally returned in 1964 under President Lyndon B. Johnson. Up to this point, eligibility for and availability of the Food Stamp Program varied by state, but through the 1970s reforms saw the introduction of national eligibility standards and nationwide expansion. Over the next two decades the program experienced a variety of reductions and expansions in eligibility and relief provision, with the last relative formative change occurring in 2002 as the electronic benefit transfer (EBT) system was introduced (Caswell & Yaktine, 2013). Consistent with its past, today, the program aims to provide public assistance to households that meet the national eligibility requirements and can pass two income and asset tests. This assistance is granted through an EBT card with an allotted amount of money, dependent on household size and income, that can be used to purchase a wide range of food and drink options.

Over the course of its history, research on public food assistance has long attempted to explain varying program participation rates. Stigmatization has been an influential factor in participation for decades, as participation in the program is often shamed by elected officials, the

media, and grocery store clerks (Gaines-Turner et al., 2019). Additionally, statistically significant relationships have been found between various demographic and economic characteristics with different levels of participation. In an attempt to further the spatial understanding of food stamp participation, the underlying geographic attributes that go hand in hand with these demographic and economic characteristics and the stigmatization of participation must be understood.

Literature Review

This literature review seeks to inform the study on what factors have been identified that influence the varying SNAP participation rates observed across different areas in the U.S. and to establish a foundation as to what the prior research has and has not explored. Much research on the topics surrounding food assistance has been conducted in the form of very localized case studies with very few of these studies acknowledging spatial attributes that also may serve as explanatory variables for participation rates.

In pursuing this study's topic, the "Regional Differences in Use of Food Stamps and Food Pantries by Low-Income Households in the United States" by Patricia Duffy, Gandhi Bhattarai, and Marina Irmia-Vladu is the first body of work that becomes relevant, as among the first bodies of work that takes the abundance of pre-existing local case studies that have identified explanatory economic and demographic attributes and applied them in a spatial analysis. Their study aims to explore the varying degrees of participation rates across the Northeast, Midwest, South, and West between public and private participation food assistance programs. The study is conducted using data from the Current Population Survey in 1999 when public food assistance participation rates were at their lowest. The authors hypothesized that

regional differences between identical households would persist and that these differences would differ between private and public food assistance.

To test their hypothesis, the authors pulled data from the Current Population Survey to model participation in the two types of food assistance and included regional dummies as well as variables reflecting individual and household characteristics. To fully understand whether similar households in different regions were more likely than one another to use a food assistance program, the authors conducted regression models with these variables. The models were potentially limited by the difficulty of diffusing causality in model that aimed to predict the probability of using food assistance and the potential for simultaneous equation bias (difficulty in defining a cause-and-effect relationship because of mutual influence between factors). An additional limitation was that this study was conducted solely using data from 1999 so patterns of regional differences can only be assumed from the results of their models.

The analysis compared use between the South, Northeast, Midwest, and West. The results indicate that regional differences in the usage of food stamps and private food assistance do persist. In the South, people were less likely to look towards private food assistance for aid but were more likely than the West and Midwest to use the government sponsored food stamps program. Similarly, the Northeast was more likely than the West or Midwest to see low-income families utilize food stamps. The authors conclude that when household characteristics are held constant, regional disparities in food assistance participation do persist. These regional disparities include reluctance to seek out any form of food assistance as well as differences in the extent that various regions use different types of food assistance. The authors insist that the topic deserves further research aimed at explaining the rationale behind these regional disparities, but

that understanding that these regional disparities do persist is an important step to tackling food insecurity.

While Duffy et al. does establish that there is a regional significance in explaining varying participation rates in food assistance, their study does not put any effort towards exploring why these regional differences persist and only ponder on the subject in their conclusion. However, Dr. James Mabli and Julie Worthington's work "Supplemental Nutrition Assistance Program Participation and Emergency Food Pantry Use" progresses this research by finding the lack of and concentration of key attributes in eight different regions. While spatial analysis is not the authors' foremost intention, they provide valuable contributions towards identifying spatial variables to public food assistance programs participation. In their analysis, Mabli and Worthington test whether or not six months of SNAP participation is related to a decrease in private food pantry use. In doing so, they explore the factors that influence food pantry use, which is the most relevant aspect of their research in this study.

The authors pulled a sample of new-entrant households from data from the SNAP food security survey in 2011 to 2012. The new-entrant households were given a baseline interview and then a follow-up interview six months later. In the interviews, households were surveyed on private food assistance use and demographic and economic information. Addresses were taken from each sample household to find their geographic access to stores that accepted SNAP benefits. From this, the authors ran a logistical regression to find the association between six months of SNAP participation and use of private food assistance. In this regression model, pantry use was set as the dependent variable, and a wide range of household characteristics were used as the independent variables. The study was limited by allowing for potential bias by not interviewing all new-entrant households before they received their first SNAP benefit. The

authors also acknowledge potential measurement errors in households' self-reports and time confounds as limitations.

For the purposes of this study, the spatial variables that Mabli and Worthington tested for in their regression model are the most relevant. The authors found the percentage by region for new-entrant SNAP households as well as the urbanicity of these households. These results indicate that the Southeast and the West make up nearly half of the new-entrant households while the Northeast, Midwest, and South make up nearly an eight each. The Mountain Plains and Mid-Atlantic make up under ten percent each. As far as urbanity is concerned, over seventy-five percent of new-entrant households were considered urban. The study found that pantry use decreased in urban households after six months of SNAP participation, but not in rural households. The authors connected this to differences in supermarket access and food prices across urban and rural areas, implying regional differences in food assistance use. Additionally, the authors found that households in the Southeastern or the Southern regions were significantly associated with reduced pantry use after six months of SNAP participation when compared to the West. The authors believe this to be related to the South's relatively low cost of living and the difficulty of pantries being able to move food across impoverished and rural landscapes. By identifying urbanity and supermarket access as factors that influence SNAP participation, Mabli and Worthington serve as one of the few examples of research into the spatial dimension of this topic and provide the direction that this study follows.

Duffy et al. and Mabli and Worthington's studies are the two foundational studies in exploring SNAP participation rates outside of localized case studies that acknowledge the spatial dimension of SNAP participation rates. In doing so, these studies provide pieces of both the analytical framework and direction that this study depends on. The South/Southeast having a

higher participation rate is consistent among both studies; however, Mabli and Worthington make a logical connection that this is due to the South's poor access to supermarkets and the region being relatively more rural; however, they do not test this theory. This connection introduces accessibility as a measurable spatial attribute that influences SNAP participation rates. This idea is expounded upon in localized case studies.

The most relevant in exploring accessibility within localized case studies is "Reaching the limits: a geographic approach for understanding food insecurity and household hunger mitigation strategies in Minneapolis-Saint Paul, USA" by Joel Larson and William Moseley. This study identifies gaps in food insecurity research and aims to fill it by developing a spatial model that predicts food insecurity. The author's model intends to predict food insecurity by identifying accessibility and availability of an area.

In order for their model to work, Larson and Moseley had to create a number of indexes. The first of these indexes was a demographic food insecurity risk model created from the combined magnitude of poverty status, single female headed households, and minority status. Next, the authors created an accessibility index by using Guy's Gaussian measure, inputting store size and distance between origin points and groceries as accessibility variables. Larson and Mosely then multiplied the values of the two indexes to create a multiplicative index that highlights what tracts demonstrate a high demographic risk and low accessibility. The authors then survey two ethnically distinct areas to understand household coping strategies with food insecurity with the hope of applying their model to identify the tracts with the greatest risk of food insecurity. Larson and Moseley chose seven counties in the Minneapolis-St. Paul metropolitan area to apply their model to.

The results of this model demonstrate a spatial component in food insecurity vulnerability, as hypothesized by Larson and Moseley, and identify accessibility as an influential variable on food insecurity. While Larson and Moseley do not include SNAP participation rates in their study, connecting the accessibility and food insecurity serves as an example towards understanding SNAP participation rates spatially and the influence that accessibility can have.

While looking towards spatial attributes as variables is the aim of this study, understanding how household characteristics and differing experiences of food assistance use can influence participation rates is important to the overall field of food assistance research. Both "Determinants of Food Resource Utilization among Low-Income Households in North Alabama, USA" by James Bukenya and "Associations between Barriers to Food Pantry Use, Visit Frequency, Pantry Experiences, and Amount of Food Received" by Haisu Zhao, Francine Overcash, Abby Gold and Marla Reicks are examples of the study of this branch of variables. Neither paper looks specifically at the SNAP program, but both papers look to identify variables that influence food assistance use.

Bukenya's paper uses an econometric approach to predict low-income households' participation in public or private food assistance programs. Bukenya uses an econometric approach to predict low-income households' participation in public or private food assistance programs. Data was used from a 2016 household food security and socio-economic telephone survey across 14 neighborhoods that were considered to be a part of a food desert in North Alabama. The survey measures food security by creating a raw score that details the degree of a household's food security by asking six questions and allowing the household to answer the question with a range of answers that each correspond to a value. These values are summed up and used to create a raw score of household food security. These households are then asked

about their participation in a variety of public and private food assistance programs to produce a table that details participation rates in different programs between varying levels of food secure households. From here, Bukenya runs a logit model to identify the factors that can predict participation in food assistance programs. Bukenya conducts this test using ethnicity, gender, marital status, education, income, and household size as the independent variables and the various types of food assistance programs as the dependent variables. The primary limitations that Bukenya identifies within his analysis are the relatively small sample size and the household's self-reported data.

On the other hand, Zhao et al. provides a quantitative study on whether reporting barriers to food pantry use was associated with demographic characteristics, frequency and degree of pantry visits, and satisfaction with pantry visits. Data is pulled from the 2022 statewide Minnesota Food Shelf Survey. Demographic and food pantry experience was self-reported by the sample group. For exploring food pantry experience, the survey asked about frequency of, perceived barriers to, and satisfaction during visitation. With the data, a bivariate analysis explored comparisons between number of barriers and demographic characteristics, pantry experience variables, and behaviors regarding pantry use. From here, a mixed model logistical regression ran to determine the probability of barriers and demographic, pantry experience, frequency of visits, and amount of food received. The authors identified their study being limited by lacking generalizability because of the sample areas major demographic differences.

As a result of his analysis, Bukenya finds that some of the household characteristics can be considered statistically significant in influencing food assistance participation. Regarding publicly funded food assistance programs, ethnicity and education are found to influence likeliness in participation. Across private food assistance programs, marital status and household

size are the biggest influences in likeliness to participate. Bukenya concludes that participation in food assistance programs is largely influenced by predisposing and need factors.

Zhao et al's analysis reports that there is not a statistically significant relationship between barriers to pantry use and demographic characteristics, but there was a relationship between barriers to pantry use and increased odds of visitation, lower odds of getting more food, and lower odds of reporting a satisfactory experience. Contrary to other literature on the subject, this analysis did not find any statistically significant evidence of rural residency being connected to increased barriers to pantry use. Since Zhao et al. tested ruralness under a different definition and indicator, this finding does not impact the foundations of this study. The authors conclude that these findings should be used to inform pantry managers to focus on revising pantry policies to improve visitor satisfaction and the amount of food received.

These two studies are indicative of what most food assistance research has been centered around. By providing an example as to what traditional research into this topic centers around, Bukenya and Zhao et al provide helpful insight as to the known influences on SNAP participation rate and the theoretical models that produce them.

Methodology

In order to accomplish the research objectives and test this study's hypothesis, this study will employ the use of three choropleth maps, an optimized hotspot analysis, and a linear regression model. The choropleth maps will be used to visualize an understanding of how SNAP participation, population density, and mileage of paved interstate differ across counties. The optimized hot spot analysis will accomplish the research objective of determining where hot spots of SNAP participation are in North Carolina. The hypothesis that this study aims to test is

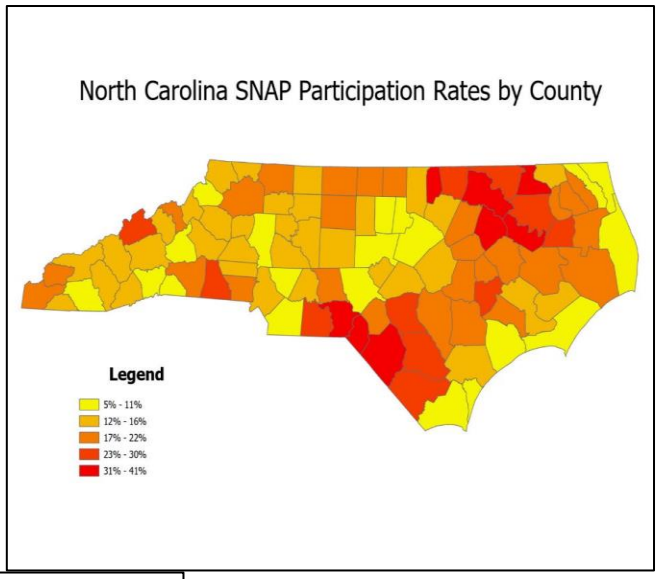
as follows: lower population density and fewer mileage of paved interstate within a county will reflect a lower participation rate in SNAP. The linear regression models will identify statistically significant or insignificant relationships between our spatial attributes and SNAP participation rates.

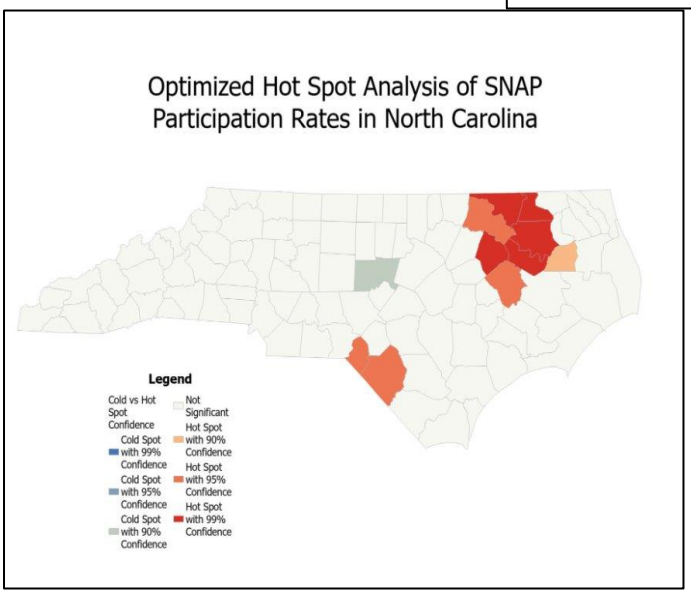
The spatial variables used in this study have been identified as a result of the findings of past literature. Urbanity and accessibility have been found to be statistically significant as a result of Mabli and Washington's study. This study employs the use of population density as representative of urbanity/ruralness and mileage of paved interstate as indicative of accessibility—two variables that have not been tested in regard to SNAP in the past.

This study will test these variables using North Carolina County data. The data for SNAP participation rates is drawn from the North Carolina SNAP Map by the NC Democratic Party. The data for miles of paved interstate within a county comes from the North Carolina Office of State Budget and Management. The data for population density is gathered through the North Carolina Rural Center.

Results

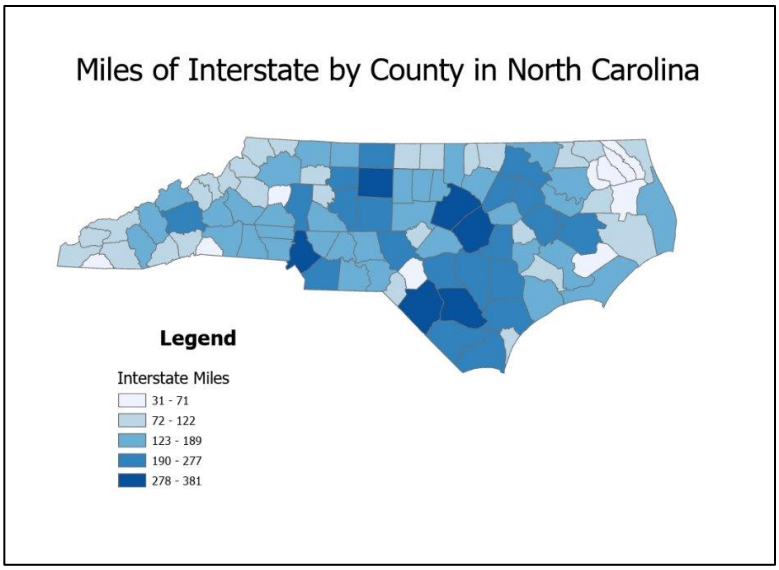
This choropleth map visualizes the SNAP participation rate by county in North Carolina. Below, the product of the optimized hot spot analysis visualizes two areas in North Carolina that are considered hotspots for SNAP participation rates.

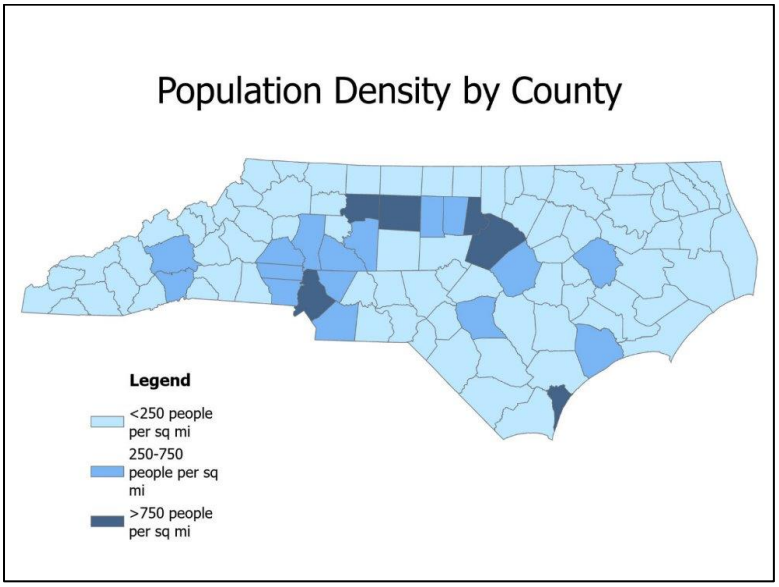




These maps work towards the research objectives by establishing our foundational understanding of how different counties in North Carolina participate in SNAP as well as which regions in the state are hotspots for participation in SNAP. Below are the choropleth maps that visualize the population density and mileage of paved interstate per county. These maps serve a similar interest in basing our understanding of urbanity and accessibility as understood by the indicators used in this study.

The population density map correlates with the hot spot of participation rates (as understood by the map above) in terms of low-density counties being seemingly a hot spot. The miles of paved interstate demonstrate no such correlation but still offer a valuable resource to refer to.





With the data used to produce these choropleth maps and the understandings derived from them, two linear regression models were run to test for a statistically significant relationship between the spatial attributes and SNAP participation. Despite correlation between ruralness and participation rates, the linear regression yielded an R score of 0.09—proving a statistically insignificant relationship. Similarly, the linear regression between participation and miles of paved interstate also proved statistically insignificant with an R score of 0.01.

Conclusion

This study aimed to contribute to the growing collection of food assistance literature by testing how urbanity and accessibility influence SNAP participation rates by using population density and miles of paved interstate as variables. In doing so, this study tested the statistical significance of these variables. The product of this is a working knowledge that population density and miles of paved interstate as indicators of urbanity and accessibility are not statistically significant in deterring the spatially varying rates of SNAP participation rates in North Carolina. In preparing to run the linear regression model, the set of choropleth maps and the product of the optimized hot spot analysis accomplished a different set of research objectives by expanding the work of spatially analyzing public food assistance and identifying hot spots of SNAP participation rates across North Carolina.

This research could be furthered by the identification and testing of a wider range of spatial attributes like land cover or walkability. Beyond the research objectives, the broad goal of this research is to contribute towards improving public food assistance policy by demonstrating how people's built environment influences their ability or willingness to participate in SNAP. The emphasis on household characteristics in research on this topic that the literature review references has a ceiling as to how policy makers can work to improve participation rates but by identifying how the lack thereof or presence of infrastructure in a community can influence participation rate allows for a whole new understanding of what policy makers can do to help promote participation.

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