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Dollar Stores and Supermarket Survivability in Non-metropolitan US Communities

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Dollar Stores and Supermarket Survivability in Non-metropolitan US Communities

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Abstract

With the growing popularity of dollar stores, concerns have surfaced over the potential relationship between dollar stores and the closures of grocery stores. Healthy food accessibility for consumers, particularly those in rural areas, has additionally become of great interest. This thesis aims to investigate the potential relationship of dollar store presence and grocery store closures. Data used included County Business Patterns, Rural Urban Continuum Codes, American Community Survey, and authorized SNAP retailer data. The spatial distance between grocery stores and the number of dollar stores at various radii were calculated. Following the computation of the number of dollar stores surrounding grocery stores, Kaplan Meier curves and Cox proportional hazards models were used for survival analysis of grocery stores. The findings of the models used imply that the presence of dollar stores is not associated with increasing the likelihood of grocery store closures.

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Chapter 1: Introduction

A recent report from the Economic Research Service found the number of grocery stores in rural areas have decreased between 1990 and 2015, while dollar stores have steadily increased over the years (Stevens, et al. 2021). The success of dollar stores has led to speculations on food availability, specifically how food availability has been affected by the growing entrance of dollar stores and the potential competition between dollar stores and grocery stores? To some, the question of how dollar stores affect grocery store sales may seem a bit out of the ordinary. But, this research question became more relevant after dollar stores began expanding their line of products to include more grocery items. Concerns over this issue were investigated by Kaufman in 1998. He concluded that grocery sales declined between 1992 and 1997 due to increasing food sales in retail stores. Competition from retail stores has become a concern for the survival of grocery stores in light of Kaufman's findings.

In many rural areas of the United States, dollar stores add convenience for residents to purchase food and other products without driving to a larger town. From this perspective, it would appear that dollar stores are increasing the convenience and accessibility of food for many people. But, in the long term how would the competition between dollar stores and grocery stores for food sales affect consumers? One concern from the long-term competition is the decrease in food sales in grocery stores due to the convenience of food availability in dollar stores. A study by Warren and Gordon-Larson (2018) found that sales volumes for grocery stores were generally a good measure for survival. Therefore, decreasing food sales could mean a reduced likelihood of survivability for grocery stores. Increased food sales from dollar stores could potentially result in decreasing food sales in grocery stores and ultimately contribute to store closures. With this scenario, will consumers still have plentiful access to healthy food

options such as a variety of fresh fruit, vegetables, meats, and dairy products that grocery stores traditionally provide? In 2019 the Wall Street Journal published an article highlighting governmental action taken to ensure food availability for residents in Oklahoma where there is limited or difficult access to grocery stores. Public concerns over this perceived threat of food access prompted many leaders in Oklahoma City to propose an ordinance that would require "new retailers in the area to designate at least 500 square feet of space to fresh food" (Ansari 2019). The proposed ordinance aimed to ensure dollar stores in the area would carry fresh food. In addition, Tulsa, Oklahoma passed zoning ordinances that would limit new dollar stores and relax parking rules for new grocery stores (Ansari 2019). Concerns over beliefs that dollar store entrants aid in grocery store closures have prompted state and federal policymakers to propose and enact regulations that promote food access for consumers (Ansari 2019; Stevens, et al. 2021; Vines 2021). These regulations vary by regulating requirements for food products on shelves or new businesses entering the local market.

Research and studies about the potential effects' dollar stores have on food availability are limited. There are large amounts of research concerning food access and the emergence of food deserts, but much of this research focuses on large cities and the association of factors such as fast-food restaurants, poverty status, and other neighborhood characteristics as the potential reasons for limited access to food in the United States (Warren, Gordon-Larson 2018; Powell et al. 2007). The research from these studies is important and provides a needed area of focus for economists to learn from and use as guidance for policy recommendations. But due to the primary focus of urban areas, people in rural regions may not greatly benefit from this research.

Concerns over healthy food availability in rural areas are not new. Past research has focused on the accessibility of grocery stores in rural areas and ease and affordability of food for

shopping. A study in 2007 measured the number of stores providing food in one county and the prices of food products for these stores. The study concluded that "Of 77 stores identified, 16% were supermarkets, 10% grocery stores, and 74% convenience stores" and that "Foods that were available at both supermarkets and convenience stores tended to be substantially more expensive at convenience stores" (Liese et al. 2007). Food prices have continued to be a point of scrutiny when evaluating food accessibility. Some dollar stores currently offer a guarantee of all product prices equal to one dollar. In 2018, dollar stores that sold produce for one dollar were examined for food quality. The study concluded that "While dollar-discount stores did have lower availability, they provided quality fresh and healthy foods which were usually less expensive" (Coughenour, Bungum, Regalado 2018). These results indicate that dollar stores may benefit many consumers, especially those with limited access to healthy foods.

Dollar stores are prevalently found in rural areas (Chenarides, et al. 2021). These stores are also concentrated more heavily in the Southeastern portion of the United States. This portion of the United States has received scrutiny for food and health-related studies, including one study that focused on the effect of dollar stores in the Southeastern U.S. and tobacco access (Hall, et al. 2019). In addition to the higher concentration of dollar stores in the Southeast, obesity rates are elevated among Southern states (Liu, et al. 2012; Xue, et al. 2021; Drichoutis, et al. 2015). While the relationship between food access and obesity has been investigated, it would be of relevance to investigate the potential impact of dollar stores on food access, in particular traditional supermarket survival, as this could ultimately affect health and obesity rates where dollar stores are prevalent.

Travel distance and transportation aid in the limitation of food availability for many people. In rural areas, this can pose a problem as one study by Sharkey and Horel (2008) found

that for "[for more than 20%] of all rural residents, their neighborhoods were at least 17.7 km from the nearest supermarket or full-line grocery or 7.6 km from the nearest convenience store". Distance, or geographical barrier, has been confirmed along with economic and informational access as foundational components of healthy food access for consumers (McEntee & Agyeman 2010). With potentially large distances to access in rural areas, the entrance of new food sources such as dollar stores is of great interest. While dollar stores are suspected to have impacts on grocery store survival, it is important to note that the success of dollar stores may be correlated with grocery store closures and not the direct cause. For example, in a small-town, sales for hair salons may increase in correlation with grocery stores sales. The survivability of the businesses may be correlated, but the increase in sales for both businesses are not directly related to each other. The increase in sales for the businesses could be attributed to an increase in job availability in the town.

The purpose of this thesis is to investigate the potential association of the presence of dollar stores on grocery store survivability, which can ultimately affect consumer access to full-service food sources. For ease of evaluation, grocery stores were viewed to be equivalent to supermarkets and superstores due to the large selection of food products found in these stores. Variables such as race, poverty status, median income, median home values, grocery and dollar store annual payrolls, and employment by dollar and grocery stores are used to aid in estimates.

To measure grocery store survivability, survival analysis with a Cox proportional hazard survival model will be used. Survival analysis is a technique that originates to approximately 1662 by John Graunt, who published the first life table (Liu 2012). Although survival analysis techniques are rooted in the medical field, the application of these techniques have expanded to use in a variety of fields. In 1972, survival techniques began to become more precise with the

invention of the Cox model which allows for "the provision of a flexible statistical approach to model the complicated survival processes as associated with measurable covariates" (Liu 2012). Comparable Cox models from previous studies in economics are discussed in further detail in the following review of literature chapter.

The data used in this study are comprised of several sources. Historical Supplemental Nutrition Assistance Program (SNAP) data was used to compile datasets of grocery and dollar store locations with beginning and end authorization dates for SNAP acceptance. SNAP data are of interest as the SNAP program is aimed to provide food access to qualifying low-income participants. Precursors to today's SNAP program dates to 1939 when the Food Stamp Program was enacted to provide food for unemployed and low-income Americans while also alleviating food surpluses (Caswell, Yaktine 2013). The present-day program began around 1970 and was nationally enacted in 1974 (USDA Food Nutrition Service 2018). SNAP data is used to indicate not only available grocery stores where eligible participants can use benefits, but also if dollar stores stock food items that may compete with grocery store products. In addition to SNAP store data, county level demographic information will be included from the American Community Survey (ACS) and the Census Bureau.

Chapter 2: Review of Literature

Survival Analysis Models

Although survival analysis techniques originate from medical science, many other fields of research including economics have employed the techniques. In a study by Glennon and Nigro (2005), the default risk of small business loans was measured using Cox proportional hazard model survival analysis techniques. The use of survival analysis for this study was effective at accurately portraying rate of event failure (loan default) over time. Limitations to this study include a data set that contained only small business loans from the SBA loan guarantee program (Glennon & Nigro 2005). The lack of small business loans from other programs does not allow for comparison of small business loans that are not included in the SBA loan program. Cox survival analysis techniques have additionally been used to evaluate survival of exporting Italian firms (Giovannetti, et al. 2011). In recent years, there has been some speculation of more accurate survival analysis techniques as compared to the commonly used Cox model. A study conducted by Cyrus (2021) used a discrete time model approach to measure trade agreements among countries citing that the survival model selected depends on the data that is being used. Even with alternative models, the Cox model remains popular in survival analysis.

Impact of Dollar Stores

Research on the impact of dollar stores is limited. Vines (2021) recently published an article investigating many beliefs regarding dollar stores. The survey discussed in the article found that 19 percent of those surveyed who shop in dollar stores identified as people “in rural areas who make less than $30,000 a year” (Vines 2021). Further those surveyed identified dollar stores as one of the only shopping options in their community (Vines 2021). The results of the

survey indicate that rural areas, and particularly consumers with lower income frequently rely on dollar stores as primary sources for shopping needs.

There have been a few studies conducted analyzing the effects dollar stores have on food access and food quality. The entrance of dollar stores and its potential impacts on food access have been evaluated using nationwide block level data, with the conclusion that the entrance of dollar stores does not increase the risk of losing food access over time (Chenarides, et al. 2021). Other studies observing impacts of dollar stores have focused on the potential impacts for childhood obesity. It has been concluded that dollar stores do not have an impact on increasing childhood obesity (Drichoutis, et al. 2015). In addition, dollar stores have been evaluated with regards to healthy food availability and their potential impacts for consumers. While this research is helpful, it only focused on stores in Las Vegas, Nevada (Coughenour, et al. 2018). Cho and Clark (2020) conducted a study to analyze the availability of SNAP acceptance of grocery and convenience stores across time and how acceptance rate changes occur due to many factors. In parallelism to other studies regarding dollar store effects, this study focused on the impact of convenience stores in respect to food access for consumers. Findings from this study indicate that "SNAP-authorized convenience stores respond to increases in demand in areas with low initial access" (Cho, Clark 2020). These conclusions are similar to many theories that dollar stores will target areas with lower food access when launching new stores.

Rural Health Disparities

Rural areas are thought to be more susceptible to higher obesity rates. The southeastern part of the United States is composed of more rural areas than other regions of the United States. A study evaluating the relationship between childhood obesity and walkability of regions concluded that there were higher levels of childhood obesity and lower levels of walkability in

the Southeastern portion of the United States (Xue, et al. 2021). While this is an important study, there were some unavoidable limitations with the data. One weakness was the use of parental reported child weights that could create over or underestimated levels of obesity (Xue, et al. 2021). In addition, the lack of neighborhood level data concerning "street connectivity", or walkability measurements, made the results difficult to interpret on a neighborhood level (Xue, et al. 2021). This limitation also limited the ability to compare urban versus rural areas in the same region for obesity rates.

In the study by Liu, et al. (2012) it was concluded that rural children are at higher levels of risk for being overweight and obese. This study investigated variables such as exercise, dietary intake, and screen time. With focuses on personal factors that lead to obesity, analysis was strong for evaluating individual's lifestyle factors as indicators of increased risk of obesity. This study did not include access to healthy food from grocery stores as a factor. As noted in the study "fewer grocery outlets, limited selection, and increased costs of fruits and vegetables may also lead to unhealthy diets in rural settings" (Liu, et al. 2012). Without the inclusion of supermarkets, differences in dietary intake among participants could differ not from personal choices but from lack of access to healthy alternatives. This could disproportionately reflect food choices in the data.

Rural Food Access

Literature investigating rural food access lists many potential factors that could result in rural "food deserts". Commonly investigated is the availability of healthy foods in stores. One study concluded that in general, rural stores have lower quality and availability of healthy foods as compared to urban stores (Pitts, et al. 2013). Similar findings were found when healthy snack availability in stores near schools in rural and urban areas were reviewed. The results from this

study concluded that rural stores generally offered fewer healthy snack options (Findholt, et al. 2014). In addition to lower quality and limited access to healthy food, many other potential barriers in rural food access have been identified. Economic challenges such as food prices, and consumers traveling to larger towns for greater variety with lower prices have been cited as challenges for rural food consumption (Bardenhagen, et al. 2017). Costs incurred to reach healthy food have received attention for both urban and rural regions. One study concluded that urban residents face a lower cost to reach food compared to rural residents due to reduced transportation costs (Losada-Rojas, et al. 2021). Limited access to fruits and vegetables in rural areas can not only impact residential health outcomes, but also financial wellbeing.

Rural Classification System

Rural areas are often analyzed differently from urban areas due to the differences in demographic structure. Some literature argues that a large percentage of the decline in rural regions of the United States have occurred due to classification changes which move many counties into a metropolitan status and can therefore distort inferences about rural demographics (Johnson & Lichter 2020). Classification systems of rural areas and the effects on study results has remained a point of discussion for many in various fields of study. Healthcare availability by rural status versus healthcare ratios, such as providers per population, was investigated in one study and found that allotment of areas lacking adequate healthcare varied between classification systems (Smith, et al. 2013). The findings of this study indicate that classification based on metropolitan status could disproportionately affect the results of studies.

Grocery Store Success

The supermarket industry has many factors that ultimately influence the success of a store. In a study by Warren and Gordon-Larson (2018), grocery store sales volume and the

closeness of competitors were found to be indicators of increased store survival. The closeness of competitors can include not only competitors from other chain stores, but also stores from within the same chain (Ahn 2019). Some studies have found indicators of store characteristics that increase sales volume. It was concluded by Ahn (2019) that the square footage of a store can aid in stores sales. Other studies have focused on the entrance of low-cost stores and the effects on grocery stores in the local market. Bauner and Wang (2019) found that with an entrance of a low-cost store such as Costco, grocery stores decrease prices on fresh perishable items and increase prices on easily stored products. Price changes in grocery store products in existing grocery stores can also occur whenever new grocery incumbents both enter or exit a market (Hosken, et al. 2015). Grocery store survivability has been investigated for many factors including the entrance of competitors, distance between competitors, and store characteristics such as sales volumes.

Chapter 3: Data

Store Data: Historical SNAP Data

To compile a dataset of grocery and dollar stores, a file labeled "Historical SNAP Retailer Locater Data" from the Food and Nutrition Service[1] was retrieved. The data contained SNAP authorized stores from all fifty states with beginning SNAP authorization dates. In addition to authorization dates, end authorization dates were included in the data. For purposes for this study, authorization dates were perceived as store openings, while authorization end dates were acknowledged as the "death" or closure of a store. It should be acknowledged that a store continuing to do business but no longer authorized for SNAP would be misclassified as a closure in this study. Figure 1 below displays the percentage of grocery stores in the final dataset that lost authorization for SNAP acceptance 1965 through 2020 period:

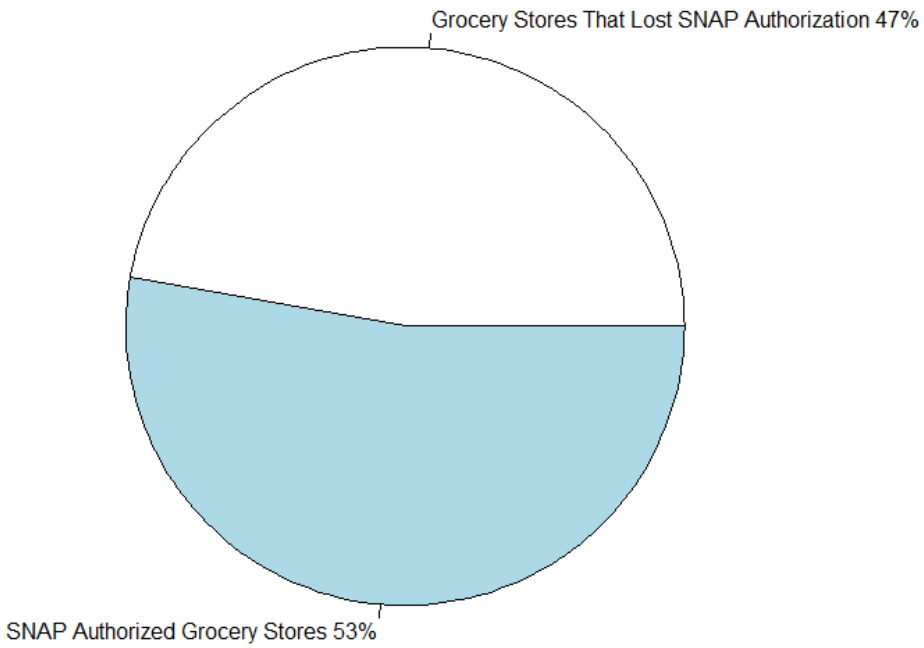

Figure 1: Grocery Stores Maintaining SNAP Authorizations versus Grocery Stores with Lost SNAP Authorizations from 1965-2020

[1] Historical SNAP Retailer Data downloaded from: https://www.fns.usda.gov/snap/retailer/historicaldata

Based on the figure above, it appears that from the dataset almost half the grocery stores lost SNAP authorization at some point during the study 1965 to 2020 period. The classification of grocery stores included in the dataset is defined in the following paragraph.

For the purposes of this study, stores were considered to be grocery stores if the store type was classified as one of the following: medium grocery store, large grocery store, supermarket, or superstore. Stores with these classifications appeared to offer full lines of food products. After grouping stores under these store types and eliminating stores that had incomplete data that made them unusable, there were 97,396 observations of grocery stores.

While the SNAP data used in this study included stores with authorization dates dating from 1930 to 2020, the dataset was truncated from beginning in 1930 to 1965. The decision to truncate the data, and begin in 1965 was made to reflect the 1964 Food Stamp Act by Congress which allowed the Food Stamp program to become permanent (USDA Food Nutrition Service 2018). Allowing for a one-year period from 1964 to 1965, stores would have become authorized to accept food stamps as the participant rate began to increase. After truncating for beginning authorization dates, the earliest authorization date appearing in grocery stores occurs on January 1, 1965. The final authorization date appears on December 31, 2020.

Due to limits in the data, the data were truncated for the SNAP end authorization dates to begin with January 1, 2004. There were no end dates before 2000, and very few end dates between 2000 and 2003. After truncating the end authorization dates, the first end authorization date for grocery stores appears on January 4, 2004. The last occurring date of a grocery store losing SNAP authorization occurs on December 30, 2020. It should be noted that the final study period for the grocery stores occurs between January 1, 1965 until December 31, 2020. All stores without end dates occurring during this time period were perceived as “alive” and accepting

SNAP benefits. With these new limits in place, there were a total of 96,805 grocery stores in the dataset. Figure 2 below illustrates the yearly number of newly authorized SNAP benefit grocery stores across the time used in this study:

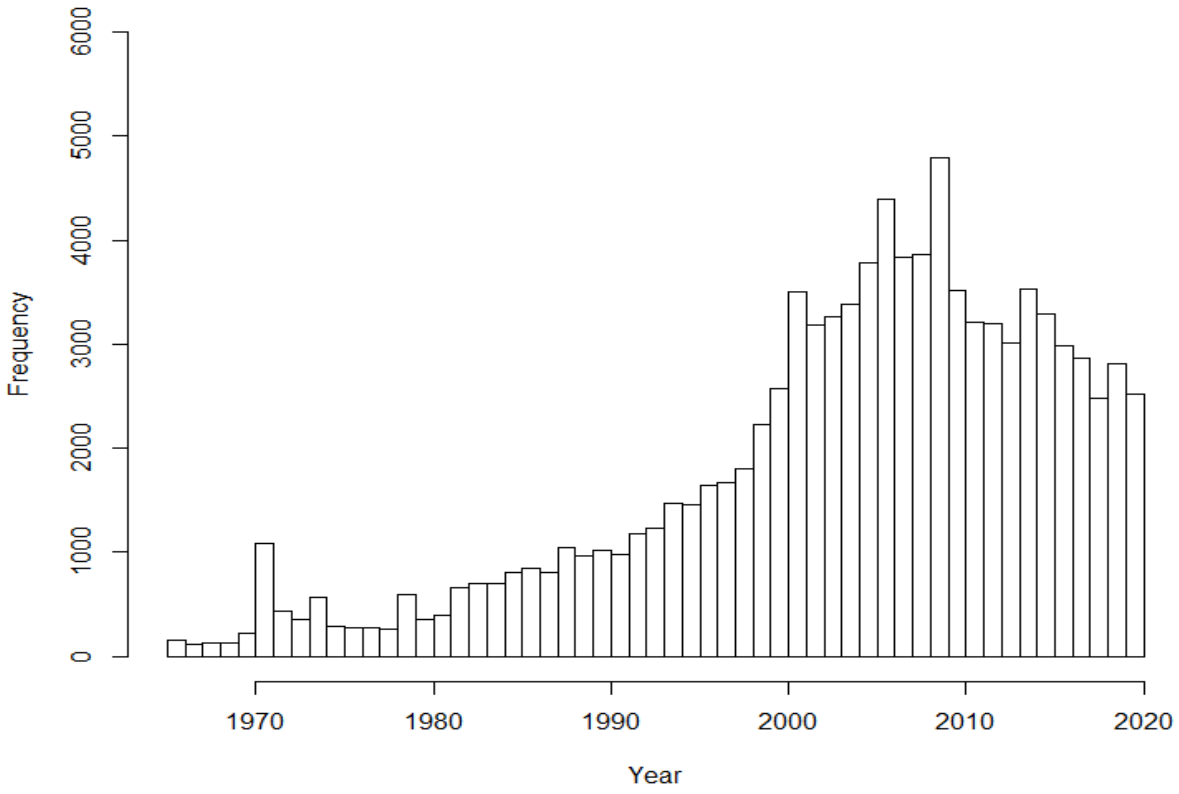

Figure 2: Yearly SNAP Authorizations of Grocery Stores by Year: 1965-2020

From Figure 2, it is easy to see that the number of grocery stores gaining SNAP authorization have grown over time. One interesting spike in the number of grocery stores gaining SNAP authorization occurs in the early 1970's years. This spike can be attributed to the congressional changes, allowing SNAP to extend to a nationwide program. From 1971 to 1974, congress enacted changes to ensure the program was available nationwide and with larger groups of eligible participants (USDA Food Nutrition Service 2018).

To compose a list of dollar stores, stores listed in the category of combination grocery/other were selected. From this list, stores were further subset by the name of the stores.

If a store had the words “dollar” or “99 Cent” in the store name, they were kept and compiled into a dataset. After these stores were compiled into a data set, there were 37,116 observations of dollar stores.

Dollar stores authorized for SNAP acceptance did not appear in this dataset in sizable numbers until the late 1990’s. It should be noted that due to incomplete latitude and longitude codes, many dollar stores in the 1990’s were lost when compiling the final dataset. Table 1 below shows the frequency of dollar stores in the data set during the 1990’s:

Table 1: Frequency of Dollar Store SNAP Authorizations 1993-1999

Year	Frequency of Dollar Store SNAP Authorizations
1993	12
1994	2
1995	2
1996	12
1997	16
1998	22
1999	40

Dollar stores do not appear in the data set until May 26, 1993. For the remainder of the 1990’s, the growth in dollar store SNAP authorization maintains a slow pattern until 1999. After 1999, the number of dollar stores gaining SNAP authorizations begins to occur with more sizable frequencies. The final SNAP authorization date for a dollar store appears on December 31, 2020. Figure 3 below shows the yearly number of dollar stores becoming SNAP authorized in the dataset:

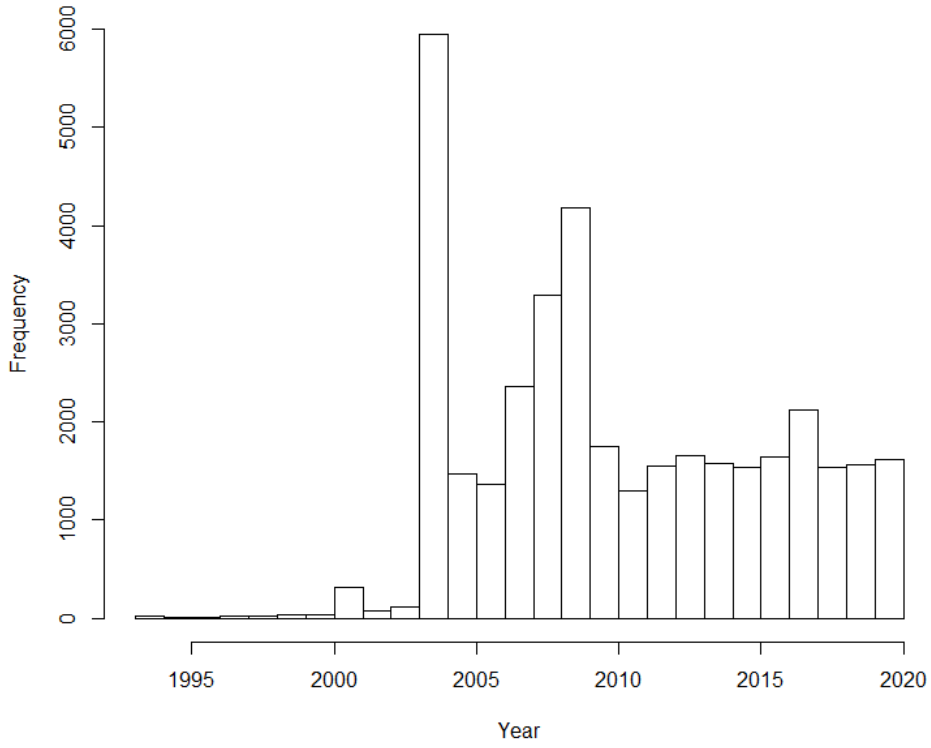

Figure 3: Dollar Store SNAP Authorizations by Year: **1993-2020**

It is interesting to note a large spike in the number of dollar stores with SNAP authorization in 2003. This could be attributed to the mandatory implementation of electronic bank transfer (EBT) of SNAP benefits in 2002 (USDA Food Nutrition Service 2018). The spike in SNAP authorized dollar stores in 2003 implies that the ease of accepting participants of SNAP benefits could be associated with more stores to moving accept SNAP. Interestingly, dollar store authorization for SNAP bypassed grocery store authorization for SNAP in one year of the dataset. Figure 4 below illustrates both dollar and grocery store SNAP authorizations during the years included in the data set:

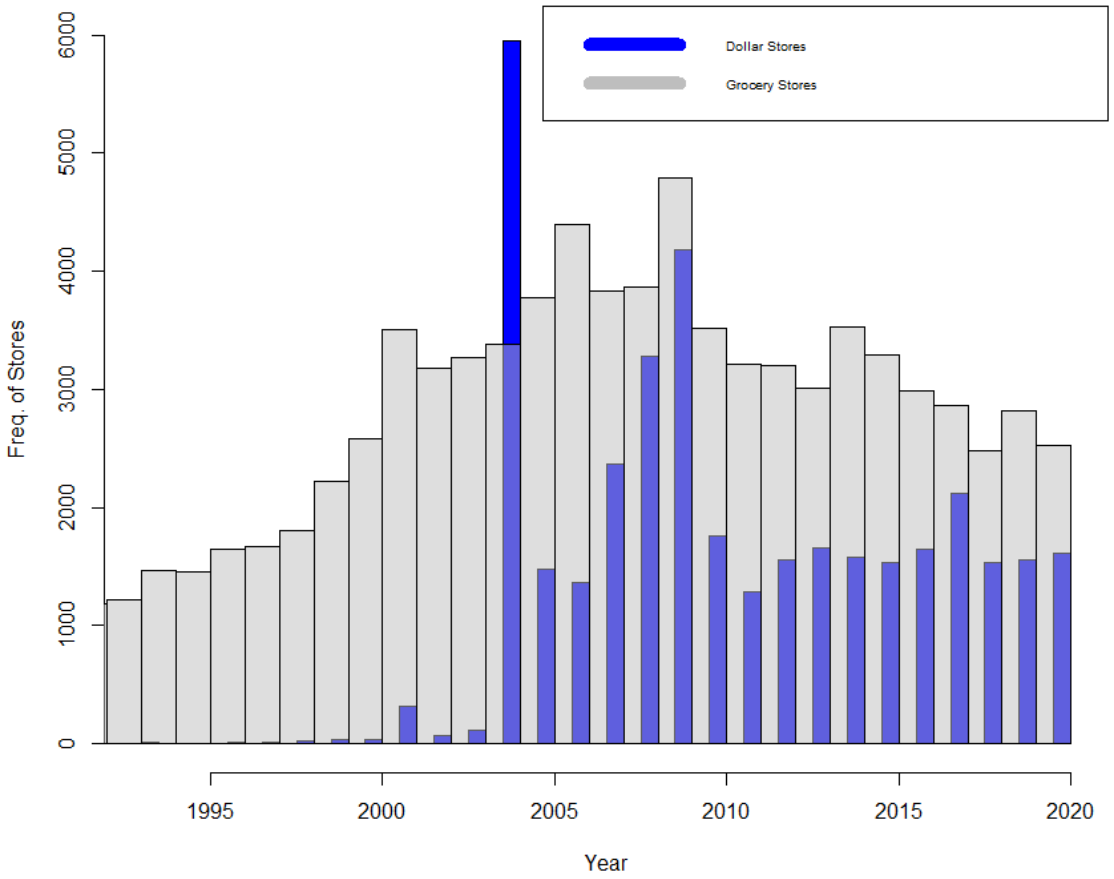

Figure 4: Grocery and Dollar Store Yearly SNAP Authorizations From 1992-2020

Dollar store authorizations for SNAP increased drastically in the mid 2000's, indicating that there was a market for carrying food and accepting SNAP benefits. One final observation from the figure above, is the frequency of grocery stores gaining authorization of SNAP benefits during the 1990's as compared to the frequency of dollar stores. There are large differences between the frequency of SNAP authorization between grocery and dollar stores during between 1993 and 1999 when dollar stores gaining authorization were very small.

The supermarket and dollar stores included in this dataset were required to meet minimum standards for the sales of food products to be eligible for SNAP authorization. For eligibility of authorization to accept SNAP, stores must stock a variety of staple food items. According to the Food and Nutrition Service (FNS), staple foods are broken into four categories:

I. fruits or vegetables

II. dairy products

III. meat, poultry, or fish

IV. breads or cereals

The FNS has different sets of criteria a store may use to become eligible for SNAP acceptance. A store can carry three stocking units of three staple food categories, or three stocking units of one perishable food in at least two staple food categories (FNS 2021). A store may also be eligible for SNAP authorization if fifty percent or more of its total gross retail sales come from a staple item (for example: a butcher shop would qualify for this criteria). Although specialty stores such as butcher shops qualify for SNAP authorization, only stores that were included in the categories previously mentioned as qualifying grocery stores were included. Additional variables from Census data as discussed in the following paragraphs were added to the dataset.

County Business Patterns

To aid in understanding the economic health of a county and the potential impacts on grocery store survival, county business patterns (CBP) for all counties in the United States were retrieved from the Census Bureau[2] for the available years of 2000 through 2018. The county business pattern data included information about the number of establishments per county. The data were further broken down into categories of establishments and relevant information regarding the types of establishments. For example, the data contained the number of manufacturing establishments with information regarding the annual payroll, quarter one payroll, and employee counts for each county. Types of establishments included from the CBP are:

[2] County Business Pattern retrieved from: https://www.census.gov/programs-surveys/cbp/data/datasets.html

grocery stores, dollar stores, manufacturing establishments, non-depository establishments (pawn shops), and bars. In addition, a total number of establishments in the county was included.

For further analysis, some of the data were normalized. Examples of data normalized are annual payroll by grocery stores in a county. The equation below demonstrates the normalization process used for grocery store annual payroll per county:

$$\frac{total\ annual\ payroll\ for\ grocery\ stores\ in\ a\ county}{total\ annual\ payroll\ for\ county}\ x\ 100$$

After further normalization of data, County Business Pattern data were merged with the grocery and dollar store data by county FIPS codes.

Rural Urban Continuum Codes

Rural Urban Continuum Codes (RUCC) are used to help better understand the population distribution throughout the United States. The codes are assigned to every county in the United States on a scale of 1 through 9 depending on the population factors associated with each county. The table below shows the codes and descriptions for each code according to the guidelines by the USDA Economic Research Service:

Table 2: 2013 Rural Urban Continuum Codes

Code	Description
Metro Counties	
1	Counties in metro areas of 1 million populations or more
2	Counties in metro areas of 250,000 to 1 million population
3	Counties in metro areas of fewer than 250,000 population
Nonmetro Counties	
4	Urban population of 20,000 or more, adjacent to a metro area
5	Urban population of 20,000 or more, not adjacent to a metro area
6	Urban population of 2,500 to 19,999, adjacent to a metro area
7	Urban population of 2,500 to 19,999, not adjacent to a metro area
8	Completely rural or less than 2,500 urban population, adjacent to a metro area
9	Completely rural or less than 2,500 urban population, not adjacent to a metro area

Retrieved from: Economic Research Service. 2020. https://www.ers.usda.gov/data-products/rural-urban-continuum-codes/documentation/

Table 2 above lists the RUUC and description used as of 2013. The RUCC codes are updated every ten years for each county. For the data in this study, the RUCC were used for the years 1993, 2003, and 2013. To reflect the current population around a store, a RUCC was merged with each store in the data set based on the store's end authorization date for SNAP acceptance. The end authorization date is the final date listed in the data for a grocery store to be certified to accept SNAP benefits. For this study, the end authorization date is perceived to be the "death" of the store due to becoming unauthorized to accept SNAP. Therefore, the closest RUCC to the earlier period of when the store became no longer SNAP authorized was used to reflect the demographics around the store when "death" occurred. For stores without an end authorization date, these stores were perceived as "alive" and accepting SNAP. In the case of a store with no end authorization date, the most recent RUCC was applied to the store. Table 3 below shows the RUCC used for each year a store lost authorization for SNAP acceptance:

Table 3: RUCC Codes used per Year of SNAP End Authorization

Year Store Lost SNAP Authorization	RUCC Code Year Used
1990-1999	1993
2000-2009	2003
2010-2020	2013

It should be noted that stores without end authorization dates were assigned a RUCC of 2013 as this is the most current available RUCC to reflect the population status surrounding a surviving SNAP authorized store. For more in depth analysis, stores were further broken into subsets to view the distribution effects of rural grocery stores and dollar stores. Figure 5 below shows the percentage of the grocery data that lies in a rural county and is adjacent or non-adjacent to a metro area:

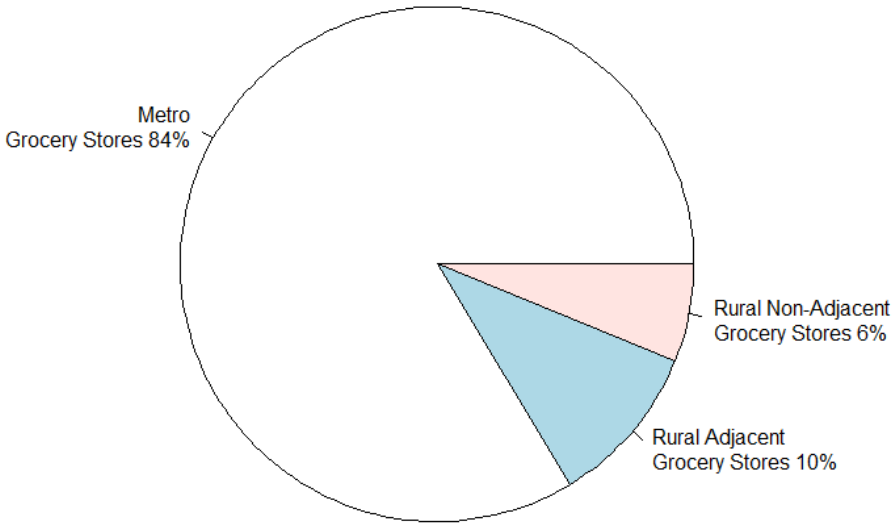

Figure 5: **Percent of Rural and Metro Grocery Stores by RUCC**

Rural grocery stores compose approximately 16% of the dataset, with 6% of rural stores being located in a county non-adjacent to a metro area. Rural counties that are not adjacent to a metro area were combined into one group. These counties had RUCC of 4,6, and 8; with authorizations

dates appearing from January 1, 1965 until December 22, 2020. Figure 6 below shows grocery stores in non-adjacent rural counties across time:

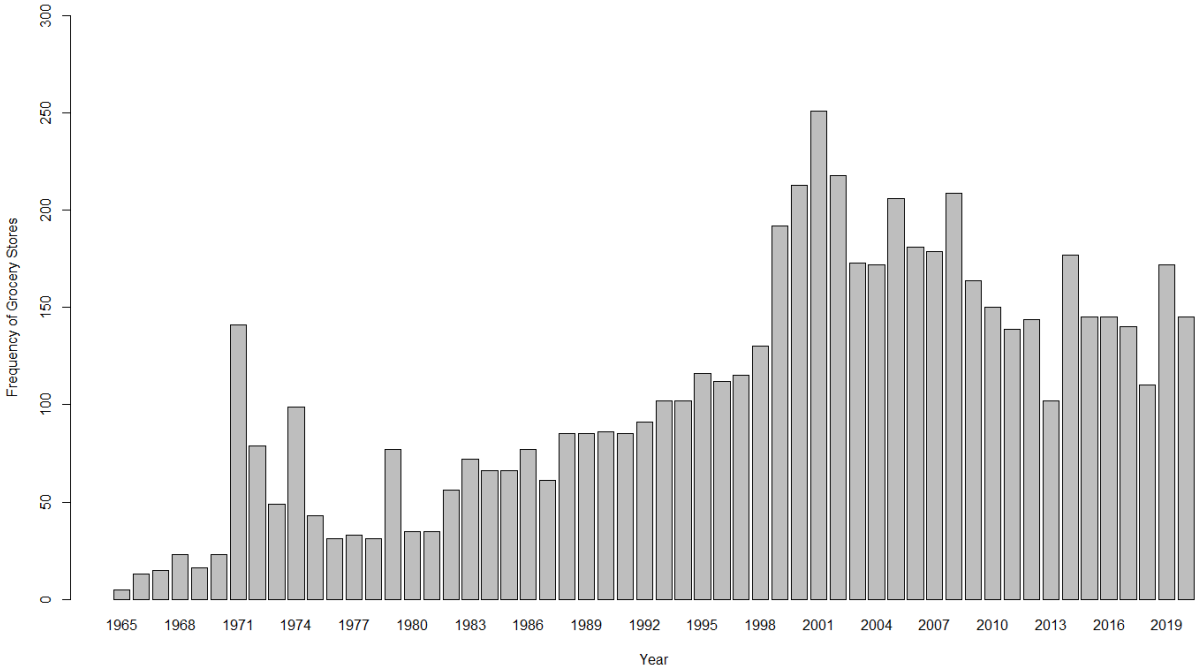

Figure 6: Grocery Store Yearly SNAP Authorizations in Rural Non-Adjacent to Metro Areas: **1965-2020**

Grocery stores in non-adjacent rural counties appear to follow an overall upward trend for SNAP authorizations over time, with a slight downward trend for later years. Non-adjacent rural stores often serve as food access for the most isolated populations due to the distance to a metro area. To further evaluate the differences in rural stores, rural counties that were adjacent to metro areas were also combined into one category. These counties had RUCC of 5, 7, and 9. This subset also had authorization dates beginning with March 25, 1965 and the final authorization date occurring December 30, 2020. Figure 7 below shows grocery stores gaining SNAP authorization located in rural counties adjacent to metro areas across time:

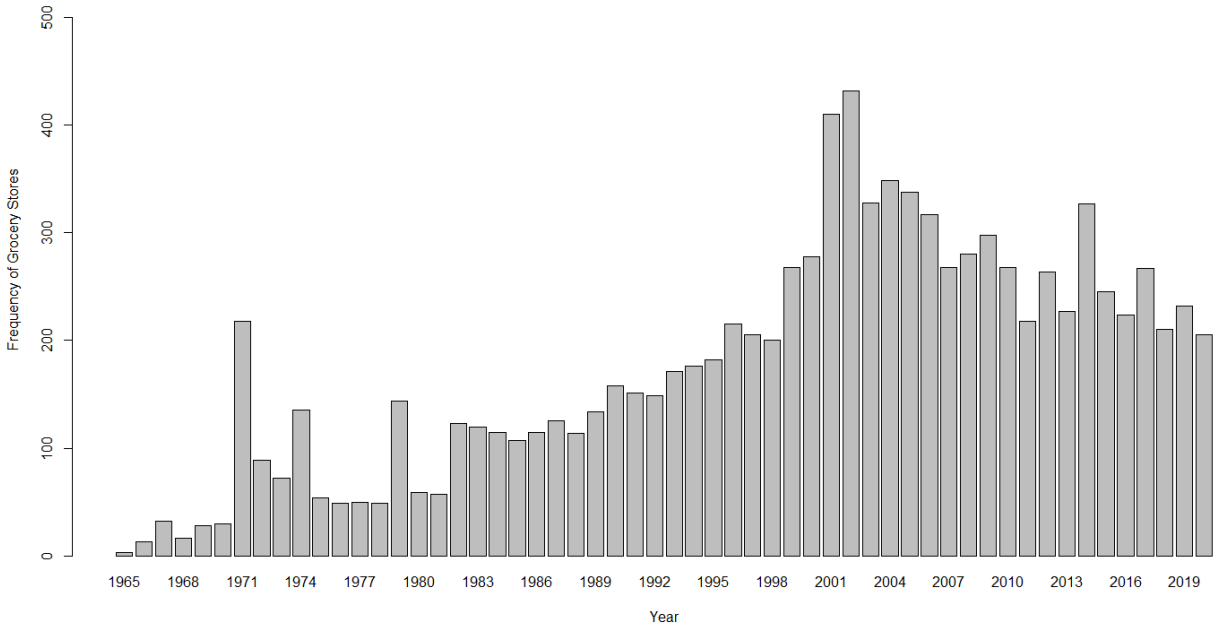

Figure 7: Grocery Store Yearly SNAP Authorizations in Rural Adjacent to Metro Areas: 1965-2020

Rural grocery stores located in counties adjacent to metro areas obtaining SNAP authorization show a general upward trend until approximately the mid 2000's, when a downward trend begins to appear through the end of the study period.

Yearly SNAP authorizations for metro stores showed an increasing trend for much of the 2000's. Stores classified as metro stores had RUCC of 1,2, and 3. Beginning SNAP authorization dates range from January 4, 1965 to December 31, 2020 for metro stores. Figure 8 below illustrates the

frequency of grocery stores acquiring SNAP authorization by year:

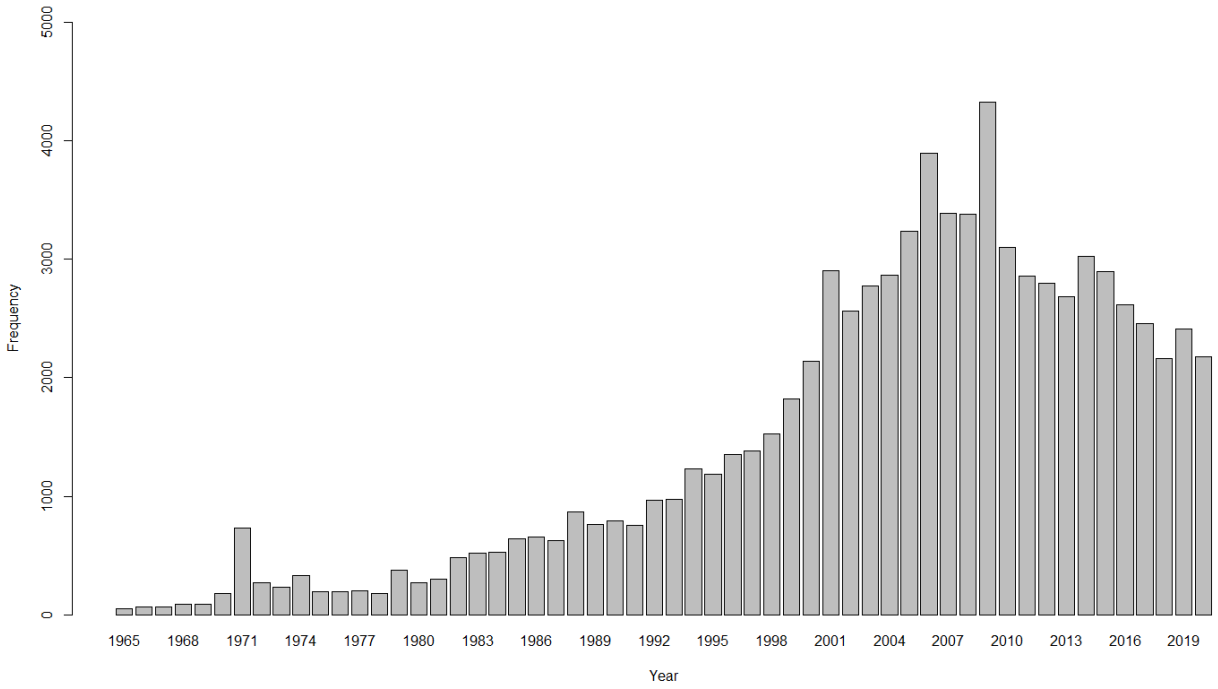

Figure 8: Frequency of SNAP Authorizations for Metro Grocery Stores: 1965-2020

A general increasing trend is observed in the frequency of SNAP authorization for metro stores until 2006. After 2006, with the exception of a few select years, the frequency of metro grocery stores acquiring SNAP authorizations shows a general decreasing trend. The same trend was noted in the previous figures for rural grocery store categories.

A similar set of comparisons for dollar stores were conducted to compare with the distributions of grocery stores in the dataset. The distribution of the data differed from those found in the sets of grocery stores graphs. The first set of comparisons for dollar stores graphed the distribution of stores by the RUCC classifications. Figure 9 below illustrates the percentage of dollar stores accepting SNAP and their locations of either metro, rural adjacent to a metro area, or non-adjacent to a metro area:

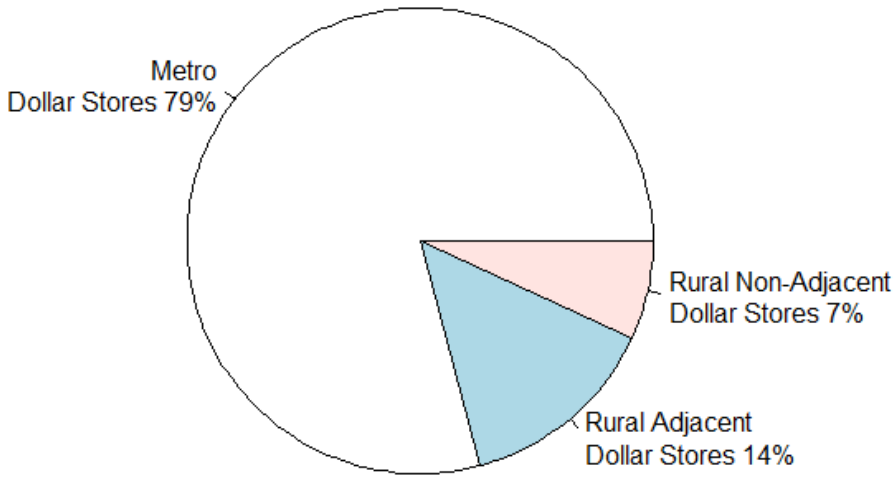

Figure 9: Percentage of SNAP Authorized Dollar Stores by RUCC Description

It is interesting to note from the graph above, that the distribution of dollar stores in metro, rural adjacent to metro areas, and rural non-adjacent to metro areas are not identical to the distribution of grocery stores. Of the dollar stores in the data, seven percent were located in rural non-adjacent counties. Dollar stores are seventeen percent more prevalent than grocery stores in rural non-adjacent to metro area counties. Of the total dollar stores, rural adjacent dollar stores are four percent higher as compared to the total number of grocery stores located in rural adjacent counties. This makes them 140% more prevalent in rural adjacent counties as compared to SNAP authorized grocery stores. Additional demographics for counties, were added to the dataset from other sources.

Census Data

To further add county demographics to the data set, data from the 2010 Census[3] were compiled for racial and poverty statistics. Racial statistics for total population, total white, total black or African American, total American Indian and Native Alaskan, total Asian, total Hispanic, total Native Hawaiian or other Pacific Islander, and total of two or more races were

[3] 2010 Census County Population retrieved from: https://www.census.gov/data/tables/time-series/demo/popest/2010s-counties-detail.html

obtained. From this data, percentages for each race[4] were calculated by dividing the race variable by the total population. In addition to racial demographics, poverty status was also included in the data. Percentage of poverty for all ages and median household income per county were retrieved from the 2010 Census[5] and added to the dataset. Median household income was divided by 1,000 to simplify the results of the regression models where income was included. Yearly data were desired for more accurate analysis. But due to incomplete yearly data from other sources, the 2010 Census data provided the variables needed for this study.

American Community Survey

Median home values used in this study were retrieved from the 2011 five-year summary of the American Community Survey[6]. As noted in the previous paragraph, yearly data were desired. But, due to incomplete yearly data for each county, a five-year summary was used during the middle of the study period. The median home values were divided by 1,000 to simplify the results of the regression models and allow for ease when evaluating the effect of median home values on grocery store survivability. The methods used to evaluate and model the data are discussed in the following chapter.

[4] Total Hispanic populations were not included in the total of one race statistics from the census. The author calculated the percentage of Hispanic population by number of Hispanic populations given in census data and divided by total population.
[5] 2010 Census County Poverty Rates retrieved: https://www.census.gov/data/datasets/2010/demo/saipe/2010-state-and-county.html
[6] 2011 ACS 5-year Summary retrieved: https://data.census.gov/cedsci/table?q=Median%20House%20Value&g=0100000US%2405000000&tid=ACSDP5Y2011.DP04&hidePreview=true

Chapter 4: Methods

Dollar Store Counts

Measuring the distance between grocery stores and dollar stores was a vital component of this study. One of the challenges to evaluating distance was defining reasonable distance standards between stores, especially those in rural areas. While distances to stores that offer food is a key variable investigated in food access studies, the parameters for distance measures vary greatly. Food access measures range from less than one mile to approximately ten miles in many studies (Russell, Heidkamp 2011; Sharkey, Horel 2008). It is difficult to set guidelines for acceptable distances to travel for food when urban and rural area dynamics greatly differ. The Economic Research Service[7] defines low access to food in rural areas as being 10 miles or more from a supermarket. In addition to defining distance to food access, methods used to measure distances differ. Some studies use road mapping networks, while others use strictly "by how the crow flies" as measurement standards (Liese, et al. 2007). The estimates used for distances may not accurately reflect the actual distances used to travel for access to purchase food. Estimating distances between two points as "the crow flies" may be grossly underestimated in areas with mountainous terrain where the road networks by which people travel will go around the terrain and not by the shortest distance from point to point.

Due to limited methods available, the distance between stores for this study were calculated by the shortest distance from point to point. To evaluate food access and the proximity of dollar stores to grocery stores, the program R was used to manage data for statistical analysis. An algorithm was written to measure the distance between grocery stores and dollar stores using

[7] According to the USDA Economic Research Service Food Access Research Atlas, "Low-access census tracts". Retrieved from: https://www.ers.usda.gov/data-products/food-access-research-atlas/documentation/ on November 8, 2021.

the Haversine function from the package geosphere. The Haversine function calculates the distance between two points using the latitude and longitude of each observation, with the assumption of a spherical earth (Hijmans 2019). The sum of dollar stores located in a specified radius to each grocery store observation calculated from the Haversine function were recorded and used for regression analysis. (Please see Appendix A for the R code.) The distances given by the function were later converted from meters into miles by dividing the distance calculated by 1,609.34. This was to reflect the use of the imperial system used in the United States. Radii calculated for each store include: 1, 2.5, 5, 10, 15, and 20 miles respectively.

Survival Analysis

In addition to dollar store counts, times for survival of grocery stores were calculated. Survival times were calculated using the beginning and end SNAP authorization dates for the stores. End authorization dates served as the time of store closures, while the beginning SNAP authorization date served as the time of opening. The survival times calculated the span of time between the opening and closing of the grocery stores. The equation below demonstrates the method by which survival times were calculated:

$$\frac{Authorization\ End\ Date - Authorizataion\ Beginning\ Date}{365.25}$$

The difference between the authorization dates was divided by 365.25 to convert the time span from number of days to a survival time in years. In addition to survival times, the dataset was further converted into the survival form needed for analysis.

To convert the data into a plottable survival dataset, the function "Surv" from the package survival was applied using the program R (Therneau 2015). Using this function, the status of a grocery store's closure was calculated to reflect if the store was open or closed at the end of the study period. The event status was recorded as a binary variable with 1 representing

the closure of the store, and 0 representing the store as remaining open. After defining the event status of each store, preliminary models were conducted.

Survival analysis regressions were conducted following the calculations of dollar store counts in proximity of grocery stores. Using R, Kaplan Meier survival curves were plotted to show the probability of survival over time. The commonly cited formula of the probability of survival, or also known as the survival function is listed below (James, et al. 2021):

$$Survival(t) = \Pr(T > t)$$

This function represents the probability that a grocery store closes at a time later than *t*. In addition to estimating the survival probabilities, a graphical representation was made using a Kaplan Meier curve. The Kaplan Meier curve uses the survival probability function, and is graphed across the study period. In order to graph the curve over time, the survival probability at each time *t* is calculated. Below is the formula for survival probability as cited by Kishore, et al. (2010) for use in a medical analysis:

$$S_t = \frac{Number\ of\ living\ subjects\ at\ the\ start - Number\ of\ subjects\ died}{Number\ of\ living\ subjects\ at\ the\ start}$$

In the context of this study, the number of living subjects at the start is equivalent to the number of grocery stores open at the beginning of the time interval. Likewise, the number of subjects died is interchangeable with the number of stores closed (SNAP deauthorized) in this situation. The survival probability was calculated for each time interval in this study and composed to create the survival function. For a dataset of this size, the function "survfit" was used in R to create the Kaplan Meier curve automatically and not manually (Therneau 2015). Kaplan Meier curves were conducted for the survival of metro grocery stores (RUCC of 1,2, and 3), stores in rural areas (RUCC of 4, 5,6,7,8, and 9), and both metro and rural stores from 1992 to present. For both sets of rural grocery stores, the data were further subset and Kaplan Meier curves

conducted for stores adjacent and non-adjacent to metro areas. Following the Kaplan Meier curves, Cox proportional hazard models were conducted.

Cox proportional hazard models are similar to other regression analysis except the dependent variable in the analysis is replaced with a hazard function (Walters 2009). Walters (2009) further explains the hazard function as a measurement of the probability that the event of "death" will occur for an observation with the equation:

$$h(t) = \frac{number\ of\ individuals\ experiencing\ an\ event\ in\ an\ interval\ beginning\ at\ t}{(number\ of\ individuals\ surviving\ at\ time\ t)x\ (width\ interval)}$$

With the function "coxph" in R, Cox proportional hazard models were used for analysis of grocery store closures. A set of preliminary models were first used to establish a preferred model for analysis of the grocery stores. Table 4 below shows the preliminary models used:

Table 4: Preliminary Cox Proportional Hazard Models

Cox Proportional Hazard Models			
	Model		
	(1)	(2)	(3)
Dollar Stores within 10 miles	-0.133***	-0.158***	-0.144***
	(0.004)	(0.005)	(0.005)
Non-adjacent, Pop.>= 20,000		-0.049	-0.053
		(0.051)	(0.051)
Adjacent, Pop. 2,500-19,999		-0.339***	-0.289***
		(0.034)	(0.036)
Non-adjacent, Pop. 2,500-19,999		-0.403***	-0.363***
		(0.040)	(0.042)
Adjacent, Pop. <2,500, completely rural		-0.440***	-0.403***
		(0.057)	(0.059)
Non-adjacent, Pop. <2,500, completely rural		-0.568***	-0.609***
		(0.053)	(0.057)
Poverty			0.008*
			(0.005)
Median Income			-0.006
			(0.004)

Note: State fixed effects were included in all models, but not reported in the table.

(To view the complete table of preliminary models, please see Appendix B.) All three preliminary models included state FIPS codes to allow for state effects. Model 1 evaluated state effects, with the effects of dollars stores within 10 miles of a grocery store. Model 2 added the Rural Urban Continuum Codes 4, 5, 6, 7, 8, and 9 to Model 1. Non-metro counties with an urban population of 20,000 or more and adjacent to a metro area (RUCC 4), served as the base RUCC to compare the results to. Model 3 added the following variables: poverty, median home value, median income, annual grocery store payroll, annual dollar store payroll, population percentage of white, population percentage of African American (black), population percentage of American Indian, population percentage of Asian, population percentage of Hispanic, and population percentage of Native Hawaiian. The variable 2 or more races was omitted to serve as a base of comparison for race demographics. Model 3 served as the preferred model for analysis of all grocery store models used in this study. The equation below shows the Cox proportional hazard formula used for the preferred analysis:

$$h(t) = h_0 \times e^{(\beta_{Dollar\ Stores\ within\ \mathrm{x}\ miles} + \beta_{RUCC} + \beta_{Poverty} + \beta_{Median\ Income} + \beta_{x} \cdots)}$$

Following the selection of a preferred model, analysis began for the effect of dollar stores on grocery stores in rural areas, metro areas (RUCC 1, 2, and 3), and both metro and rural grocery stores with SNAP authorization dates from 1992 to the end of the study. Dollar store effects measured included models for each of the following radii: 2.5, 5, 10, 15, and 20 miles for each set of grocery stores previously mentioned. Final interpretation of the results included interpreting the hazard ratio of grocery store closures. To evaluate the effects of the variables, the exponent of the coefficient was required. The formula for finding the effects of the variable on the hazard ratio is listed below:

$$\left((exponent\ of\ coefficient_x) - 1\right) \times 100 = \%\ effect\ on\ hazard\ ratio$$

Following the calculations of the effects on the hazard ratio, the results were recorded and analyzed. The results of these models are discussed in the following section.

Chapter 5: Results

Kaplan Meier Curves

Before conducting Cox proportional hazard models, Kaplan Meier survival curves were plotted for rural and metro stores with authorization dates present through the entire study. In addition, rural and metro stores with authorization dates from 1992 until the end of the study period. All curves were similar, but each curve had slight differences from each other. Figure 10 below shows the Kaplan Meier curve for rural grocery stores in the dataset across the with SNAP authorizations across entire study period:

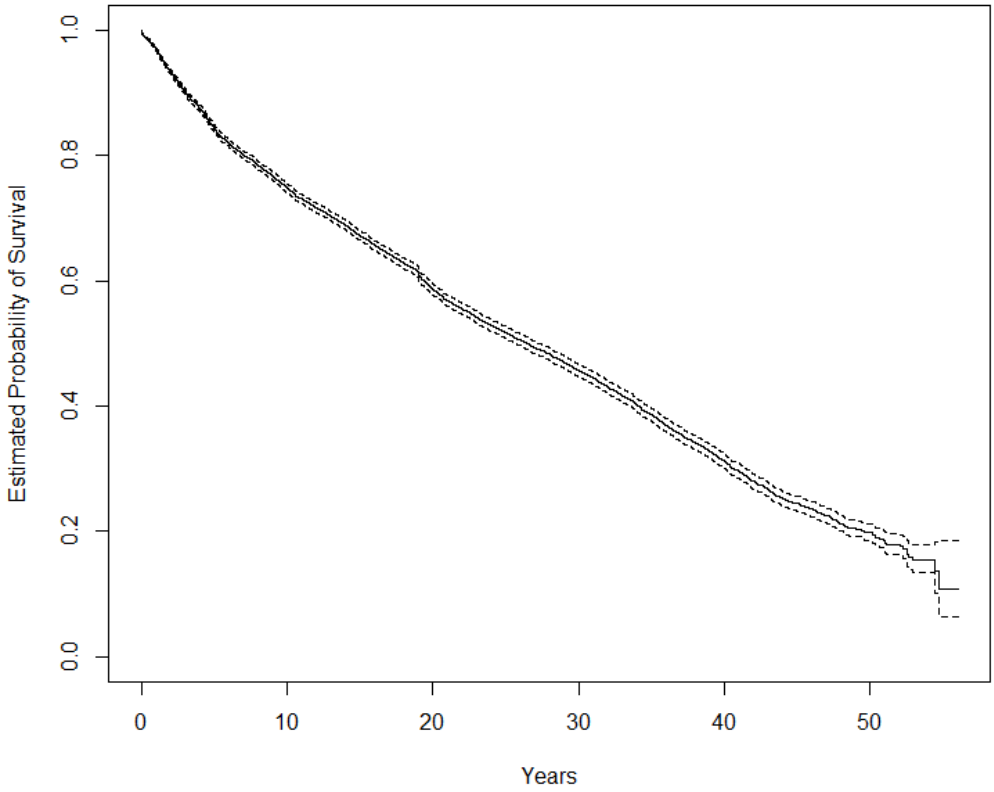

Figure 10: Kaplan Meier Curve of Rural Grocery Stores with Beginning SNAP Authorizations from 1965-2020

Due to the large number of observations, the confidence intervals surrounding the curve in the figure above follow the survival curve very closely, until the end of the study period. At this

point the confidence intervals surrounding the main curve separate with larger distances from the curve. In addition to a large number of observations, this graph portrays the survival probability over a time interval of fifty years. The probability of survival for all rural grocery stores at the fifty-year mark shown on the curve lies at twenty percent. At twenty-five years, the probability of survival is approximately fifty percent. The data was further subset to analyze any differences in rural grocery stores adjacent and non-adjacent to metro areas. The Kaplan Meier curve for rural non-adjacent to metro areas grocery store with beginning SNAP authorizations from 1965 through 2020 is shown below in Figure 11:

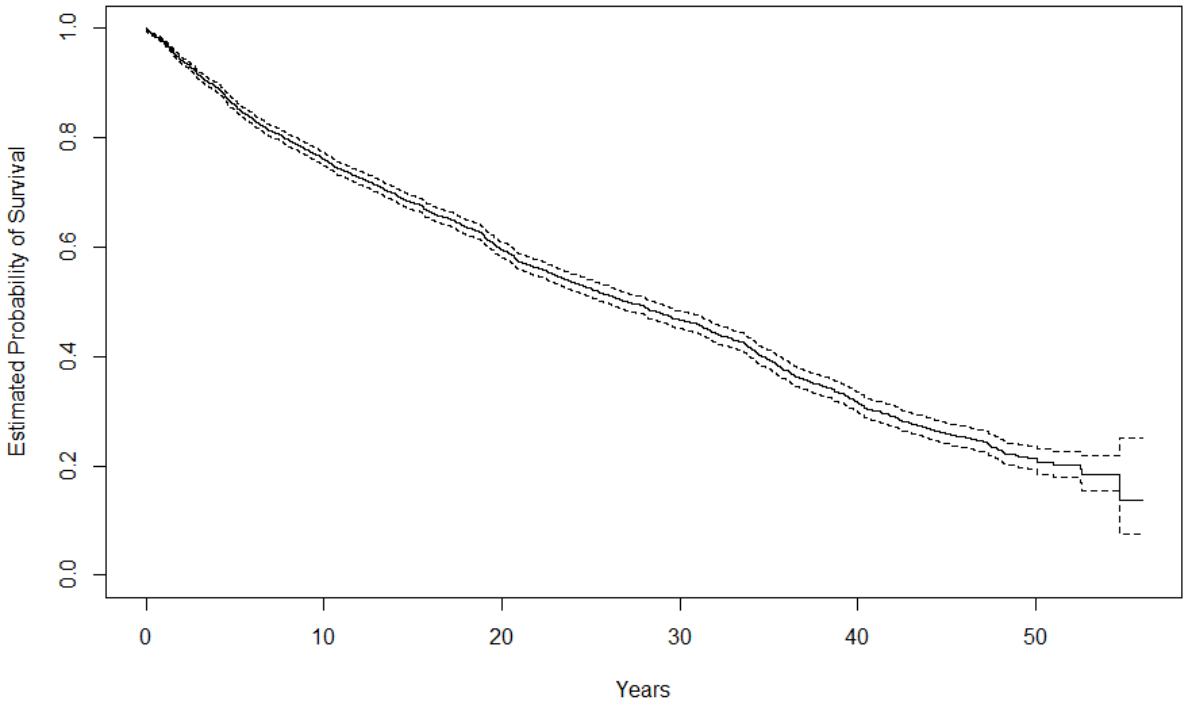

Figure 11: Kaplan Meier Curve for Grocery Stores in Rural Non-adjacent Counties with Beginning SNAP Authorizations from 1965-2020

The probability of survival for grocery stores located in non-adjacent to metro counties at fifty years is approximately twenty-five percent. At twenty-five years, the survival probability is approximately fifty-five percent. Both confidence interval curves follow the survival curve closely. The margins between the confidence interval curves and the survival curve widen

slightly as the time period increases. The results for this subset were similar to the results found for all rural grocery stores. A Kaplan Meier curve was also constructed for rural grocery stores located in counties adjacent to a metro area. Figure 12 below illustrates the Kaplan Meier curve for the rural adjacent to metro grocery stores for years 1965 through 2020:

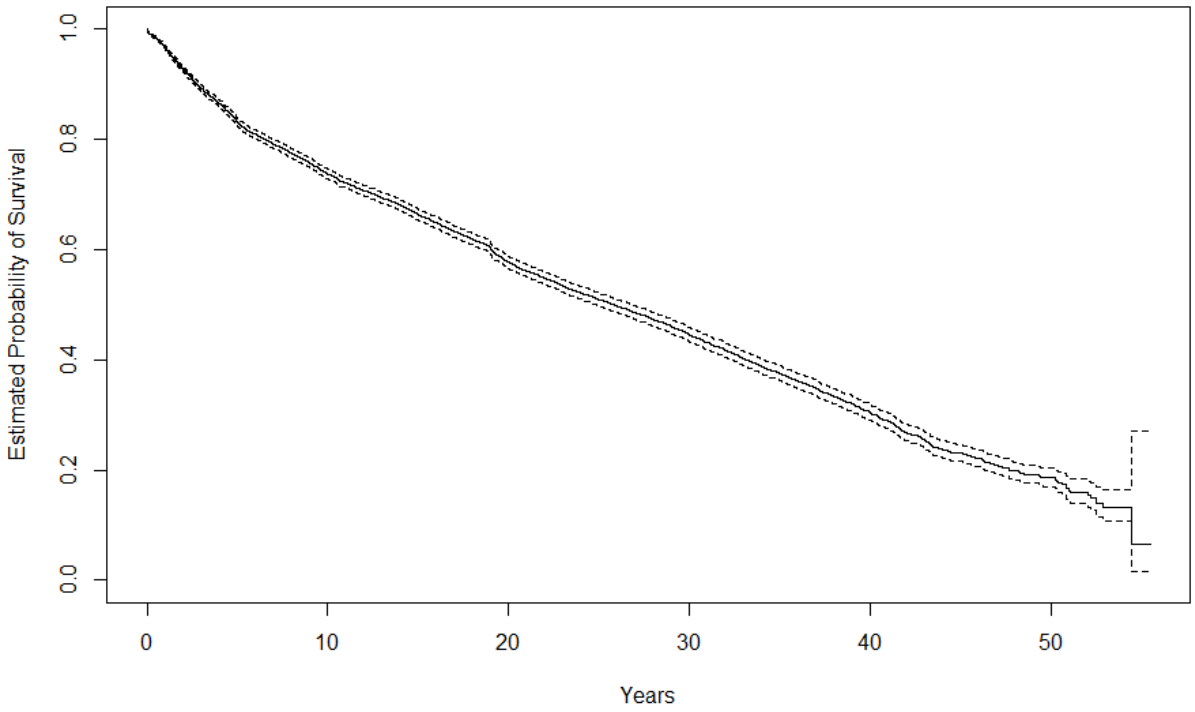

Figure 12: Kaplan Meier Curve for Rural Grocery Stores in Adjacent to Metro Counties with Beginning SNAP Authorizations from 1965- 2020

At fifty years, the survival probability of rural grocery stores located in counties adjacent to metro areas is approximately eighteen percent. This probability is slightly lower as compared to the other subsets of grocery stores previously discussed. At twenty-five years, the probability of survival is approximately fifty-five percent. The confidence interval curves follow the survival curve closely before the margins widen slightly towards the end of the study period. Survival probabilities were similar for the remaining groups of grocery stores evaluated.

Kaplan Meier curves were also conducted for metro grocery stores. Figure 13 below shows the Kaplan Meier curve for metro grocery stores across the entire study period:

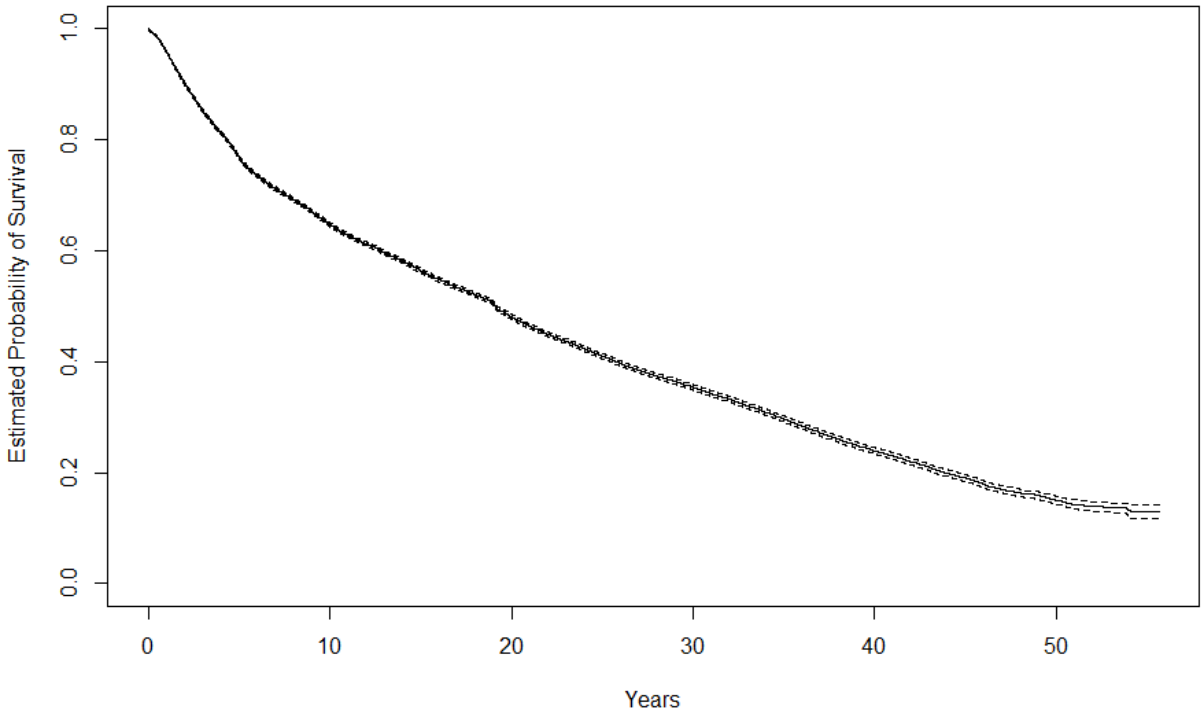

Figure 13: Kaplan Meier Curve of Metro Grocery Stores with Beginning SNAP Authorizations from 1965-2020

The metro stores showed a similar probability of survival at fifty years as the rural stores, with a fifteen percent probability of survival. At twenty-five years, the probability of survival is approximately forty-five percent. As with the rural grocery stores, the confidence interval curves closely followed the main survival curve.

The final set of grocery stores evaluated were for rural and metro grocery stores with SNAP authorization dates from 1992 to the end of the study period in 2020. Figure 14 below shows the Kaplan Meier survival curve for rural grocery stores with authorization dates from 1992 to the end of the study period:

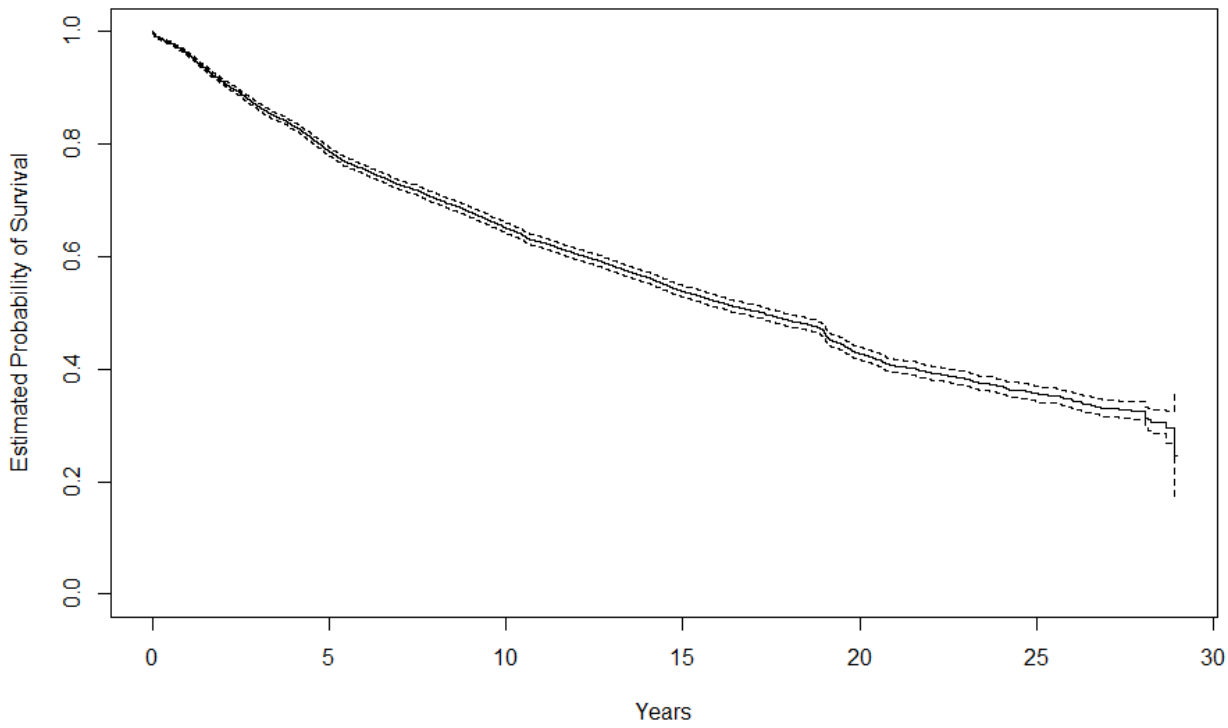

Figure 14: Kaplan Meier Curve of Rural Grocery Stores with Beginning SNAP Authorization From 1992-2020

In parallelism to the previous curves, the probability of survival for grocery stores from 1992 to the end of the study period is approximately thirty-five percent around the twenty-eighth year. At the fifteenth year, the probability of survival is approximately fifty-five percent. The confidence interval curves closely followed the survival curve until the end of the study period where the distance from the survival curve grew for both curves. It should be noted that for the models from 1992 to 2020, a smaller time period was used as compared to the models spanning the entire study period available. The rural grocery stores with SNAP authorization dates from 1992 through 2020 were further separated into groups for adjacent and non-adjacent to a metro area for the same time period. Kaplan Meier curves were conducted for the remaining rural grocery store groups. Figure 15 below shows the Kaplan Meier curve for rural adjacent to metro area grocery stores with SNAP authorization dates from 1992 through 2020:

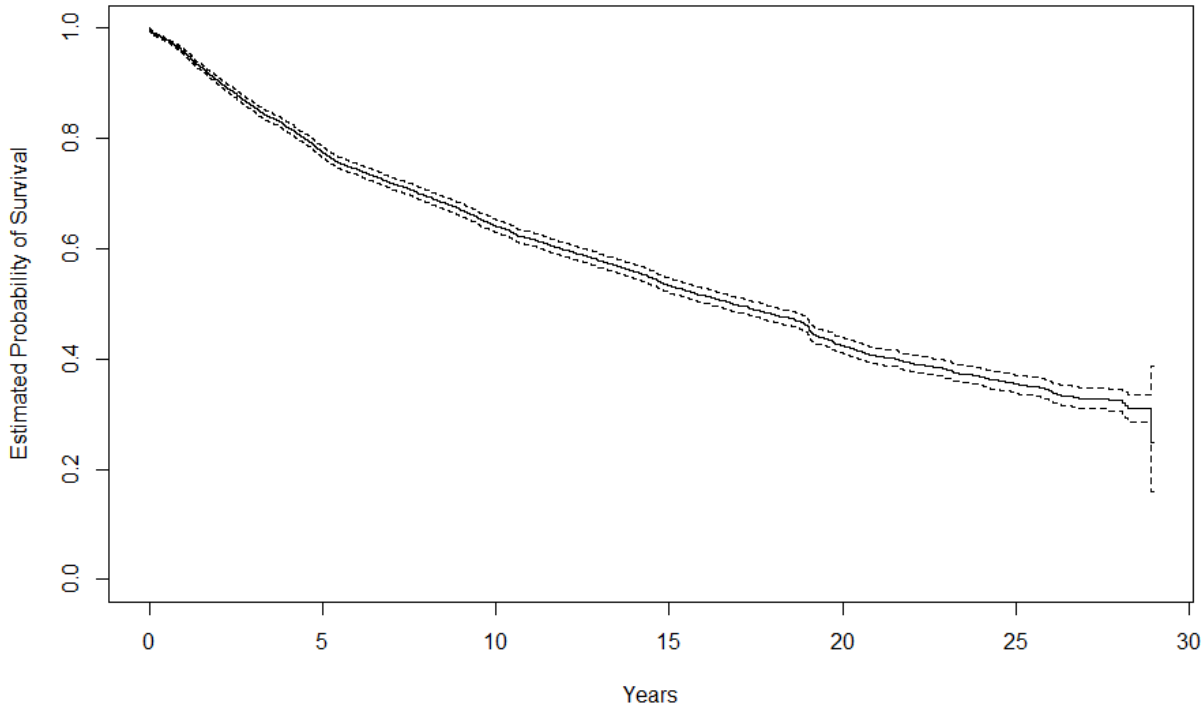

Figure 15: Kaplan Meier Curve for Rural Grocery Stores in Adjacent to Metro Counties with Beginning SNAP Authorizations from 1992-2020

With beginning SNAP authorizations from 1992 through 2020, the probability of survival for rural grocery stores located in counties adjacent to metro areas around twenty-eight years is approximately thirty-five percent. In comparison, at fifteen years the probability of survival is approximately fifty percent. The confidence interval curves for this model closely follow the survival curve until the latter part of the period where the margins widen slightly. A Kaplan Meier curve was created to analyze grocery stores located in counties non-adjacent to metro areas. Figure 16 below shows the curve for non-adjacent to metro area stores with beginning SNAP authorizations from 1992 through 2020:

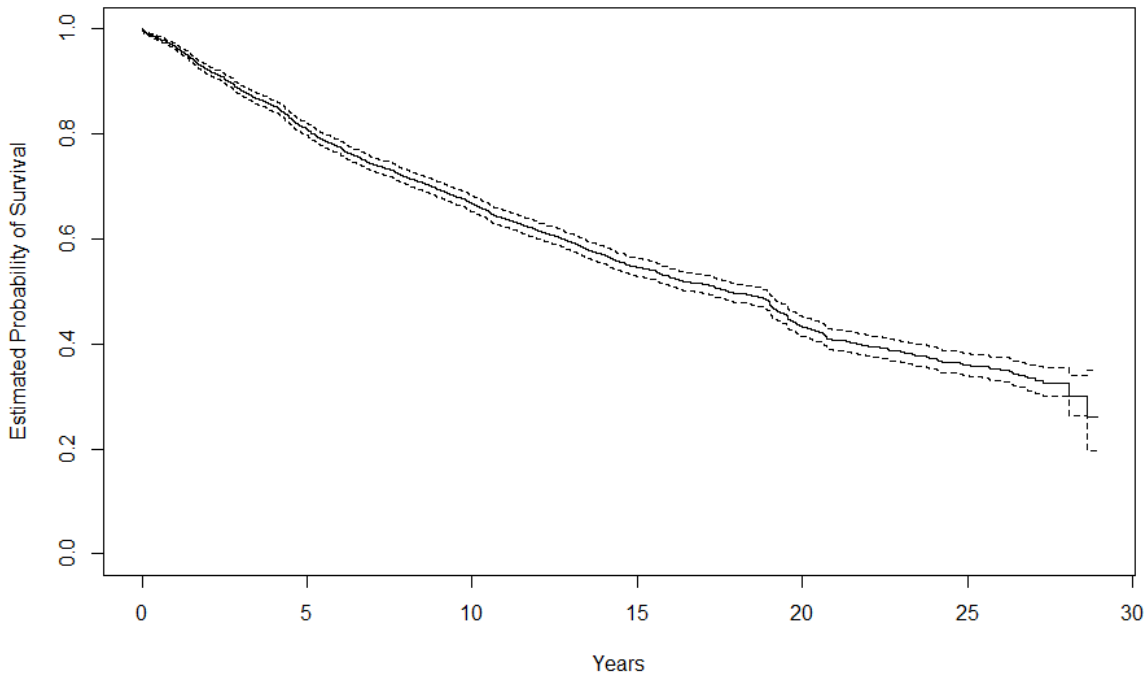

Figure 16: Kaplan Meier Curve of Rural Grocery Stores Non-adjacent to Metro Counties with Beginning SNAP Authorizations from 1992-2020

For grocery stores with beginning SNAP authorizations from 1992 through 2020, the survival probability while being located in a non-adjacent to metro county is approximately thirty-five percent around twenty-eight years. At fifteen years, the probability of survival is roughly fifty-five percent. As with the previous Kaplan Meier models, the confidence interval curves follow the survival curve closely until the latter parts of the study period where the margins widen slightly.

Following the Kaplan Meier curves for the rural grocery stores, the metro stores were evaluated for the probability of survival. The metro grocery stores during this period had very similar results. Figure 17 below shows the Kaplan Meier curve for metro grocery stores with SNAP authorizations beginning in 1992:

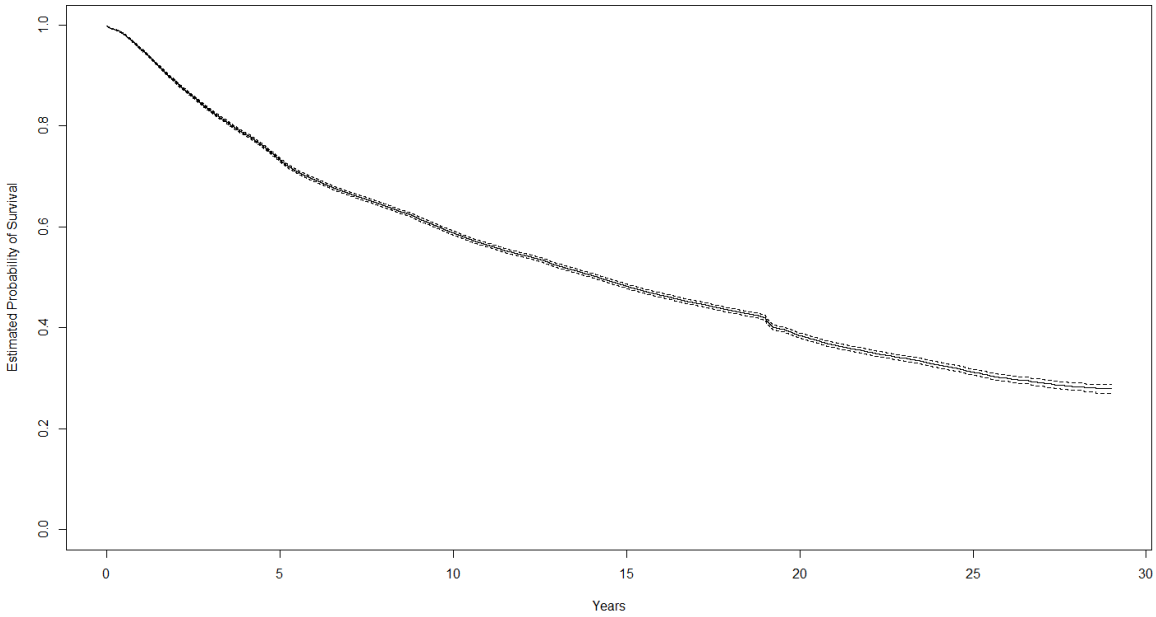

Figure 17: Kaplan Meier Survival Curve for Metro Grocery Stores with Beginning SNAP Authorizations from 1992-2020

The confidence interval curves surrounding the metro grocery store survival curve follow the curve closely through all time periods. Towards the end of the study period, around twenty-eight years, the probability of survival is approximately thirty percent. At fifteen years, the probability of survival is approximately fifty percent.

Cox Proportional Hazard Models

Following the Kaplan Meier curves, Cox proportional hazard models were used for further analysis of supermarket survival. As discussed in the methods chapter, model 3 was the preferred model for analysis use. For each set of grocery stores analyzed, models for each dollar store radius were ran. For all dollar store radii, the models found the association with the presence of dollar stores to have significant differences with a decreasing effect on the hazard ratio of grocery store closures for each grocery store category. The effects of the other variables varied by model, and category of grocery stores. Table 5 below shows the simplified coefficients

for the dollar store radii analyzed for all grocery store models with beginning SNAP authorizations from 1965 through 2020:

Table 5: Summary of Dollar Store Effects for Grocery Stores with Beginning SNAP Authorizations from 1965-2020: Simplified Coefficients

Dollar Store Radius Summary				
Dollar Store Radius	**Rural Grocery with SNAP Authorizations 1965-2020**	**Rural Adjacent to Metro Grocery with SNAP Authorizations 1965-2020**	**Rural Non-Adjacent to Metro Grocery with SNAP Authorizations 1965-2020**	**Metro Grocery with SNAP Authorizations 1965-2020**
2.5 Miles	-0.245***	-0.230***	-0.277***	-0.277***
5 Miles	-0.179***	-0.166***	-0.207***	-0.022***
10 Miles	-0.144***	-0.141***	-0.159***	-0.012***
15 Miles	-0.091***	-0.087***	-0.115***	-0.008***
20 Miles	-0.055***	-0.050***	-0.085***	-0.007***
Note:			*p<0.1; **p<0.05; ***p<0.01	

The results for the dollar store counts and their association with grocery store closures for stores with SNAP authorization dates from 1992 and 2020 are also associated with significant and decreasing effects on the hazard ratio of grocery store closures. Table 6 below shows the results for these stores:

Table 6: Summary of Dollar Store Effects for Grocery Stores with Beginning SNAP Authorizations from 1992-2020: Simplified Coefficients

Dollar Store Radius Summary				
Dollar Store Radius	**Rural Grocery with SNAP Authorizations 1992-2020**	**Rural Adjacent to Metro Grocery with SNAP Authorizations 1992-2020**	**Rural Non-Adjacent to Metro Grocery with SNAP Authorizations 1992-2020**	**Metro Grocery with SNAP Authorizations 1992-2020**
2.5 Miles	-0.293***	-0.274***	-0.332***	-0.034***
5 Miles	-0.214***	-0.200***	-0.250***	-0.024***
10 Miles	-0.171***	-0.166***	-0.196***	-0.013***
15 Miles	-0.111***	-0.106***	-0.140***	-0.009***
20 Miles	-0.068***	-0.062***	-0.105***	-0.007***
Note:			*p<0.1; **p<0.05; ***p<0.01	

The models for all grocery stores with beginning SNAP authorizations from 1992 through 2020 showed significant and decreasing effect for the affiliated effect of each dollar store radii evaluated. While the effect of dollar stores was significant and decreasing for all models, the margin of effect on the hazard ratio for grocery store closures with the relation to dollar stores varied slightly. The association of dollar stores and their plausible effect on the likelihood of grocery store closures for rural grocery stores throughout the entire study period varied only slightly for each dollar store radius. Table 7 below shows the effect of dollar stores on the hazard ratio for grocery store closures:

Table 7: Effect of Dollar Stores on the Hazard Rate of Rural Grocery Store Closures: With Beginning SNAP Authorizations 1965-2020

Rural Grocery Stores with SNAP Authorizations From 1965-2020			
Dollar Store Radius	**Hazard Ratio**	**Calculations for Effect on Hazard Rate**	**Effect on Hazard Rate**
2.5 Miles	.783	(.783-1) x 100	21.7% lower
5 Miles	.836	(.836-1) x 100	16.4% lower
10 Miles	.866	(.866-1) x 100	13.4% lower
15 Miles	.913	(.913-1) x 100	8.7% lower
20 Miles	.947	(.947-1) x 100	5.3% lower

Note: Hazard Ratio is the exponential coefficient for the dollar store radius in each model.

The effect of dollar store counts produced decreasing results on the hazard rate for all rural grocery stores with beginning SNAP authorizations between 1965 and 2020. For all dollar store count radii used, the affiliated effect of a unit increase in dollar stores lowered the hazard rate between 5.3% to 21.7%. Upon further subsetting the rural grocery stores in to groups of adjacent and non-adjacent to metro areas, the related effects were found to vary slightly. Table 8 shows the effect of dollar store counts for all radii for the hazard ratio of grocery stores located in counties adjacent to metro areas:

Table 8: Effect of Dollar Stores on the Hazard Rate of Rural Grocery Store Closures in Adjacent to Metro Counties: With Beginning SNAP Authorizations 1965-2020

Rural Grocery Stores Adjacent to Metro with SNAP Authorizations 1965-2020			
Dollar Store Radius	**Hazard Ratio**	**Calculations for Effect on Hazard Rate**	**Effect on Hazard Rate**
2.5 Miles	.795	(.795-1) x 100	20.5% lower
5 Miles	.847	(.847-1) x 100	15.3% lower
10 Miles	.869	(.869-1) x 100	13.1% lower
15 Miles	.917	(.917-1) x100	8.3% lower
20 Miles	.951	(.951-1) x 100	4.9% lower

The results found for the effect of the presence of a dollar store for each radii on the hazard rate of a grocery store closure for stores located in counties adjacent metro areas were similar to the previous rural grocery group. For stores with beginning SNAP authorizations from 1965 through 2020, the associated presence of a dollar store on the hazard rate decreased the rate between 4.9% and 20.5%. While the results for grocery stores in counties adjacent to metro areas were similar to all rural grocery stores, the results for grocery stores in counties non-adjacent to metro areas were slightly higher. Table 9 below shows the results for these counties:

Table 9: Effect of Dollar Stores on the Hazard Rate of Rural Grocery Store Closures in Non-Adjacent to Metro Counties: With Beginning SNAP Authorizations 1965-2020

Rural Grocery Stores Non-Adjacent to Metro with SNAP Authorizations 1965-2020			
Dollar Store Radius	**Exponential Coefficient**	**Calculations for Effect on Hazard Rate**	**Effect on Hazard Rate**
2.5 Miles	.758	(.758-1) x 100	24.2% lower
5 Miles	.813	(.813-1) x 100	18.7% lower
10 Miles	.853	(.853-1) x 100	14.7% lower
15 Miles	.891	(.891-1) x 100	10.9% lower
20 Miles	.919	(.919-1) x 100	8.1% lower

The association of the presence of a dollar store for any given radii had a decreasing effect on the hazard ratio for rural grocery stores located in counties non-adjacent to metro areas. The effects

on the hazard rate were slightly higher than the previous two groups with effects ranging from 8.1% to 24.2% lower. To further investigate any potential relationship between the presence of dollar stores and grocery store closures, the rural grocery stores were further subsetted into groups with beginning SNAP authorizations from 1992 through 2020. Table 10 shows the results for models with all rural grocery stores with SNAP authorizations from 1992 through 2020 below:

Table 10: Effect of Dollar Stores on the Hazard Rate of Rural Grocery Stores with Beginning SNAP Authorizations from 1992-2020

Rural Grocery Stores with SNAP Authorizations 1992-2020			
Model: (Dollar Store Radius)	**Exponential Coefficient for Dollar Store Counts**	**Calculations for effect on Hazard Rate**	**Effect on Hazard Rate**
2.5 Miles	.746	(.746-1) x100	25.4% lower
5 Miles	.807	(.807-1) x 100	19.3% lower
10 Miles	.843	(.843-1) x100	15.7% lower
15 Miles	.895	(.895-1) x 100	10.5% lower
20 Miles	.934	(.934-1) x 100	6.6% lower

The models for all rural grocery stores with beginning SNAP authorizations from 1992 through 2020 indicated that the presence of dollar stores is associated with a decreasing effect on the hazard rate of grocery store closures. The effect of dollar stores on the hazard rate varied from lowering the hazard rate between 25.4% and 6.6%. These amounts are slightly higher as compared to the results for all rural grocery stores with beginning SNAP authorizations from 1965 through 2020. Upon further subsetting the grocery stores into stores located in counties adjacent to a metro area, the results from the previous models were similar. Table 11 below shows the results of the models measuring the potential affects of dollar stores and their association between grocery stores in rural areas adjacent to metro areas:

Table 11: Effect of Dollar Stores on the Hazard Rate of Rural Grocery Stores Located in Counties Adjacent to Metro Areas with Beginning SNAP Authorizations from 1992-2020

Rural Grocery Stores Adjacent to Metro with SNAP Authorizations 1992-2020			
Dollar Store Radius	**Exponential Coefficient**	**Calculations for Effect on Hazard Rate**	**Effect on Hazard Rate**
2.5 Miles	.760	(.760-1) x 100	24.0% lower
5 Miles	.819	(.819-1) x 100	18.1% lower
10 Miles	.847	(.847-1) x 100	15.3% lower
15 Miles	.899	(.899-1) x 100	10.1% lower
20 Miles	.940	(.940-1) x 100	6.0% lower

The results of rural grocery stores located in counties adjacent to metro areas with beginning SNAP authorization dates between 1992 and 2020 indicate that the association of dollar stores and grocery stores has a decreasing effect on the hazard rate of grocery store closures. The effects presented by the model range between 6.0% and 24% for each count of dollar stores for each radii. The models for grocery stores in areas non-adjacent to metros displayed similar results. Table 12 below shows the results of the models for grocery stores with beginning SNAP authorization dates between 1992 and 2020 and located in counties non-adjacent to metro areas:

Table 12: Effect of Dollar Stores on the Hazard Rate of Rural Grocery Stores Located in Counties Non-Adjacent to Metro Areas with Beginning SNAP Authorizations from 1992-2020

Rural Grocery Stores Non-Adjacent to Metro with SNAP Authorizations 1992-2020			
Dollar Store Radius	**Exponential Coefficient**	**Calculations for Effect on Hazard Rate**	**Effect on Hazard Rate**
2.5 Miles	.717	(.717-1) x 100	28.3% lower
5 Miles	.779	(.779-1) x 100	22.1% lower
10 Miles	.822	(.822-1) x 100	17.8% lower
15 Miles	.870	(.870-1) x 100	13% lower
20 Miles	.900	(.900-1) x 100	10% lower

The association of grocery stores and the presence of dollar stores was found to be decreasing on the hazard rate of grocery store closures for all models used. The results of the model showed the

presence of dollar stores to be linked to a decrease in the hazard rates between 10.0% and 28.3%. The models for metro grocery stores found the potential related effects between dollar stores and grocery stores to be much lower.

The projected effect of dollar stores on metro grocery stores from the models varied greatly between the rural and metro grocery stores analyzed. Table 13 below shows the presumed effect of the association of dollar stores on the likelihood of metro grocery store closures with beginning SNAP authorizations dates between 1965 and 2020:

Table 13: Effect of Dollar Stores on the Hazard Rate of Metro Grocery Stores with Beginning SNAP Authorizations from 1992-2020

Metro Grocery Stores with Beginning SNAP Authorization From 1965-2020			
Dollar Store Radius	**Exponential Coefficient for Dollar Store Counts**	**Calculations for Effect on Hazard Rate**	**Effect on Hazard Rate**
2.5 Miles	.971	(.971-1) x 100	2.9% lower
5 Miles	.979	(.979-1) x 100	2.1% lower
10 Miles	.988	(.988) x 100	1.18% lower
15 Miles	.992	(.992-1) x100	.81% lower
20 Miles	.994	(.994-1) x 100	.65% lower

In contrast to the speculated association of the effect of dollar stores on rural grocery stores throughout the entire study period, the effect of dollar stores on metro grocery stores was much smaller. For all dollar store radii analyzed, the hazard ratio for metro grocery store closures was lowered between .65% and 2.93% for each unit increase of dollar stores. The results for metro grocery stores between 1992 and 2020 were slightly different from the other metro group. Table 14 below shows the results of dollar store effects on the hazard ratio for metro grocery stores with SNAP authorizations beginning in 1992:

Table 14: Effect of Dollar Stores on the Hazard Rate for Metro Grocery Stores from 1992-2020

Metro Grocery Stores: 1992-2020			
Dollar Store Radius	**Exponential Coefficient for Dollar Store Counts**	**Calculations for Effect on Hazard Rate**	**Effect on Hazard Rate**
2.5 Miles	.967	(.967-1) x 100	3.3% lower
5 Miles	.976	(.976-1) x 100	2.4% lower
10 Miles	.987	(.987-1) x 100	1.3% lower
15 Miles	.991	(.991-1) x 100	0.9% lower
20 Miles	.993	(.993-1) x 100	0.7% lower

For models investigating the association of dollar stores and grocery stores in metro areas with beginning SNAP authorizations dates between 1992 and 2020, the presumed effects of the presence of dollar stores on the hazard rate for metro grocery store closures were very similar to the previously discussed metro model. For metro grocery stores with SNAP authorizations beginning in 1992, the association with the presence of dollars stores decreased the hazard rate for store closures between 3.3%% and 0.7% for each addition of a dollar store. While the radius of dollar stores had decreasing effects on grocery store closures for all models, the remaining variables included in the models varied between the other grocery store categories examined. The results of these models are discussed in the following sections.

Other Variables

Models with Beginning SNAP Authorizations from 1965-2020

For each model, the RUCC was used as a variable to analyze the potential effects of the location of a grocery store and its survivability. For metro stores, the RUCC 1 was used as the base comparison for other metro codes. Counties classified as RUCC 1, have populations of a million or more people. For models investigating all rural grocery stores, RUCC 4 was dropped and used as a base comparison for the other rural codes. Counties classified as a RUCC 4 had

populations of 20,000 or more, and were adjacent to a metro area. For models with rural grocery stores adjacent to metro areas, the RUCC for urban population of 20,000 or more and adjacent to a metro area as used as a base for comparison for the remaining RUCC. Models with rural grocery stores non-adjacent to metro areas used the RUCC with urban population of 20,000 or more and non-adjacent to metro area as a base comparison. Table 15 below shows the coefficients found for the RUCCs for the models with beginning SNAP authorizations from 1965 to 2020:

Table 15: Summary of Effects of RUCC for Grocery Stores with Beginning SNAP Authorizations from 1965-2020

Grocery Stores with Beginning SNAP Authorizations from 1965-2020: Model with Dollar Store Radius of 5 miles				
	Metro	Rural Grocery Stores		
	Metro Stores	**All Rural Stores**	**Adjacent to Metro**	**Non-Adjacent to Metro**
Non-adj., Pop.>= 20,000		0.028		
Metro Pop. 250,000-1 Mil.	**-0.145*** **			
Metro Pop. <250,000	**-0.132*** **			
Adj., Pop 2,500-19,999		**-0.177*** **	**-0.159*** **	
Non-adj., Pop. 2,500-19,999		**-0.222*** **		**-0.344*** **
Adj., Pop. <2,500, completely rural		**-0.276*** **	**-0.283*** **	
Non-adj., Pop. <2,500, completely rural		**-0.463*** **		**-0.545*** **

Note: Values given are the corresponding coefficient for the variable. Full coefficients and standard errors can be found in full models in Appendix C.

For each model, the RUCC was found to be significantly different as compared to the base RUCC, with the exception of the model with all rural stores found in counties non-adjacent to metro areas with populations greater than 200,000. All significant results were associated with a decreasing effect on the hazard ratio for grocery store closures. The results for other dollar store

radii had similar findings. To view the complete results of the associated effects for RUCC and grocery store closures, please see Appendix C.

The associated effects of the remaining variables for each category of grocery stores displayed similar results across all models. Table 16 below displays the summary of results for the model with dollar stores within 5 miles and the remaining variables in the grocery store models with beginning SNAP authorizations between 1965 and 2020:

Table 16: Summary of Effects of Remaining Variables for Grocery Stores with Beginning SNAP Authorizations from 1965-2020

Grocery Stores with Beginning SNAP Authorizations from 1965-2020: Model with Dollar Store Radius of 5 miles				
	Metro	Rural Grocery Stores		
	Metro Stores	**All Rural Stores**	**Adjacent to Metro**	**Non-Adjacent to Metro**
Dollar Store Presence	**-0.022*** **	**-0.179*** **	**-0.166*** **	**-0.207*** **
Poverty	**0.008*** **	-0.007	0.009	0.007
Median Income	**-0.020*** **	**-0.009** **	-0.004	**-0.012***
Median Home Value	**0.001*** **	-0.0005	**-0.001** **	0.000000
Grocery Store Annual Payroll	**14.724*** **	**-2.270***	1.221	**-4.960*** **
Dollar Store Annual Payroll	**-280.219*** **	**-92.782*** **	**-115.209*** **	**-67.612*** **
Percent White	-1.312	1.830	-0.899	4.037
Percent Black	-0.118	2.112	-0.586	4.327
Percent Asian	0.197	0.898	-4.353	3.679
Percent American Indian	-0.903	1.834	-1.254	4.131
Percent Hispanic	**0.953*** **	0.209	0.015	**0.550** **
Percent Native Hawaiian	**-8.785***	-8.560	-5.528	-2.461

Note: values given are the coefficient for the corresponding variables. To see complete model with standard errors, please see Appendix C.

Across all dollar store models, the presumed variable effects of the remaining variables such as race demographics and poverty were similar. To view the results of all models with beginning

SNAP authorizations between 1965 and 2020 please see Appendix C. Dollar store annual payrolls were consistently associated with a significant and decreasing effect on the hazard rate of grocery store closures. Annual grocery store payrolls were almost always found to be significant. The association with the hazard rate of grocery store closures were increasing for metro areas and decreasing for rural areas where significant. In almost all models, race demographics did not indicate to have a significant effect. In the metro model and the rural non-adjacent to metro model, the Hispanic variable was found to be significant and increasing in the association of the hazard rate for grocery store closures. The results for grocery store models with beginning SNAP authorizations between 1992 and 2020 varied slightly and are discussed in the following section.

Models with Beginning SNAP Authorizations from 1992-2020

As with the previous models discussed, the RUCC was used as a variable to analyze the potential effects of the location of a grocery store and its survivability. For metro stores, the RUCC 1 was used as the base comparison for other metro codes. Counties classified as RUCC 1, have populations of a million or more people. For models investigating all rural grocery stores, RUCC 4 was dropped and used as a base comparison for the other rural codes. Counties classified as a RUCC 4 had populations of 20,000 or more, and were adjacent to a metro area. For models with rural grocery stores adjacent to metro areas, the RUCC for urban population of 20,000 or more and adjacent to a metro area as used as a base for comparison for the remaining RUCC. Models with rural grocery stores non-adjacent to metro areas used the RUCC with urban population of 20,000 or more and non-adjacent to metro area as a base comparison. Table 17 below shows the coefficients found for the RUCCs for the models with beginning SNAP authorizations from 1992 to 2020:

Table 17: Summary of Effects of RUCC for Grocery Stores with Beginning SNAP Authorizations from 1992-2020

Grocery Stores with Beginning SNAP Authorizations from 1992-2020: Model with Dollar Store Radius of 5 miles				
	Metro Stores	**All Rural Stores**	**Adjacent to Metro**	**Non-Adjacent to Metro**
Non-adj., Pop.>= 20,000 Metro Pop. 250,000-1 Mil.	**-0.120*** **	-0.006		
Metro Pop. <250,000	**-0.079*** **			
Adj., Pop 2,500-19,999		**-0.201*** **	**-0.173*** **	
Non-adj., Pop. 2,500-19,999		**-0.292*** **		**-0.407*** **
Adj., Pop. <2,500, completely rural		**-0.286*** **	**-0.284*** **	
Non-adj., Pop. <2,500, completely rural		**-0.497*** **		**-0.585*** **

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Note: Values given are the corresponding coefficient for the variable. Full coefficients and standard errors can be found in full models in Appendix D

As with the previous models discussed, the association of grocery store closures and the location of the grocery stores in all models showed significant and decreasing effects. The only variable that was found to be insignificant was the variable of counties non-adjacent to metro areas and with populations greater than or equal to 20,000 in the model with all rural grocery stores. The results for other dollar store radii models displayed similar effects. To see the complete models for all grocery stores with beginning SNAP authorizations from 1992 through 2020, please see Appendix D. The remaining variables were found to have similar results for the metro stores from the previous sections. There were slight variations between the results of the rural stores with SNAP authorizations beginning in 1965 and those that began in 1992. Table 18 below shows the summary of the results for the other variable effects and their association with grocery store closures for all models with SNAP authorizations beginning in 1992:

Table 18: Summary of Effects of Remaining Variables for Grocery Stores with Beginning SNAP Authorizations from 1992-2020

Grocery Stores with Beginning SNAP Authorizations from 1992-2020: Model with Dollar Store Radius of 5 Miles				
	Metro	Rural		
	Metro Stores	All Rural Stores	Adjacent to Metro	Non-Adjacent to Metro
Dollar Store Presence	**-0.034*** **	**-0.214*** **	**-0.200*** **	**-0.250*** **
Poverty	**0.011*** **	0.001	0.006	-0.009
Median Income	**-0.022*** **	**-0.016*** **	**-0.013***	**-0.024*** **
Median Home Value	**0.001*** **	**-0.001*** **	**-0.002*** **	-0.001
Grocery Store Annual Payroll	**17.657*** **	2.121	**6.448*** **	-2.530
Dollar Store Annual Payroll	**-332.382*** **	**-108.802*** **	**-139.322*** **	**-76.594*** **
Percent White	0.227	1.160	-0.187	3.024
Percent Black	1.313	1.535	0.212	3.446
Percent Asian	1.745	-1.504	-0.609	-0.375
Percent American Indian	1.012	1.350	-0.574	3.589
Percent Hispanic	**0.862*** **	0.346*	0.037	**0.881*** **
Percent Native Hawaiian	-6.901	-18.013	-14.146	-14.482

Note: Values given are the corresponding coefficient for the variable. Full coefficients and standard errors can be found in full models in Appendix D

As with the models with beginning SNAP authorizations from 1965, this group of stores also had results indicating that race demographics were not significantly associated with the likelihood of grocery stores closures. With the exception of Hispanic variables which were found to be significant and associated with the increasing effect on the hazard rate of grocery store closures. Median income and dollar store annual payroll were not only significant but also associated with decreasing effects on the likelihood of grocery store closures across all models with the dollar store radius of five miles. Grocery store annual payrolls were not consistently associated as having any effects across the models. The results for other dollar store radii showed similar

effects. To see the results of all models with beginning SNAP authorizations from 1992 through 2020, please see Appendix D.

Chapter 6: Conclusions

The use of survival analysis allowed for the potential relationship between dollar store presence and grocery store closures to be investigated. Using the SNAP authorizations of stores allowed for the inclusion of both grocery and dollar stores, in addition it guaranteed that the stores in the data carried healthy staple items. The results of this research suggest that the presence of dollar stores is not associated with an increase the likelihood of grocery store closures. In addition, the results support other research on the effect of dollar stores on food access (Chenarides, et al. 2021). Further, the decreasing effect dollar store annual payrolls have on the likelihood of grocery stores indicates that dollar stores with larger payrolls are not associated with the contribution to increased risk for grocery store closures. The effect of rural RUCC also indicates that the population definition of a region is associated with negatively impacting the hazard ratio of rural grocery store closures.

While the results found from the models are supportive of previous work, it should be noted that this thesis investigates the association of dollar store presence and grocery store closures. This does not mean that dollar stores are the cause of grocery store closures or lack thereof. The association between the two groups of stores can occur due to economic environmental factors surrounding the stores that can be attributed to the success or failure of the stores. An example of potential factors that could influence grocery store survivability that are not included in the model are zoning regulations. Some towns may have zoning regulations that prohibit the entrance of new dollar stores, and other regulations that could protect grocery incumbents. Zoning regulations could also result in grocery and dollar stores becoming located closely together because both are retail businesses. Dollar stores could also be complementary to grocery stores. Consumers could prefer to shop at grocery stores located closely to dollar stores

due to convenience if they can purchase necessary items at a dollar store not stocked by a grocery store. In addition, migration of populations from rural to urban areas could be a factor affecting the survival of grocery stores as new strip malls might be anchored by a grocery store but also contain a dollar store. These mechanisms need to be explored further in future research.

While the results of this thesis support the findings of other studies, there are many limitations to this study. One of the largest limitations occurs due to the limited data concerning store closures. This data contained only stores with end authorizations dates beginning in 2004. This disproportionately represents the number of end authorizations, as there should in theory be store closures that result in the ending of SNAP authorization across all years of data instead of the introduction of end dates appearing well into the study period. In addition, the methods of calculating distances between dollar and grocery stores could have been improved with the use of road network mapping. While the method of calculating the distance between stores by the shortest distance between points is effective, there are circumstances where the results could be inaccurate. For example, in mountainous regions, the shortest distance between two points does not reflect the actual miles traveled to reach the destination. Other potential areas of further research could involve investigating methods of measurements for food access. It would be of interest to measure the ratio of the population of a region and the number of groceries stores available, and then evaluate the effect of dollar stores and the accessibility of healthy foods.

While there are limitations with this study, it does allow for the contribution to the limited area of research concerning the effect of dollar stores and the closures of grocery stores. In addition, research in this area is important to aid in recommendations for policy makers. Due to limited analysis concerning this niche of research, consumers will form opinions of the relationship between dollar stores and grocery stores based on personal perceptions. While

observations and perceptions are important when conducting research, they need to be backed by data before a hypothesis can be accepted or rejected concerning the relationship between the two stores. In addition, policy makers should have access to research by which can be used to base regulations in addition to the opinions of their constituents.

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Appendices

Appendix A:

Create function to count dollar stores in given radius. Convert measurements from meters to miles:

```
dollCount<-function(x,y,year,r1,r2,r3,r4,r5,r6){
distMat<-distm(c(x,y),cbind(Dollar[Dollar$Start<=year&Dollar$End>=year,
                    ("Longitude","Latitude")]),fun = distHaversine)

r1<-sum(distMat/1609.34<=r1)
r2<-sum(distMat/1609.34<=r2)
r3<-sum(distMat/1609.34<=r3)
r4<-sum(distMat/1609.34<=r4)
r5<-sum(distMat/1609.34<=r5)
r6<-sum(distMat/1609.34<=r6)
return(c(r1,r2,r3,r4,r5,r6))
            }
```

Set up a loop to count dollar stores in programmed radii for each grocery store observation:

```
cl<-makeCluster(cores-5)
registerDoParallel(cl)
n<-nrow(Grocery); n
finalMatrix <- foreach(i=seq(n), .combine=rbind,.packages="geosphere") %dopar% {
  tempMatrix = c(i,dollCount(Grocery$Longitude[i],
                    Grocery$Latitude[i],
                    Grocery$year[i],
                    1,2.5,5,10,15,20)
              )
  tempMatrix
}
stopCluster(cl)
```

Appendix B:

Cox Proportional Hazard Models			
	Model		
	(1)	(2)	(3)
Dollar Stores within 10 miles	-0.133***	-0.158***	-0.144***
	(0.004)	(0.005)	(0.005)
Non-adjacent, Pop.>= 20,000		-0.049	-0.053
		(0.051)	(0.051)
Adjacent, Pop. 2,500-19,999		-0.339***	-0.289***
		(0.034)	(0.036)
Non-adjacent, Pop. 2,500-19,999		-0.403***	-0.363***
		(0.040)	(0.042)
Adjacent, Pop. <2,500, completely rural		-0.440***	-0.403***
		(0.057)	(0.059)
Non-adjacent, Pop. <2,500, completely rural		-0.568***	-0.609***
		(0.053)	(0.057)
Poverty			0.008*
			(0.005)
Median Income			-0.006
			(0.004)
Median Home Value			-0.001**
			(0.0004)
Grocery Store Annual Payroll			-2.418*
			(1.240)
Dollar Store Annual Payroll			-83.225***
			(4.798)
Percent White			1.083
			(1.967)
Percent Black			1.016
			(1.963)
Percent Asian			-0.073
			(2.690)
Percent American Indian			1.137
			(2.040)
Percent Hispanic			0.104
			(0.160)
Percent Native Hawaiian			-11.150
			(9.546)
Observations	15,813	15,813	15,801
R2	0.089	0.099	0.122
Max. Possible R2	1.000	1.000	1.000
Log Likelihood	-64,548.620	-64,455.780	-64,145.040
Wald Test	1,298.350*** (df = 48)	1,492.930*** (df = 53)	1,899.270*** (df = 64)
LR Test	1,467.711*** (df = 48)	1,653.394*** (df = 53)	2,050.969*** (df = 64)
Score (Logrank) Test	1,287.803*** (df = 48)	1,455.519*** (df = 53)	1,848.488*** (df = 64)
Note:			*p<0.1; **p<0.05; ***p<0.01

Appendix C:

Rural Grocery Stores with SNAP Authorizations: 1965-2020
Dollar Store Radius 2.5 Miles

	All Rural Stores	Adjacent to Metro	Non-Adjacent to Metro
Dollar Stores radius 2.5 miles	-0.245***	-0.230***	-0.277***
	(0.010)	(0.012)	(0.017)
Non-adj., Pop.>= 20,000	0.029		
	(0.051)		
Adj., Pop. 2,500-19,999	-0.073**	-0.065*	
	(0.034)	(0.037)	
Non-adj., Pop. 2,500-19,999	-0.125***		-0.231***
	(0.041)		(0.058)
Adj., Pop. <2,500, completely rural	-0.167***	-0.187***	
	(0.058)	(0.064)	
Non-adj., Pop. <2,500, completely rural	-0.377***		-0.440***
	(0.057)		(0.073)
Poverty	0.007	0.008	0.010
	(0.005)	(0.007)	(0.008)
Median Income	-0.009**	-0.005	-0.011
	(0.004)	(0.006)	(0.007)
Median Home Value	-0.001	-0.001**	-0.0001
	(0.0004)	(0.001)	(0.001)
Grocery Store Annual Payroll	-2.520**	0.898	-5.138***

Rural Grocery Stores with SNAP Authorizations: 1965-2020
Dollar Store Radius 2.5 Miles

	(1.244)	(1.799)	(1.826)
Dollar Store Annual Payroll	92.278***	-115.615***	-66.604***
	(4.912)	(6.730)	(7.109)
Percent White	1.795	-0.521	3.504
	(1.960)	(2.975)	(2.908)
Percent Black	2.222	-0.054	3.924
	(1.956)	(2.962)	(2.914)
Percent Asian	0.966	-3.769	3.245
	(2.653)	(4.813)	(3.476)
Percent American Indian	1.799	-0.765	3.478
	(2.032)	(3.162)	(2.975)
Percent Hispanic	0.326**	0.128	0.649**
	(0.159)	(0.208)	(0.262)
Percent Native Hawaiian	-9.142	-2.037	-6.122
	(9.380)	(17.729)	(11.895)
Observations	15,801	9,853	5,948
R2	0.105	0.115	0.101
Max. Possible R2	1.000	1.000	0.999
Log Likelihood	-64,298.290	-38,382.020	-21,021.610
Wald Test	1,691.530*** (df = 64)	1,174.880*** (df = 60)	591.800*** (df = 58)
LR Test	1,744.464*** (df = 64)	1,198.962*** (df = 60)	635.113*** (df = 58)
Score (Logrank) Test	1,661.947*** (df = 64)	1,147.361*** (df = 60)	623.649*** (df = 58)

Note: *p<0.1; **p<0.05; ***p<0.01

Metro Grocery Stores with SNAP Authorizations: 1965-2020
Dollar Store Radius 2.5 Miles

	Metro Grocery with SNAP Authorizations 1965-2020
Dollar Stores radius 2.5 miles	-0.030***
	(0.001)
Metro, Pop. 250,000- 1 Mil.	-0.095***
	(0.016)
Metro, Pop.< 250,000	-0.031
	(0.023)
Poverty	0.011***
	(0.003)
Median Income	-0.015***
	(0.001)
Median Home Value	0.0004***
	(0.0001)
Grocery Store Annual Payroll	-0.284
	(1.211)
Dollar Store Annual Payroll	0.551
	(1.219)
Percent White	0.804
	(1.240)

Metro Grocery Stores with Dollar Store Radius 2.5 Miles	
Percent Black	0.293
	(1.373)
Percent Asian	0.850***
	(0.057)
Percent American Indian	1.006
	(5.078)
Percent Hispanic	17.071***
	(1.109)
Percent Native Hawaiian	-302.204***
	(7.774)
Observations	80,992
R2	0.083
Max. Possible R2	1.000
Log Likelihood	-399,263.000
Wald Test (df = 64)	6,883.430***
LR Test (df = 64)	7,030.428***
Score (Logrank) Test (df = 64)	6,851.583***
Note:	*p<0.1; **p<0.05; ***p<0.01

Rural Grocery Stores with SNAP Authorizations: 1965-2020
Dollar Store Radius 5 Miles

	All Rural Stores	Adjacent to Metro	Non-Adjacent to Metro
Dollar Stores radius 5 miles	-0.179*** (0.007)	-0.166*** (0.008)	-0.207*** (0.013)
Non-adj., Pop.>= 20,000	0.028 (0.051)		
Adj., Pop. 2,500-19,999	-0.177*** (0.035)	-0.159*** (0.038)	
Non-adj., Pop. 2,500-19,999	-0.222*** (0.042)		-0.344*** (0.059)
Adj., Pop. <2,500, completely rural	-0.276*** (0.059)	-0.283*** (0.064)	
Non-adj., Pop. <2,500, completely rural	-0.463*** (0.057)		-0.545*** (0.074)
Poverty	0.007 (0.005)	0.009 (0.007)	0.007 (0.008)
Median Income	-0.009** (0.004)	-0.004 (0.006)	-0.012* (0.007)
Median Home Value	-0.0005 (0.0004)	-0.001** (0.001)	0.00000 (0.001)
Grocery Store Annual Payroll	-2.270*	1.221	-4.960***

Rural Grocery Stores with SNAP Authorizations: 1965-2020
Dollar Store Radius 5 Miles

	(1.243)	(1.796)	(1.831)
Dollar Store Annual Payroll	-92.782***	-115.209***	-67.612***
	(4.885)	(6.695)	(7.073)
Percent White	1.830	-0.899	4.037
	(1.977)	(2.985)	(2.930)
Percent Black	2.112	-0.586	4.327
	(1.973)	(2.973)	(2.935)
Percent Asian	0.898	-4.353	3.679
	(2.677)	(4.801)	(3.515)
Percent American Indian	1.834	-1.254	4.131
	(2.050)	(3.172)	(2.997)
Percent Hispanic	0.209	0.015	0.550**
	(0.159)	(0.208)	(0.264)
Percent Native Hawaiian	-8.560	-5.528	-2.461
	(9.545)	(17.806)	(12.213)
Observations	15,801	9,853	5,948
R2	0.108	0.118	0.105
Max. Possible R2	1.000	1.000	0.999
Log Likelihood	-64,268.690	-38,362.580	-21,010.790
Wald Test	1,705.660*** (df = 64)	1,173.710*** (df = 60)	609.100*** (df = 58)
LR Test	1,803.668*** (df = 64)	1,237.836*** (df = 60)	656.769*** (df = 58)

Rural Grocery Stores with SNAP Authorizations: 1965-2020
Dollar Store Radius 5 Miles

Score (Logrank) Test	1,672.269*** (df = 64)	1,148.798*** (df = 60)	639.674*** (df = 58)

Note: *p<0.1; **p<0.05; ***p<0.01

Metro Grocery Stores with Dollar Store Radius 5 Miles

	Metro Grocery with SNAP Authorizations 1965-2020
Dollar Stores radius 5 miles	-0.022***
	(0.0005)
Metro, Pop. 250,000- 1 Mil.	-0.145***
	(0.016)
Metro, Pop.< 250,000	-0.132***
	(0.023)
Poverty	0.008***
	(0.003)
Median Income	-0.020***
	(0.01)
Median Home Value	0.001***
	(0.0001)
Grocery Store Annual Payroll	14.724***
	(1.112)
Dollar Store Annual Payroll	-280.219***
	(7.498)
Percent White	-1.312
	(1.211)
Percent Black	-0.118

Metro Grocery Stores with Dollar Store Radius 5 Miles	
	(1.219)
Percent Asian	0.197
	(1.241)
Percent American Indian	-0.903
	(1.380)
Percent Hispanic	0.953***
	(0.057)
Percent Native Hawaiian	-8.785*
	(5.129)

Observations	80,992
R2	0.099
Max. Possible R2	1.000
Log Likelihood	-398,564.600
Wald Test (df = 64)	8,896.950***
LR Test (df = 64)	8,427.168***
Score (Logrank) Test (df = 64)	8,731.983***
Note:	*p<0.1; **p<0.05; ***p<0.01

Rural Grocery Stores with SNAP Authorizations: 1965-2020 Dollar Store Radius 10 Miles			
	All Rural Stores	Adjacent to Metro	Non-Adjacent to Metro
Dollar Stores radius 10 miles	-0.144*** (0.005)	-0.141*** (0.006)	-0.159*** (0.009)
Non-adj., Pop.>= 20,000	-0.053 (0.051)		
Adj., Pop. 2,500-19,999	-0.289*** (0.036)	-0.277*** (0.039)	
Non-adj., Pop. 2,500-19,999	-0.363*** (0.042)		-0.397*** (0.060)
Adj., Pop. <2,500, completely rural	-0.403*** (0.059)	-0.413*** (0.065)	
Non-adj., Pop. <2,500, completely rural	-0.609*** (0.057)		-0.605*** (0.075)
Poverty	0.008* (0.005)	0.010 (0.007)	0.006 (0.008)
Median Income	-0.006 (0.004)	-0.002 (0.006)	-0.009 (0.007)
Median Home Value	-0.001** (0.0004)	-0.001*** (0.001)	-0.0001 (0.001)
Grocery Store Annual Payroll	-2.418* (1.240)	0.726 (1.791)	-4.713*** (1.820)

Rural Grocery Stores with SNAP Authorizations: 1965-2020 Dollar Store Radius 10 Miles			
Dollar Store Annual Payroll	-83.225***	-101.608***	-62.397***
	(4.798)	(6.588)	(6.938)
Percent White	1.083	-2.300	3.825
	(1.967)	(2.982)	(2.912)
Percent Black	1.016	-2.358	3.876
	(1.963)	(2.971)	(2.917)
Percent Asian	-0.073	-6.606	3.160
	(2.690)	(4.792)	(3.554)
Percent American Indian	1.137	-2.509	3.976
	(2.040)	(3.179)	(2.978)
Percent Hispanic	0.104	-0.097	0.431
	(0.160)	(0.209)	(0.265)
Percent Native Hawaiian	-11.150	0.848	-6.088
	(9.546)	(17.771)	(12.141)
Observations	15,801	9,853	5,948
R2	0.122	0.137	0.109
Max. Possible R2	1.000	1.000	0.999
Log Likelihood	-64,145.040	-38,253.280	-20,994.330
Wald Test	1,899.270*** (df = 64)	1,329.630*** (df = 60)	640.250*** (df = 58)
LR Test	2,050.969*** (df = 64)	1,456.435*** (df = 60)	689.673*** (df = 58)
Score (Logrank) Test	1,848.488*** (df = 64)	1,302.274*** (df = 60)	660.164*** (df = 58)
Note:			*p<0.1; **p<0.05; ***p<0.01

Metro Grocery Stores with SNAP Authorizations: 1965-2020
Dollar Store Radius 10 Miles

	Metro Grocery with SNAP Authorizations 1965-2020
Dollar Stores radius 10 miles	-0.012***
	(0.0002)
Metro, Pop. 250,000- 1 Mil.	-0.236***
	(0.016)
Metro, Pop.< 250,000	-0.278***
	(0.023)
Poverty	-0.007***
	(0.003)
Median Income	-0.027***
	(0.001)
Median Home Value	0.001***
	(0.0001)
Grocery Store Annual Payroll	10.899***
	(1.128)
Dollar Store Annual Payroll	-277.851***
	(7.332)
Percent White	-0.082
	(1.220)
Percent Black	1.343

	(1.228)
Percent Asian	2.635**
	(1.250)
Percent American Indian	0.298
	(1.413)
Percent Hispanic	1.198***
	(0.057)
Percent Native Hawaiian	-26.318***
	(5.264)
Observations	80,992
R2	0.118
Max. Possible R2	1.000
Log Likelihood	-397,699.100
Wald Test (df = 64)	11,334.290***
LR Test (df = 64)	10,158.220***
Score (Logrank) Test (df = 64)	10,995.790***
Note:	*p<0.1; **p<0.05; ***p<0.01

Rural Grocery Stores with SNAP Authorizations: 1965-2020 Dollar Store Radius 15 Miles			
	All Rural Stores	Adjacent to Metro	Non-Adjacent to Metro
Dollar Stores radius 15 miles	-0.091*** (0.003)	-0.087*** (0.004)	-0.115*** (0.006)
Non-adj., Pop.>= 20,000	-0.170*** (0.051)		
Adj., Pop. 2,500-19,999	-0.295*** (0.036)	-0.281*** (0.039)	
Non-adj., Pop. 2,500-19,999	-0.406*** (0.043)		-0.335*** (0.059)
Adj., Pop. <2,500, completely rural	-0.387*** (0.059)	-0.381*** (0.065)	
Non-adj., Pop. <2,500, completely rural	-0.612*** (0.058)		-0.518*** (0.074)
Poverty	0.009* (0.005)	0.008 (0.007)	0.007 (0.008)
Median Income	-0.0003 (0.004)	0.005 (0.006)	-0.006 (0.007)
Median Home Value	-0.001*** (0.0004)	-0.002*** (0.001)	-0.0002 (0.001)
Grocery Store Annual Payroll	-2.405* (1.240)	0.905 (1.792)	-4.873*** (1.810)

Rural Grocery Stores with SNAP Authorizations: 1965-2020 Dollar Store Radius 15 Miles			
Dollar Store Annual Payroll	-78.111***	-94.891***	-57.903***
	(4.808)	(6.640)	(6.889)
Percent White	0.489	-1.957	1.695
	(1.952)	(2.951)	(2.892)
Percent Black	0.263	-2.135	1.472
	(1.949)	(2.939)	(2.900)
Percent Asian	-1.699	-9.101*	0.968
	(2.729)	(4.813)	(3.564)
Percent American Indian	0.656	-1.691	1.788
	(2.024)	(3.150)	(2.959)
Percent Hispanic	-0.031	-0.222	0.283
	(0.161)	(0.211)	(0.265)
Percent Native Hawaiian	-14.071	8.959	-12.091
	(9.538)	(17.988)	(12.010)
Observations	15,801	9,853	5,948
R2	0.123	0.140	0.112
Max. Possible R2	1.000	1.000	0.999
Log Likelihood	-64,135.470	-38,240.840	-20,984.360
Wald Test	1,915.690*** (df = 64)	1,352.650*** (df = 60)	660.830*** (df = 58)
LR Test	2,070.115*** (df = 64)	1,481.315*** (df = 60)	709.626*** (df = 58)
Score (Logrank) Test	1,817.166*** (df = 64)	1,285.897*** (df = 60)	684.050*** (df = 58)
Note:			*p<0.1; **p<0.05; ***p<0.01

Metro Grocery Stores with SNAP Authorizations 1965-2020
Dollar Store Radius 15 Miles

	Metro Grocery with SNAP Authorizations 1965-2020
Dollar Stores radius 15 miles	-0.008***
	(0.0001)
Metro, Pop. 250,000- 1 Mil.	-0.322***
	(0.017)
Metro, Pop.< 250,000	-0.374***
	(0.023)
Poverty	-0.012***
	(0.003)
Median Income	-0.028***
	(0.001)
Median Home Value	0.001***
	(0.0001)
Grocery Store Annual Payroll	9.273***
	(1.125)
Dollar Store Annual Payroll	-253.705***
	(7.235)
Percent White	0.051
	(1.215)

Percent Black	1.628
	(1.224)
Percent Asian	2.410*
	(1.245)
Percent American Indian	0.942
	(1.388)
Percent Hispanic	1.319***
	(0.056)
Percent Native Hawaiian	-28.580***
	(5.239)
Observations	80,992
R2	0.130
Max. Possible R2	1.000
Log Likelihood	-397,150.300
Wald Test (df = 64)	13,033.740***
LR Test (df = 64)	11,255.750***
Score (Logrank) Test (df = 64)	12,562.930***
Note:	*p<0.1; **p<0.05; ***p<0.01

Rural Grocery Stores with SNAP Authorizations: 1965-2020 Dollar Store Radius 20 Miles			
	All Rural Stores	Adjacent to Metro	Non-Adjacent to Metro
Dollar Stores radius 20 miles	-0.055*** (0.002)	-0.050*** (0.002)	-0.085*** (0.004)
Non-adj., Pop.>= 20,000	-0.214*** (0.051)		
Adj., Pop. 2,500-19,999	-0.222*** (0.035)	-0.204*** (0.038)	
Non-adj., Pop. 2,500-19,999	-0.362*** (0.042)		-0.265*** (0.058)
Adj., Pop. <2,500, completely rural	-0.276*** (0.059)	-0.255*** (0.064)	
Non-adj., Pop. <2,500, completely rural	-0.528*** (0.057)		-0.433*** (0.073)
Poverty	0.012** (0.005)	0.012* (0.007)	0.009 (0.008)
Median Income	0.004 (0.004)	0.012** (0.006)	-0.006 (0.007)
Median Home Value	-0.001*** (0.0004)	-0.002*** (0.001)	-0.0001 (0.001)
Grocery Store Annual Payroll	-2.799** (1.248)	0.748 (1.799)	-5.650*** (1.828)

Rural Grocery Stores with SNAP Authorizations: 1965-2020 Dollar Store Radius 20 Miles			
Dollar Store Annual Payroll	-77.588***	-95.587***	-53.310***
	(4.865)	(6.718)	(6.857)
Percent White	0.942	-1.601	1.098
	(1.952)	(2.964)	(2.890)
Percent Black	0.594	-1.864	0.607
	(1.950)	(2.952)	(2.901)
Percent Asian	-1.634	-10.215**	0.230
	(2.738)	(4.860)	(3.572)
Percent American Indian	1.030	-1.501	1.082
	(2.026)	(3.162)	(2.960)
Percent Hispanic	-0.106	-0.265	0.138
	(0.161)	(0.211)	(0.265)
Percent Native Hawaiian	-12.164	20.575	-13.144
	(9.510)	(17.926)	(11.935)
Observations	15,801	9,853	5,948
R2	0.122	0.138	0.121
Max. Possible R2	1.000	1.000	0.999
Log Likelihood	-64,142.890	-38,248.030	-20,956.930
Wald Test	1,887.740*** (df = 64)	1,328.520*** (df = 60)	718.980*** (df = 58)
LR Test	2,055.284*** (df = 64)	1,466.944*** (df = 60)	764.484*** (df = 58)
Score (Logrank) Test	1,752.031*** (df = 64)	1,240.930*** (df = 60)	749.725*** (df = 58)
Note:			*p<0.1; **p<0.05; ***p<0.01

Metro Grocery Stores with SNAP Authorizations: 1965-2020
Dollar Store Radius 20 Miles

	Metro Grocery with SNAP Authorizations 1965-2020
Dollar Stores radius 20 miles	-0.007***
	(0.0001)
Metro, Pop. 250,000- 1 Mil.	-0.375***
	(0.017)
Metro, Pop.< 250,000	-0.434***
	(0.023)
Poverty	-0.017***
	(0.003)
Median Income	-0.027***
	(0.001)
Median Home Value	0.001***
	(0.0001)
Grocery Store Annual Payroll	9.055***
	(1.114)
Dollar Store Annual Payroll	-232.204***
	(7.154)
Percent White	2.781**
	(1.211)

Metro Grocery Stores with SNAP Authorizations: 1965-2020
Dollar Store Radius 20 Miles

Percent Black	4.517***
	(1.220)
Percent Asian	5.053***
	(1.240)
Percent American Indian	4.115***
	(1.371)
Percent Hispanic	1.356***
	(0.055)
Percent Native Hawaiian	-25.676***
	(5.215)
Observations	80,992
R2	0.139
Max. Possible R2	1.000
Log Likelihood	-396,713.700
Wald Test (df = 64)	14,223.970***
LR Test (df = 64)	12,128.930***
Score (Logrank) Test (df = 64)	13,741.840***
Note:	*p<0.1; **p<0.05; ***p<0.01

Appendix D:

Rural Grocery Stores with SNAP Authorizations: 1992-2020 Dollar Store Radius 2.5 Miles			
	All Rural Stores	Adjacent to Metro	Non-Adjacent to Metro
Dollar Stores radius 2.5 miles	-0.293*** (0.011)	-0.274*** (0.014)	-0.332*** (0.020)
Non-adj., Pop.>= 20,000	-0.011 (0.059)		
Adj., Pop. 2,500-19,999	-0.069* (0.040)	-0.053 (0.043)	
Non-adj., Pop. 2,500-19,999	-0.161*** (0.048)		-0.231*** (0.066)
Adj., Pop. <2,500, completely rural	-0.161** (0.068)	-0.175** (0.075)	
Non-adj., Pop. <2,500, completely rural	-0.388*** (0.067)		-0.425*** (0.086)
Poverty	-0.0001 (0.006)	0.003 (0.008)	-0.005 (0.009)
Median Income	-0.016*** (0.005)	-0.014** (0.007)	-0.023*** (0.008)
Median Home Value	-0.001*** (0.0004)	-0.002*** (0.001)	-0.001 (0.001)

Rural Grocery Stores with SNAP Authorizations: 1992-2020 Dollar Store Radius 2.5 Miles			
Grocery Store Annual Payroll	1.674	5.925***	-3.113
	(1.565)	(2.170)	(2.402)
Dollar Store Annual Payroll	-109.223***	-141.487***	-75.044***
	(6.106)	(8.316)	(8.704)
Percent White	1.324	0.419	2.372
	(2.379)	(3.601)	(3.607)
Percent Black	1.912	1.019	3.028
	(2.369)	(3.583)	(3.601)
Percent Asian	-1.234	0.213	-0.807
	(2.991)	(5.775)	(4.124)
Percent American Indian	1.531	0.138	2.822
	(2.462)	(3.801)	(3.683)
Percent Hispanic	0.488***	0.171	1.027***
	(0.183)	(0.237)	(0.310)
Percent Native Hawaiian	-17.778	-9.250	-18.614
	(11.220)	(20.535)	(14.561)
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Observations	11,988	7,515	4,473
R2	0.119	0.131	0.118
Max. Possible R2	1.000	0.999	0.999
Log Likelihood	-46,018.430	-27,706.570	-14,749.140
Wald Test	1,445.980*** (df = 64)	999.110*** (df = 60)	517.670*** (df = 58)

LR Test	1,515.736*** (df = 64)	1,054.755*** (df = 60)	563.616*** (df = 58)
Score (Logrank) Test	1,406.183*** (df = 64)	977.956*** (df = 60)	537.625*** (df = 58)

Note: *p<0.1; **p<0.05; ***p<0.01

Metro Grocery Stores with SNAP Authorizations 1992-2020
Dollar Store Radius 2.5 Miles

	Metro Grocery with SNAP Authorizations 1992-2020
Dollar Stores radius 2.5 miles	-0.034***
	(0.001)
Metro, Pop. 250,000- 1 Mil.	-0.067***
	(0.018)
Metro, Pop.< 250,000	0.034
	(0.026)
Poverty	0.014***
	(0.003)
Median Income	-0.017***
	(0.001)
Median Home Value	0.0003***
	(0.0001)
Grocery Store Annual Payroll	0.952
	(1.329)
Dollar Store Annual Payroll	1.642
	(1.337)
Percent White	1.973
	(1.359)

Metro Grocery Stores with SNAP Authorizations 1992-2020 Dollar Store Radius 2.5 Miles	
Percent Black	1.977
	(1.554)
Percent Asian	0.772***
	(0.062)
Percent American Indian	3.524
	(5.512)
Percent Hispanic	20.599***
	(1.256)
Percent Native Hawaiian	-360.464***
	(9.240)
Observations	70,688
R2	0.084
Max. Possible R2	1.000
Log Likelihood	-342,175.800
Wald Test (df = 64)	6,186.320***
LR Test (df = 64)	6,213.494***
Score (Logrank) Test (df = 64)	6,001.264***
Note:	*p<0.1; **p<0.05; ***p<0.01

Rural Grocery Stores with SNAP Authorizations: 1992-2020 Dollar Store Radius 5 Miles			
	All Rural Stores	Adjacent to Metro	Non-Adjacent to Metro
Dollar Stores radius 5 miles	-0.214*** (0.008)	-0.200*** (0.010)	-0.250*** (0.015)
Non-adj., Pop.>= 20,000	-0.006 (0.059)		
Adj., Pop. 2,500-19,999	-0.201*** (0.041)	-0.173*** (0.044)	
Non-adj., Pop. 2,500-19,999	-0.292*** (0.048)		-0.407*** (0.068)
Adj., Pop. <2,500, completely rural	-0.286*** (0.069)	-0.284*** (0.076)	
Non-adj., Pop. <2,500, completely rural	-0.497*** (0.068)		-0.585*** (0.087)
Poverty	0.001 (0.006)	0.006 (0.008)	-0.009 (0.009)
Median Income	-0.016*** (0.005)	-0.013* (0.007)	-0.024*** (0.008)
Median Home Value	-0.001*** (0.0004)	-0.002*** (0.001)	-0.001 (0.001)
Grocery Store Annual Payroll	2.121 (1.564)	6.448*** (2.163)	-2.530 (2.410)

Rural Grocery Stores with SNAP Authorizations: 1992-2020 Dollar Store Radius 5 Miles			
Dollar Store Annual Payroll	-108.802***	-139.322***	-76.594***
	(6.055)	(8.264)	(8.620)
Percent White	1.160	-0.187	3.024
	(2.397)	(3.608)	(3.637)
Percent Black	1.535	0.212	3.446
	(2.387)	(3.591)	(3.629)
Percent Asian	-1.504	-0.609	-0.375
	(3.024)	(5.759)	(4.185)
Percent American Indian	1.350	-0.574	3.589
	(2.481)	(3.813)	(3.713)
Percent Hispanic	0.346*	0.037	0.881***
	(0.183)	(0.237)	(0.314)
Percent Native Hawaiian	-18.013	-14.146	-14.482
	(11.451)	(20.607)	(15.059)
Observations	11,988	7,515	4,473
R2	0.125	0.137	0.125
Max. Possible R2	1.000	0.999	0.999
Log Likelihood	-45,979.220	-27,681.000	-14,731.770
Wald Test	1,481.390*** (df = 64)	1,013.940*** (df = 60)	546.890*** (df = 58)
LR Test	1,594.159*** (df = 64)	1,105.900*** (df = 60)	598.372*** (df = 58)
Score (Logrank) Test	1,444.016*** (df = 64)	998.437*** (df = 60)	568.412*** (df = 58)
Note:	*p<0.1; **p<0.05; ***p<0.01		

Metro Grocery Stores with SNAP Authorizations 1992-2020
Dollar Store Radius 5 Miles

	Metro Grocery with SNAP Authorizations 1992-2020
Dollar Stores radius 5 miles	-0.024***
	(0.001)
Metro, Pop. 250,000- 1 Mil.	-0.120***
	(0.018)
Metro, Pop.< 250,000	-0.079***
	(0.026)
Poverty	0.011***
	(0.003)
Median Income	-0.022***
	(0.001)
Median Home Value	0.001***
	(0.0001)
Grocery Store Annual Payroll	17.657***
	(1.264)
Dollar Store Annual Payroll	-332.382***
	(8.894)
Percent White	0.227
	(1.330)

Metro Grocery Stores with SNAP Authorizations 1992-2020
Dollar Store Radius 5 Miles

Percent Black	1.313
	(1.338)
Percent Asian	1.745
	(1.361)
Percent American Indian	1.012
	(1.568)
Percent Hispanic	0.862***
	(0.061)
Percent Native Hawaiian	-6.901
	(5.574)
Observations	70,688
R2	0.103
Max. Possible R2	1.000
Log Likelihood	-341,436.700
Wald Test (df = 64)	8,341.490***
LR Test (df = 64)	7,691.818***
Score (Logrank) Test (df = 64)	,985.836***
Note:	*p<0.1; **p<0.05; ***p<0.01

Rural Grocery Stores with SNAP Authorizations: 1992-2020 Dollar Store Radius 10 Miles			
	All Rural Stores	Adjacent to Metro	Non-Adjacent to Metro
Dollar Stores radius 10 miles	-0.171*** (0.006)	-0.166*** (0.007)	-0.196*** (0.011)
Non-adj., Pop.>= 20,000	-0.090 (0.059)		
Adj., Pop. 2,500-19,999	-0.346*** (0.042)	-0.322*** (0.046)	
Non-adj., Pop. 2,500-19,999	-0.471*** (0.050)		-0.516*** (0.070)
Adj., Pop. <2,500, completely rural	-0.439*** (0.070)	-0.437*** (0.077)	
Non-adj., Pop. <2,500, completely rural	-0.677*** (0.069)		-0.703*** (0.090)
Poverty	0.001 (0.006)	0.006 (0.008)	-0.011 (0.009)
Median Income	-0.014*** (0.005)	-0.013* (0.007)	-0.021*** (0.008)
Median Home Value	-0.001*** (0.0004)	-0.002*** (0.001)	-0.001 (0.001)
Grocery Store Annual Payroll	2.167 (1.556)	6.264*** (2.155)	-2.209 (2.389)

Rural Grocery Stores with SNAP Authorizations: 1992-2020
Dollar Store Radius 10 Miles

Dollar Store Annual Payroll	-98.884***	-124.818***	-72.476***
	(5.955)	(8.170)	(8.437)
Percent White	0.836	-1.667	3.404
	(2.378)	(3.599)	(3.612)
Percent Black	0.788	-1.717	3.527
	(2.369)	(3.582)	(3.603)
Percent Asian	-2.171	-3.410	-0.468
	(3.057)	(5.749)	(4.248)
Percent American Indian	1.076	-2.029	4.057
	(2.463)	(3.817)	(3.685)
Percent Hispanic	0.185	-0.135	0.693**
	(0.184)	(0.239)	(0.315)
Percent Native Hawaiian	-17.893	-4.363	-16.676
	(11.510)	(20.549)	(15.014)
Observations	11,988	7,515	4,473
R2	0.139	0.156	0.132
Max. Possible R2	1.000	0.999	0.999
Log Likelihood	-45,879.930	-27,595.180	-14,713.610
Wald Test	1,624.030*** (df = 64)	1,134.710*** (df = 60)	571.810*** (df = 58)
LR Test	1,792.739*** (df = 64)	1,277.529*** (df = 60)	634.685*** (df = 58)
Score (Logrank) Test	1,562.910*** (df = 64)	1,106.034*** (df = 60)	582.699*** (df = 58)

Note: *p<0.1; **p<0.05; ***p<0.01

Metro Grocery Stores with SNAP Authorizations 1992-2020
Dollar Store Radius 10 Miles

	Metro Grocery with SNAP Authorizations 1992-2020
Dollar Stores radius 10 miles	-0.013***
	(0.0002)
Metro, Pop. 250,000- 1 Mil.	-0.222***
	(0.018)
Metro, Pop.< 250,000	-0.249***
	(0.026)
Poverty	-0.006**
	(0.003)
Median Income	-0.030***
	(0.001)
Median Home Value	0.001***
	(0.0001)
Grocery Store Annual Payroll	13.684***
	(1.283)
Dollar Store Annual Payroll	-331.753***
	(8.662)
Percent White	2.266*
	(1.345)

Metro Grocery Stores with SNAP Authorizations 1992-2020
Dollar Store Radius 10 Miles

Percent Black	3.602***
	(1.353)
Percent Asian	5.251***
	(1.376)
Percent American Indian	2.735*
	(1.637)
Percent Hispanic	1.130***
	(0.062)
Percent Native Hawaiian	-25.507***
	(5.744)
Observations	70,688
R2	0.126
Max. Possible R2	1.000
Log Likelihood	-340,538.500
Wald Test (df = 64)	10,877.250***
LR Test (df = 64)	9,488.167***
Score (Logrank) Test (df = 64)	10,265.830***

Note: *p<0.1; **p<0.05; ***p<0.01

Rural Grocery Stores with SNAP Authorizations: 1992-2020 Dollar Store Radius 15 Miles			
	All Rural Stores	Adjacent to Metro	Non-Adjacent to Metro
Dollar Stores radius 15 miles	-0.111*** (0.004)	-0.106*** (0.004)	-0.140*** (0.008)
Non-adj., Pop.>= 20,000	-0.237*** (0.059)		
Adj., Pop. 2,500-19,999	-0.360*** (0.042)	-0.337*** (0.046)	
Non-adj., Pop. 2,500-19,999	-0.534*** (0.050)		-0.432*** (0.069)
Adj., Pop. <2,500, completely rural	-0.437*** (0.070)	-0.423*** (0.077)	
Non-adj., Pop. <2,500, completely rural	-0.683*** (0.069)		-0.574*** (0.088)
Poverty	0.001 (0.006)	0.004 (0.008)	-0.011 (0.009)
Median Income	-0.006 (0.005)	-0.0005 (0.007)	-0.018** (0.008)
Median Home Value	-0.002*** (0.0004)	-0.003*** (0.001)	-0.001 (0.001)
Grocery Store Annual Payroll	1.995 (1.552)	6.828*** (2.162)	-2.938 (2.358)

Rural Grocery Stores with SNAP Authorizations: 1992-2020 Dollar Store Radius 15 Miles			
Dollar Store Annual Payroll	-94.983***	-121.078***	-66.796***
	(5.985)	(8.240)	(8.421)
Percent White	-0.646	-3.029	0.387
	(2.358)	(3.559)	(3.556)
Percent Black	-0.831	-3.153	0.259
	(2.351)	(3.541)	(3.551)
Percent Asian	-4.774	-9.614*	-3.636
	(3.129)	(5.801)	(4.239)
Percent American Indian	-0.295	-2.959	0.979
	(2.444)	(3.780)	(3.631)
Percent Hispanic	0.013	-0.259	0.493
	(0.185)	(0.242)	(0.314)
Percent Native Hawaiian	-20.827*	6.488	-24.898*
	(11.572)	(20.716)	(14.783)
Observations	11,988	7,515	4,473
R2	0.141	0.161	0.133
Max. Possible R2	1.000	0.999	0.999
Log Likelihood	-45,868.620	-27,574.220	-14,712.040
Wald Test	1,633.170*** (df = 64)	1,162.930*** (df = 60)	577.840*** (df = 58)
LR Test	1,815.365*** (df = 64)	1,319.464*** (df = 60)	637.824*** (df = 58)
Score (Logrank) Test	1,502.932*** (df = 64)	1,076.032*** (df = 60) 5	82.948*** (df = 58)
Note:			*p<0.1; **p<0.05; ***p<0.01

Metro Grocery Stores with SNAP Authorizations 1992-2020
Dollar Store Radius 15 Miles

	Metro Grocery with SNAP Authorizations 1992-2020
Dollar Stores radius 15 miles	-0.009***
	(0.0001)
Metro, Pop. 250,000- 1 Mil.	-0.327***
	(0.018)
Metro, Pop.< 250,000	-0.368***
	(0.026)
Poverty	-0.012***
	(0.003)
Median Income	-0.031***
	(0.001)
Median Home Value	0.001***
	(0.0001)
Grocery Store Annual Payroll	11.733***
	(1.283)
Dollar Store Annual Payroll	-298.494***
	(8.518)
Percent White	2.191
	(1.337)

Metro Grocery Stores with SNAP Authorizations 1992-2020
Dollar Store Radius 15 Miles

Percent Black	3.722***
	(1.346)
Percent Asian	4.718***
	(1.368)
Percent American Indian	3.463**
	(1.588)
Percent Hispanic	1.279***
	(0.061)
Percent Native Hawaiian	-28.487***
	(5.708)
Observations	70,688
R2	0.140
Max. Possible R2	1.000
Log Likelihood	-339,932.900
Wald Test (df = 64)	12,790.470***
LR Test (df = 64)	10,699.290***
Score (Logrank) Test (df = 64)	12,022.630***

Note: *p<0.1; **p<0.05; ***p<0.01

Rural Grocery Stores with SNAP Authorizations: 1992-2020 Dollar Store Radius 20 Miles			
	All Rural Stores	Adjacent to Metro	Non-Adjacent to Metro
Dollar Stores radius 20 miles	-0.068*** (0.002)	-0.062*** (0.003)	-0.105*** (0.005)
Non-adj., Pop.>= 20,000	-0.301*** (0.059)		
Adj., Pop. 2,500-19,999	-0.276*** (0.042)	-0.245*** (0.045)	
Non-adj., Pop. 2,500-19,999	-0.495*** (0.050)		-0.348*** (0.068)
Adj., Pop. <2,500, completely rural	-0.330*** (0.069)	-0.291*** (0.076)	
Non-adj., Pop. <2,500, completely rural	-0.592*** (0.068)		-0.461*** (0.086)
Poverty	0.007 (0.006)	0.010 (0.008)	-0.005 (0.009)
Median Income	-0.00004 (0.005)	0.009 (0.007)	-0.016** (0.008)
Median Home Value	-0.002*** (0.0004)	-0.003*** (0.001)	-0.001 (0.001)
Grocery Store Annual Payroll	1.093 (1.557)	6.314*** (2.172)	-4.442* (2.351)

Rural Grocery Stores with SNAP Authorizations: 1992-2020 Dollar Store Radius 20 Miles			
Dollar Store Annual Payroll	-94.631***	-123.050***	-60.933***
	(6.076)	(8.331)	(8.458)
Percent White	-0.350	-3.182	-0.259
	(2.368)	(3.574)	(3.544)
Percent Black	-0.700	-3.397	-0.763
	(2.361)	(3.556)	(3.544)
Percent Asian	-5.098	-12.227**	-4.633
	(3.169)	(5.878)	(4.263)
Percent American Indian	-0.118	-3.293	0.146
	(2.454)	(3.791)	(3.623)
Percent Hispanic	-0.106	-0.324	0.307
	(0.185)	(0.242)	(0.313)
Percent Native Hawaiian	-17.850	21.940	-25.958*
	(11.606)	(20.664)	(14.718)
Observations	11,988	7,515	4,473
R2	0.141	0.161	0.146
Max. Possible R2	1.000	0.999	0.999
Log Likelihood	-45,863.310	-27,574.660	-14,677.450
Wald Test	1,625.880*** (df = 64)	1,152.410*** (df = 60)	641.210*** (df = 58)
LR Test	1,825.987*** (df = 64)	1,318.571*** (df = 60)	707.011*** (df = 58)
Score (Logrank) Test	1,455.246*** (df = 64)	1,041.807*** (df = 60)	655.688*** (df = 58)
Note:			*p<0.1; **p<0.05; ***p<0.01

Metro Grocery Stores with SNAP Authorizations 1992-2020
Dollar Store Radius 20 Miles

	Metro Grocery with SNAP Authorizations 1992-2020
Dollar Stores radius 20 miles	-0.007***
	(0.0001)
Metro, Pop. 250,000- 1 Mil.	-0.393***
	(0.018)
Metro, Pop.< 250,000	-0.444***
	(0.026)
Poverty	-0.017***
	(0.003)
Median Income	-0.031***
	(0.001)
Median Home Value	0.001***
	(0.0001)
Grocery Store Annual Payroll	11.579***
	(1.269)
Dollar Store Annual Payroll	-270.136***
	(8.399)
Percent White	5.399***
	(1.331)

Metro Grocery Stores with SNAP Authorizations 1992-2020 Dollar Store Radius 20 Miles	
Percent Black	7.143***
	(1.340)
Percent Asian	7.804***
	(1.361)
Percent American Indian	7.261***
	(1.559)
Percent Hispanic	1.323***
	(0.060)
Percent Native Hawaiian	-25.109***
	(5.672)
Observations	70,688
R2	0.153
Max. Possible R2	1.000
Log Likelihood	-339,427.100
Wald Test (df = 64)	14,188.190***
LR Test (df = 64)	11,711.010***
Score (Logrank) Test (df = 64)	13,407.140***
Note:	*p<0.1; **p<0.05; ***p<0.01