FINDING MEANING FOR FOOD DESERTS: FOOD RETAIL ESTABLISHMENTS IN COLORADO COUNTIES

by

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Introduction

Retail food density is a key driver in determining if a population in a certain area will have the resources necessary to maintain an adequate level of health and nutrition. However, with the rising recognition of and research into food deserts, this problem may be more prevalent than originally speculated. While there is still disagreement on the specific semantics of a definition of a food desert, there is consensus on the concept that they are counties with a lack of establishments for residents to purchase fresh and affordable food items. Often these areas are also saturated with fast food options. Studies have been performed to determine the effects on those who live in places with less food retail resources, but fewer have tried to uncover the reasons for the disparity. It is generally reported that low income, minority dominant counties are more susceptible to being food deserts. However, it is unclear if the race and income of a county are the only factors indicating a food desert. This thesis will work to advance this query by examining which characteristics of a county most consistently determine the amount of food retail establishments that exist there to analyze if the current classification of a food desert is a meaningful description.

The inability for some to attain healthy nutrition is a both a health and public infrastructure concern. Location should not be a limiting factor in the ability to pursue a balanced diet. By understanding the underlying cause of deficiencies in some areas, there can be targeted remediation efforts to increase welfare by more effectively allocating resources in the form of nutritious and affordable food retail establishments.

The remainder of this thesis will include an explanation of the data and methodology used for analysis. Results from these methods will be presented and analyzed. The paper will conclude with a discussion of key findings, limitations, and opportunities for further research.

Literature Review

Background

Increased interest in the topic of food deserts originates from a study performed in the United Kingdom over the issue of food access. This paper revealed the existence of spatial inequality of grocery stores within low-income areas in Cardiff that could lead to more serious problems in the diet and nutrition of residents (Guy and David 2004). Since then, several variations of qualifications needed to be considered a food desert have appeared. A general definition states that food deserts are "poor urban areas, where residents cannot buy affordable, healthy food" (Cummins and Macintyre 2002). Some researchers have taken on more specific explanations of food deserts in terms of quantity of food resources available. For example, Hendrickson et. al (2006) used the definition "urban areas with 10 or fewer stores and no stores with more than 20 employees". In other recent studies, the qualifications have expanded to include geographic and socioeconomic factors. A paper by Thomsen et. al (2015) qualified urban and rural food deserts as low-income Census blocks where residents are 1 and 10 miles away from the nearest food store, respectively. Notably, one of the limitations around the study of food deserts is that there is a lack of consensus on what the true definition of one is. Socioeconomic, geographic, and demographic factors all influence how to describe food deserts in some way, thereby presenting a challenge in creating a universal definition that encompasses all elements of the concept.

Main findings

While a concrete definition does not yet exist for food deserts, there are several common principals that have emerged through research. Findings in the topics of store quantity, resident demographics, and resident income are summarized in Table 1. These results indicate that low income neighborhoods of color are more likely to exhibit qualities of a food desert based on the measure of food access than wealthier, predominantly white neighborhoods. None of the studies, however, were able to prove a causal relationship between the stated factors and the existence of a food desert.

Topic	Findings
Store quantity	Neighborhoods of color have fewer supermarkets as opposed to white neighborhoods. However, there are larger concentrations of smaller, local grocery stores available in these neighborhoods (Raja et al., 2008) Chain store locations within food deserts tend to have less variety than locations outside of food deserts (Hendrickson et al. 2006)
Resident demographics	Predominantly black neighborhoods have fewer supermarkets than neighborhoods that are predominantly white (Morland et al., 2002) Non-chain grocery store prices in black neighborhoods are similar to those of chain grocery stores, but the products are of lesser quality (Block and Kouba, 2006)
Resident income	Inner city areas with more poverty tend to have less chain stores than wealthier areas outside of the boundary (Chung and Myers, 1999) The poor pay relatively more for food because of extra transportation costs incurred to get to the closest super market (Chung and Myers, 1999) Wealthier neighborhoods tend to have more variety in grocery stores than lower income neighborhoods (Lewis et al., 2005)

Table 1: Summarization of Food Desert Literature Findings

Causes of food deserts

An underlying cause for the existence of food deserts has not been proven yet through empirical research, but a wide range of theories have been proposed. One explanation is dependent on the costs necessary to operate independent food stores in areas where chain stores do not exist. King et al. (2004) conclude that individually owned stores that serve more low-income customers have relatively lower sales margins and higher labor costs than chain stores that serve higher income customers. All else equal, the cost structure differs because of the relatively larger population of customers that receive and use SNAP, Supplemental Nutrition Assistance Program, benefits. While this theory explains how smaller stores are affected by operation cost differences, it does not explain why larger chains would be disincentivized from operating in the area.

Bitler and Haider (2010) suggest that the food deserts may be caused by an issue with the supply and demand relationship in low-income, low access areas. Theoretically, retailers with low competition should be able to set prices and control the supply as if they were operating as a monopoly. However, a market failure could occur where the company inadequately prices products to the point where there is no demand and the firm does not create profits. An extension of the market failure can also explain why firms who do not price discriminate will still choose to not operate. Firms in an area with no competition should expect to be compensated for taking the market opportunity. However, if the market lacks accurate information about the consumers' willingness to pay, firms do not benefit from operating in the long run (USDA, 2009). Formal research has not yet been performed to prove or disprove this theory.

Further research

Food deserts are a relatively new subject area for economic, health, and public policy research. Progress has been made in identifying commonalities between food desert areas, but there are important topics surrounding the understanding of them that warrant future study. The cause of food deserts has still not been identified based on the literature that is currently available. Without this pertinent piece of information, solutions cannot be identified because the root issue cannot be targeted. Further analysis needs to be performed on the extent to which supply side and demand side effects influence the existence of food deserts. Current theory points towards the explanation that the two forces work together in combination to contribute to the overall food desert effect, but it is not clear whether they work in equal parts or if one precedes the other (Bitler and Haider, 2010). The cause of food deserts cannot be determined until this interaction is fully understood.

Further study is also required to understand why stores do not locate in low income areas. Although it is proposed that market failures can be potential causes for the spatial inequality, econometric analysis is still required to prove the theory's validity (Chung and Myers, 1999). This issue is perhaps the most counterintuitive because an open market opportunity in other contexts would already have been seized by potential firms. Food deserts do not exhibit the same effect and it is not yet known why.

Data and Methodology

Data sources

The data used for this thesis is partially sourced from the Census Bureau. Demographic data in Colorado by county is taken from the 1990, 2000, and 2010 decennial surveys. All explanatory variables are measured in units of persons, with the exception of the median household income variables which are measured in units of households. Food retail establishment count from all Colorado counties is taken from the County Business Patterns data yearly from 1990-2016. Each data point represents a county in a year. From 1990-1999, there are a total of 63 data points for each year. Starting in 2000, there are 64 data points for each year because of the creation of Broomfield county which split apart from Boulder county.

Methodology

A fixed effect panel data regression method will be implemented to identify consistent county characteristics that affect the food retail establishment supply. The model is specified as:

$$y_{it} = \alpha + x'_{it}\beta + c_i + \delta_t + u_{it} \qquad (1)$$

where y_{it} is the count of food retail establishments of county *i* at time t, x'_{it} is a vector of time-variant explanatory variables, β are the respective variable coefficients, c_i is an individual fixed effect for county *i*, δ_t is an individual fixed effect for time *t*, and u_{it} is an error term.

An important question to consider in performing these regressions is on the issue of causality. Do residents move to a county because there are food resources available or do stores choose to locate in places with a distinct demographic composition? To address this issue, previous explanatory variable data will be prescribed to retail establishment data that varies every year. Specifically, retail data from the years 1990-1999 will be paired with the 1990 Census data, 2000-2009 will be paired with the 2000 Census data and 2010-2016 will be paired with the 2010 Census data. If the number of establishments in a year are regressed with the population from that year, an assumption is made that population changes directly caused any changes in the number of establishments. The direction of causality between composition of people in a county and stores in a county cannot be determined. Keeping explanatory variable data constant throughout the decade and only allowing the establishment variable to change allows the regression results to filter out the two-way causality effect as the decade passes. This method will allow the regression results to track how long the industrial structure of a county takes to respond to changes in the demographic composition or if there is any response at all. If an explanatory variable stays significant throughout the entire decade, it will show that there are no overly bias results from endogeneity and only one direction of causality is present in the data.

The true aim of the regression is not to build a model for predicting the number of retail establishments will be in county- that number is already known in the supplied data. Rather, the interest lies in identifying any consistent, statistically significant explanatory variables that allow us to understand what characteristics in a county affect the total food retail establishment supply. The magnitude of change each variable possesses on the dependent variable will be garnered from the sign and value of the coefficient.mm

While there are multiple explanatory variables representing different characteristics of each county observation, the model for this thesis does not include all possible explanatory variables. The regression does not include qualitative variables, such as unique geographical features or climate, that could influence the number of establishments in a county. Further extensions to this analysis could include these variables to achieve a more robust understanding on the causality of food deserts.

Descriptive Statistics

Before analysis, summary statistics will be presented to create understanding of the data set and food retail industry in the state of Colorado. Table 2 gives an overview of the percent of variation in establishment counts in each Colorado county from 1990-2016 by calculating each county's coefficient of variation. This value is calculated by dividing the standard deviation by the mean, providing a percentage value. The larger this value is, the more variability is present in the number of establishments in the county over time.

Table 2: Coefficient of Variation for Establishments by County

ESTABLISHMENTS BY COUNTY	
COUNTY	COEFFICIENT OF VARIATION
1	11.15%
3	24.82%
5	14.27%
7	28.39%
9	70.38%
11	48.34%
13	10.57%
14	5.29%
15	26.15%
17	38.78%
19	41.89%

21	26.55%
23	28.21%
25	40.67%
27	30.50%
29	23.81%
31	7.04%
33	39.14%
35	47.07%
37	22.44%
39	37.53%
41	8.88%
43	19.90%
45	15.34%
47	48.99%
49	20.52%
51	18.57%
53	34.14%
55	30.63%
57	35.72%
59	5.60%
61	38.18%
63	31.88%
65	53.12%
67	18.38%
69	18.01%
71	35.14%
73	47.34%
75	31.55%
77	11.89%
79	31.44%
81	61.52%
83	48.49%
85	17.00%
87	29.70%
89	49.89%
91	30.67%
93	33.09%
95	27.72%
97	16.92%
99	56.82%
101	32.57%

103	51.26%
105	24.22%
107	15.86%
109	46.34%
111	43.86%
113	25.94%
115	64.90%
117	17.94%
119	18.15%
121	44.89%
123	11.93%
125	22.26%

The average and median variability values for Colorado are similar at 30.78% and 30.10%, respectively. With a coefficient of 70.38% over 26 years, Baca (county 9) is the most varied. The least varied county is Broomfield with a coefficient of 5.29%. This value could be slightly skewed, however, due to the recent creation of the county in 2000 which leads to fewer observations available. Generally, larger metropolitan counties tend to have smaller variance in food retail stores than smaller rural counties. For example, Boulder (county 13), Denver (county 14), El Paso (county 41), and Jefferson (county 59) have much lower coefficients when compared with the rest of the table. Overall, this table demonstrates that the food retail establishment totals are constantly changing in Colorado. While grocery stores appear to be permanent fixtures of cities and neighborhoods, there must also be change drivers in the state that cause these variations to exist.

Table 3: Race, Education, and Income Averages by Decade

Variable	1990-1999	2000-2009	2010-2016
Race			
White	83.943%	79.270%	76.258%
Black	0.830%	1.138%	18.945%
American Indian	0.922%	0.972%	1.406%
Asian	0.552%	0.763%	1.071%
Other	0.053%	1.471%	1.433%

Education			
Less than 9th	5.595%	4.031%	4.342%
9-12, no diploma	7.324%	6.189%	3.741%
High school diploma or equivalent	20.416%	18.295%	19.441%
Some college	14.224%	16.762%	16.355%
Associate degree	4.228%	4.393%	5.411%
Bachelor degree	9.622%	11.681%	13.021%
Graduate/professional	3.996%	5.490%	6.530%
Income			
>10,000	10.760%	5.337%	3.930%
10,000-14,999	10.442%	4.672%	2.772%
15,000-24,999	21.117%	12.313%	8.481%
25,000-49,999	37.709%	33.184%	24.021%
50,000+	19.916%	44.492%	60.795%

Table 3 provides a description of the racial, educational, and income composition of Colorado by decade for context. In general, Colorado is a majority white state. The average education level tends to be at least a high school degree or some college experience. Average household income in Colorado is trending higher with more than half of residents earning over a median of $50,000 annually per household by the 2010 census.

Results

The preliminary regression ran on the dependent variable, establishment count, includes all explanatory variables, year fixed effects, and county fixed effects. This specification pools all years of data together to generate an understanding of characteristics that may be significant. A table of year fixed effects from this specification can be found in the appendix.

Table 4: Pooled Year Regression on Establishment Count with Year and County Fixed Effects

VARIABLES	(1) Establishment count
Total population	-0.000539**

	(0.000209)
Population square	3.41e-10*
	(2.07e-10)
Total households	0.00407***
	(0.000580)
Household square	-4.19e-10**
	(1.99e-10)
Adults over 25	0.000185
	(0.000381)
Adult over 25 square	-1.17e-09**
	(5.07e-10)
Population density per square mile	0.0227**
	(0.00993)
Black	-2.84e-05**
	(1.28e-05)
American Indian	-0.000313**
	(0.000128)
Hispanic	-0.000103**
	(4.50e-05)
Asian	0.00179***
	(0.000488)
Other race	0.000547
	(0.000508)
9-12, no diploma	0.00313***
	(0.000488)
HS diploma and equiv.	0.000495
	(0.000474)
Some college	0.000809**
	(0.000351)
Associate degree	-0.00300***
	(0.000724)
Bachelors	0.00238***
	(0.000469)
Graduate/professional	-0.000737*
	(0.000425)
10-14,999	-0.00877***
	(0.00177)
15-24,999	-0.00387***
	(0.00106)
25-49,999	-0.00396***
	(0.000533)
50k+	-0.00409***
	(0.000589)
Poverty Count	0.00143***
	(0.000207)
Area of County	-0.00369

	(0.00360)
county==Alamosa	-17.82
	(14.73)
county==Arapahoe	22.06***
	(6.863)
county==Archuleta	-13.67
	(12.69)
county==Baca	-10.50
	(8.430)
county==Bent	-15.05
	(12.02)
county==Boulder	-3.430
	(7.699)
county==Broomfield	-55.15***
	(15.29)
county==Chaffee	-13.36
	(13.50)
county==Cheyenne	-13.48
	(11.32)
county==Clear Creek	-17.71
	(16.03)
county==Conejos	-15.52
	(12.89)
county==Costilla	-16.35
	(13.23)
county==Crowley	-19.25
	(14.64)
county==Custer	-17.26
	(15.00)
county==Delta	-15.26
	(12.40)
county==Denver	-71.71**
	(32.39)
county==Dolores	-16.33
	(13.94)
county==Douglas	-14.14
	(13.80)
county==Eagle	-2.091
	(11.54)
county==El Paso	53.41***
	(7.330)
county==Elbert	-13.21
	(10.75)
county==Fremont	-17.47*
	(10.20)
county==Garfield	-0.387

	(6.203)
county==Gilpin	-19.99
	(16.93)
county==Grand	-7.310
	(10.82)
county==Gunnison	-5.390
	(6.117)
county==Hinsdale	-15.85
	(13.75)
county==Huerfano	-14.03
	(11.77)
county==Jackson	-13.67
	(11.93)
county==Jefferson	23.49***
	(8.868)
county==Kiowa	-13.86
	(11.31)
county==Kit Carson	-8.748
	(9.715)
county==La Plata	-7.469
	(10.87)
county==Lake	-19.24
	(16.10)
county==Larimer	7.308**
	(3.350)
county==Lincoln	-10.94
	(8.288)
county==Logan	-10.93
	(10.34)
county==Mesa	-1.659
	(2.403)
county==Mineral	-17.11
	(14.61)
county==Moffat	-1.678
	(1.229)
county==Montezuma	-14.06
	(9.649)
county==Montrose	-11.31
	(8.476)
county==Morgan	-9.549
	(12.16)
county==Otero	-15.53
	(12.40)
county==Ouray	-14.96
	(15.73)
county==Park	-11.65

	(9.521)
county==Phillips	-16.36
	(15.12)
county==Pitkin	-14.65
	(14.31)
county==Prowers	-11.73
	(11.36)
county==Pueblo	-8.661**
	(4.343)
county==Rio Blanco	-5.247
	(6.086)
county==Rio Grande	-13.66
	(14.12)
county==Routt	-5.929
	(9.100)
county==Saguache	-9.478
	(6.283)
county==San Juan	-19.39
	(16.37)
county==San Miguel	-12.47
	(13.16)
county==Sedgwick	-18.36
	(15.68)
county==Summit	-12.57
	(15.32)
county==Teller	-15.79
	(15.15)
county==Washington	-10.97
	(8.557)
county==Weld	6.253
	(3.824)
county==Yuma	-8.294
	(8.953)
Constant	22.70
	(17.78)
R-squared	0.991

Standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Total population, total households, and total adults over 25 years have quadratic relations with the dependent variable. The coefficient of the squared term is the opposite sign of the linear term, suggesting that the effect of the term can switch signs at some point. However, the magnitude of the squared term is small enough so that no values within the current data set are large enough to allow the sign of the quadratic to overcome the sign of the linear term. Thus, the squared term's effect can be neglected. The coefficient of the total population variable is negative, providing the relationship that for every additional person that is added to the state of Colorado there is a decrease of .000539 stores. More meaningfully, it would take an increase of 10,000 people to decrease the number of stores by 5.39. Colorado's population has seen an increase of 80,000 from 2017-2018 according to the Census (Associated Press 2018), which presents the question of whether food access will be a greater problem in the future. However, this negative relationship is offset by the positive coefficients on total household and total adults over 25. As total population increases, the count of households and adults must increase. The negative effect of total population is offset by the larger magnitude of the latter two coefficients, .00407 and .000185 respectively. Population density per square mile also exhibits a positive coefficient, which supports the relationship that a growth in population will provide more stores. Specifically, if the number of people per square mile increases by 1, the amount of food retail establishments will increase by .0227. In context, an increase of 100 more people per square mile will increase retail stores by 2.27.

The reference level for the race variables in this regression and all subsequent specifications is the count of white residents in the county. The negative coefficient on the Hispanic variable is consistent with the expectations of the relationship between food deserts and minority groups. Relative to white residents, an increase in 1 Hispanic resident in a county will change food retail establishments by -.000103 stores. To scale this effect, an increase of 10,000 Hispanic residents will decrease food retail establishments by 1.03. The coefficient on the Black and American Indian variables align with the same expectation. The results show that an increase of a Black resident will decrease stores by 2.84_{E}-5, or an increase of 10,000 Black residents will reduce the number of retail stores by .284, relative to an increase in white residents. An increase of an American Indian resident will decrease stores by .000103, or an increase of 10,000 residents will decrease stores by 1.03

compared to an increase of white residents. This is consistent with food desert literature in that an area with a high concentration of a minority group will have less access to food than an area with the same count of white residents. The coefficient term on the Asian variable is positive, .00179, relative to white. This is not surprising, however, due to differing cultural stigmas between Asians, blacks, and Hispanics. The model minority stereotype is influential in separating economic expectations for Asians from other minority groups (Kuo 2018). The Asian experience is assumed to mirror the white experience in financial success and quality of life, regardless if this is empirically true. This notion is reflected in the regression in the positive coefficient, relative to white. Furthermore, food desert literature is rarely focused on the food access of Asians because their trends have not aligned with the food access trends of blacks and Hispanics. Subsequent regressions will also take note of these relationships to determine if they contribute to a meaningful definition of food desert.

The income variables are regressed relative to the lowest category of annual median income, households with less than $10,000. All levels of the income variables exhibit negative coefficients. As the number of households with higher incomes increase, there will be less retail food establishments available relative to households with lower income. On the surface level, this appears counterintuitive to the pre-existing food desert research suggesting that lower income communities have fewer food retail resources. This negative relationship, however, may arise from the issue of providing quality food stores as opposed to providing mass quantities of food stores. Counties with wealthier populations may see larger stores with a greater variety of products. Because corporations know that they will be catering to a market with larger disposable incomes, the investment in more capital intensive physical locations and product offerings will be profitable for them. Lower income counties, on the other hand, might not be able to host the same kinds of stores. Shop owners may not generate the profits necessary to maintain large stores, so an alternative is to operate smaller stores with more manageable inventories. This results in the opportunity for a larger quantity of stores to operate in the same area because one store cannot supply all products that customers may demand. This speculation does not assume that these are specialty stores. Rather, they are limited offering stores due to the consumers' inability to spend large amounts of disposable income needed to support larger, more expensive stores.

This idea is further supported by the coefficient on the poverty variable which provides the count of individuals who are in poverty. The positive coefficient suggests that as the number of individuals in poverty increases, the availability of retail food establishments increases as well. Specifically, an increase in the poverty count by 1 individual increases the number of stores by .00143. More contextually, an additional 10,000 residents in poverty will increase the amount of food stores by 1.43. This effect combined with the coefficients for the income variables show a departure from the expectations of how food stores are located. An important assumption made in food desert literature is that neighborhoods with less income and more poverty will have less access to food resources. The results from the preliminary assumption are not consistent with this conclusion.

Statistically significant county fixed effects gives indications on which counties have unusual food retail patterns. While these fixed effects do not give a concrete reason for why the patterns exist, it does allow speculations to be made about why these counties are different. Arapahoe, El Paso, Jefferson, and Larimer counties all return large positive coefficients. Respectively, these coefficients are 22.06, 53.41, 23.49, and 7.308. By residing in one of these counties, the amount of food retail establishments increases by virtue of being in that area because all explanatory variables have been controlled for. One possible answer for this trend is the infrastructure of the county itself. The counties with positive fixed effect coefficients are all classified as suburban areas of Colorado. More families and schools may choose to locate in these counties rather than in major metropolis areas because of the general decrease in congestion and increase in living spaces. After controlling for area and total households, it may be possible for suburbs to still have more food retail locations because of increased demand from the larger concentration of working families and school children. Both populations require constant access to food retail establishments which may contribute to explaining the unique fixed effects increase exhibited by these counties.

On the other hand, Broomfield, Denver, Fremont, and Pueblo counties returned negative fixed effects coefficients. Broomfield's decrease in food retail establishments, with a coefficient of -55.15, may be explained by the relative youth of the county. Originally part of Boulder county, Broomfield did not split off into an autonomous county until 2000. Residents of this county have been used to shopping at food retail establishments in the Boulder county area for a larger part of the state's history. Broomfield has not had the same amount of time as other Colorado counties to establish specifics demand and supply needs for food retail establishments stores within its new boundaries. Perhaps, the county also does not find a need to increase the number of stores because residents are accustomed to frequenting preferred stores which may still reside in Boulder county. Denver county may face a different explanation for its fixed effect coefficient of -71.71. Denver is the metropolis hub of Colorado with 2 major industrial areas within the county boundary- downtown Denver and the Denver Tech Center. As such, this county may see lower amounts of food retail establishments due to the large city presence. Residents living in cities do not require the same level of convenient access to food retail establishments as residents living in suburbs do. Often, these are not families living in high-rise apartments, but rather young professionals. A singular food retail establishment located between many offices or apartment complexes can satisfy the needs of a larger population of people which decreases the need for multiple locations. These locations could also offer more product variety to satisfy the demands of so many people in one area, further deterring the need for multiple locations. Fremont county may face lower amounts of food retail establishments because its area composition is the opposite of a metropolis. Within the boundaries of Fremont are a multitude of outdoor attractions. In fact, most of the county consists of mountains roads that lead to various hikes and peaks. The decrease in food retail establishments may come from the inability for them to be built in this county because commuters are not in the area for long before departing for the mountain range. Pueblo county faces a similar situation. While there is a central city of Pueblo, much of the county is empty land. An interstate runs through these large expanses to connect to New Mexico in the south and agricultural land to the east. Like the commuter nature of Fremont, there are not many people who stay in Pueblo outside of the main city which may allow for the county to exhibit a unique decreased need for food retail establishments from the general trend.

To explore if the relationships found in the pooled regression are evident across the decades in the data set, a second regression specification is performed. This specification divides the decades into individual regressions to define which explanatory variables are consistent indicators of food retail establishment count in more detail. County fixed effects are included in the table and year fixed effects for this specification can be found in the appendix.

Table 5: Decade Specific Regression with County and Time Fixed Effects

	(1)	(2)	(3)
VARIABLES	1990-1999	2000-2009	2010-2016
Total population	-0.000582***	-0.000143	-0.000269
	(0.000204)	(0.000199)	(0.000211)
Population square	3.88e-10*	0	2.24e-10
	(2.01e-10)	(2.02e-10)	(2.12e-10)
Total households	0.00410***	0.00383***	0.00398***
	(0.000584)	(0.000594)	(0.000597)
Household square	-4.18e-10**	-2.85e-10	-1.96e-10
	(2.01e-10)	(2.02e-10)	(2.02e-10)
Adults over 25	0.000242	-0.000595*	-0.000583
	(0.000378)	(0.000358)	(0.000375)
Adult over 25 square	-1.28e-09***	-3.15e-10	-7.98e-10
	(4.90e-10)	(4.91e-10)	(5.19e-10)
Population density per square mile	0.0239**	0.0197*	0.0269***
	(0.00993)	(0.0102)	(0.0102)
Black	-2.77e-05**	-4.43e-05***	-4.73e-05***

	(1.29e-05)	(1.28e-05)	(1.29e-05)
American Indian	-0.000324**	-0.000401***	-0.000541***
	(0.000128)	(0.000130)	(0.000127)
Hispanic	-0.000101**	-8.69e-05*	-6.27e-05
	(4.53e-05)	(4.61e-05)	(4.59e-05)
Asian	0.00182***	0.00176***	0.00204***
	(0.000490)	(0.000501)	(0.000500)
Other race	0.000526	0.000505	0.000332
	(0.000512)	(0.000521)	(0.000521)
9-12, no diploma	0.00310***	0.00330***	0.00319***
	(0.000491)	(0.000500)	(0.000501)
HS diploma and equiv.	0.000535	0.000647	0.00108**
	(0.000475)	(0.000485)	(0.000479)
Some college	0.000794**	0.000701*	0.000497
	(0.000354)	(0.000360)	(0.000358)
Associate degree	-0.00293***	-0.00266***	-0.00187***
	(0.000725)	(0.000740)	(0.000725)
Bachelors	0.00238***	0.00261***	0.00276***
	(0.000474)	(0.000480)	(0.000479)
Graduate/professional	-0.000722*	-0.000595	-0.000403
	(0.000428)	(0.000435)	(0.000434)
10-14,999	-0.00888***	-0.00657***	-0.00632***
	(0.00178)	(0.00176)	(0.00178)
15-24,999	-0.00386***	-0.00458***	-0.00490***
	(0.00107)	(0.00108)	(0.00108)
25-49,999	-0.00401***	-0.00359***	-0.00378***
	(0.000534)	(0.000542)	(0.000547)
50k+	-0.00413***	-0.00390***	-0.00407***
	(0.000593)	(0.000603)	(0.000605)
Poverty Count	0.00142***	0.00165***	0.00168***
	(0.000208)	(0.000207)	(0.000209)
Area of County	-0.00368	-0.00358	-0.00351
	(0.00363)	(0.00369)	(0.00370)
county==Alamosa	-17.66	-18.30	-17.55
	(14.87)	(15.13)	(15.15)
county==Arapahoe	22.16***	26.49***	30.18***
	(6.925)	(6.991)	(6.953)
county==Archuleta	-13.59	-13.39	-12.79
	(12.81)	(13.03)	(13.05)
county==Baca	-10.45	-10.28	-9.889
	(8.508)	(8.657)	(8.670)
county==Bent	-14.99	-14.80	-14.36
	(12.13)	(12.34)	(12.36)
county==Boulder	-3.261	-4.322	-3.462
	(7.767)	(7.904)	(7.919)
county==Broomfield			-60.93***
			(15.71)
county==Chaffee	-13.38	-12.11	-11.80
	(13.62)	(13.86)	(13.88)

county==Cheyenne	-13.42	-13.25	-12.80
	(11.42)	(11.62)	(11.64)
county==Clear Creek	-17.70	-16.79	-16.41
	(16.18)	(16.46)	(16.49)
county==Conejos	-15.41	-15.82	-15.34
	(13.01)	(13.24)	(13.26)
county==Costilla	-16.27	-16.25	-15.76
	(13.35)	(13.58)	(13.60)
county==Crowley	-19.20	-18.68	-18.16
	(14.78)	(15.03)	(15.06)
county==Custer	-17.21	-16.71	-16.16
	(15.14)	(15.41)	(15.43)
county==Delta	-15.29	-14.04	-13.75
	(12.51)	(12.73)	(12.75)
county==Denver	-73.22**	-71.29**	-81.83**
	(32.65)	(33.26)	(33.28)
county==Dolores	-16.26	-15.76	-15.05
	(14.07)	(14.32)	(14.34)
county==Douglas	-14.09	-11.49	-9.762
	(13.93)	(14.16)	(14.18)
county==Eagle	-1.967	-1.279	-0.00495
	(11.65)	(11.85)	(11.87)
county==El Paso	53.59***	52.25***	53.38***
	(7.393)	(7.524)	(7.539)
county==Elbert	-13.17	-12.28	-11.59
	(10.85)	(11.04)	(11.06)
county==Fremont	-17.61*	-14.15	-13.57
	(10.30)	(10.46)	(10.48)
county==Garfield	-0.315	0.272	1.126
	(6.259)	(6.369)	(6.376)
county==Gilpin	-20.03	-19.66	-19.32
	(17.09)	(17.39)	(17.41)
county==Grand	-7.281	-6.732	-6.339
	(10.92)	(11.12)	(11.13)
county==Gunnison	-5.256	-5.750	-4.949
	(6.172)	(6.281)	(6.291)
county==Hinsdale	-15.78	-15.62	-15.08
	(13.87)	(14.12)	(14.14)
county==Huerfano	-13.99	-13.47	-13.00
	(11.88)	(12.08)	(12.10)
county==Jackson	-13.59	-13.46	-12.89
	(12.04)	(12.26)	(12.27)
county==Jefferson	23.61***	27.85***	31.69***
	(8.948)	(9.061)	(9.035)
county==Kiowa	-13.80	-13.65	-13.21
	(11.42)	(11.62)	(11.64)
county==Kit Carson	-8.700	-8.438	-8.022
	(9.805)	(9.977)	(9.992)
county==La Plata	-7.311	-6.954	-5.542

	(10.97)	(11.17)	(11.18)
county==Lake	-19.17	-18.88	-18.30
	(16.25)	(16.53)	(16.56)
county==Larimer	7.719**	5.790*	8.234**
	(3.344)	(3.425)	(3.443)
county==Lincoln	-10.89	-10.61	-10.19
	(8.364)	(8.510)	(8.523)
county==Logan	-10.91	-10.39	-10.10
	(10.43)	(10.61)	(10.63)
county==Mesa	-1.626	-0.0369	1.112
	(2.425)	(2.446)	(2.437)
county==Mineral	-17.04	-16.75	-16.23
	(14.75)	(15.01)	(15.03)
county==Moffat	-1.619	-1.695	-1.232
	(1.238)	(1.262)	(1.262)
county==Montezuma	-13.97	-13.70	-12.86
	(9.738)	(9.909)	(9.923)
county==Montrose	-11.29	-10.52	-10.01
	(8.554)	(8.703)	(8.716)
county==Morgan	-9.456	-9.261	-8.537
	(12.27)	(12.49)	(12.51)
county==Otero	-15.47	-15.44	-15.13
	(12.51)	(12.73)	(12.75)
county==Ouray	-14.90	-14.42	-13.86
	(15.87)	(16.15)	(16.18)
county==Park	-11.67	-10.59	-10.22
	(9.609)	(9.775)	(9.790)
county==Phillips	-16.30	-15.91	-15.45
	(15.26)	(15.53)	(15.55)
county==Pitkin	-14.65	-13.27	-12.66
	(14.44)	(14.69)	(14.71)
county==Prowers	-11.62	-11.93	-11.32
	(11.46)	(11.66)	(11.68)
county==Pueblo	-8.630**	-8.509*	-8.231*
	(4.383)	(4.460)	(4.467)
county==Rio Blanco	-5.187	-5.204	-4.781
	(6.141)	(6.249)	(6.259)
county==Rio Grande	-13.57	-13.55	-12.97
	(14.25)	(14.50)	(14.52)
county==Routt	-5.881	-5.268	-4.639
	(9.184)	(9.345)	(9.358)
county==Saguache	-9.404	-9.591	-9.150
	(6.341)	(6.452)	(6.462)
county==San Juan	-19.11	-18.73	-18.09
	(16.53)	(16.81)	(16.84)
county==San Miguel	-12.41	-11.91	-11.29
	(13.28)	(13.51)	(13.53)
county==Sedgwick	-18.30	-17.86	-17.37
	(15.82)	(16.10)	(16.12)

county==Summit	-12.56	-11.61	-11.17
	(15.46)	(15.73)	(15.76)
county==Teller	-15.81	-14.34	-13.91
	(15.29)	(15.56)	(15.58)
county==Washington	-10.92	-10.79	-10.42
	(8.636)	(8.788)	(8.801)
county==Weld	6.838*	2.254	4.731
	(3.792)	(3.843)	(3.927)
county==Yuma	-8.250	-8.041	-7.677
	(9.035)	(9.193)	(9.207)
Constant	20.73	21.62	20.71
	(17.94)	(18.26)	(18.28)
R-squared	0.991	0.990	0.990

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The decade specification reveals that many of the significant explanatory variables from the pooled year regression are consistent predictors of food retail establishment counts. However, there are those that lose significance over time. Total population, total adults over 25, and their squared terms cease to be significant after the first decade. They cannot be not relied upon to be a consistent explanatory characteristic in counties. Total households, however, does continue to have positive, significant effects throughout all 3 decades. The magnitude for the coefficients is relatively similar at .00410 in the 1990's, .00383 in the 2000's, and .00398 in the 2010's. The quadratic term is not significant, showing that households exhibits a linear effect on the dependent variable across time. Population density also stays consistent. With total population and area controlled for in the regression, this variable measures the effect of changes in density on retail food establishments. The coefficients on this term are positive across decades at .0239, .0197, and .0269. As the population density of an area increases, food retail establishments also increase. This is consistent with the total household term because these two terms increase at the same time- an additional household in an area will subsequently increase the population density of that same area.

Of the race variables, the Black and American Indian terms come out as more consistent explanatory variables across time than the Hispanic variable. Hispanic decreases in significance as the decades continue. This result is surprising, both because of the large Hispanic population within the state of Colorado and in how related the experiences between blacks and Hispanics are perceived to be. The negative coefficient on the Black and American Indian terms across decades is consistent with the expectations set with food desert literature and the previous specification ran. Relative to the white population, an area with the same count of either Black or American Indian residents will face lower amounts of food retail establishments. Both sets of coefficients experience an increase in magnitude across time as the coefficients become more negative. Race, especially in people of color, has a larger effect on the amount of food retail establishments in an area as time draws closer to the present. While these results cannot be classified as formal racial discrimination, they can be classified as concerns in food access as other studies have also reported. The Asian variable is also shown to be consistent with prior precedents as the coefficients are positive and significant across all three decades. Relative to a population of white residents of the same size, Asian residents will experience a larger amount of food retail establishments. The magnitude of this coefficient drops slightly in the 2000's, but increases again in the 2010's.

The income variables from this specification depict the same relationship as in the pooled year regression. Relative to the lowest income category, households with higher median annual incomes have less food retail establishments. All income variables exhibit significant, negative results across the decades. Magnitudes of these coefficients also trend upwards, except for the $10,000-$14,999 level which faced decreasing magnitudes seen when the coefficient gets less negative over time. The income relationship with food retail establishments is, again, reinforced by the poverty count variable. Over the decades, poverty count coefficients are significant and positive. As there are more people in poverty, it might be that smaller stores will open to try to service the entire spectrum of consumer demands at a manageable operational cost to store owners. Residents of higher income will, instead, see a decline in the number of stores present in their area. The quality and variety of the stores, however, could increase which mitigates the need for multiple stores to operate when one is sufficiently servicing demand.

All counties that exhibited unusual establishment patterns in the pooled regression also exhibit the same pattern in the decade specification, apart from Fremont. Fremont county's fixed effect is only weakly significant for the 1990's, then ceases to have any unexpected patterns. Arapahoe, El Paso, Jefferson, and Larimer counties continue to have positive, significant coefficient terms across the decade. All the coefficient terms also increase in magnitude and become more positive. This may be showing that more people are moving into these suburban neighborhoods which increases the total number of households in the area. Consistent with the total household term, more grocery stores will open to meet consumer demands and the additional demand in food retail from those specifically living in suburban areas is captured in the growing individual fixed effect terms. Denver and Pueblo counties continue to have significant, negative coefficients, but the coefficient term for Denver is growing increasingly negative. A possible explanation for this is that as cities are growing, there is a need to consolidate more stores into a single entity. For example, one store location could have multiple businesses and product offerings within it operated by different vendors, but still count as one store. It is true that area of a county is controlled for and does not exhibit any significant effect, so it cannot be proven that the city of Denver is running out of space, thereby having to compact spaces together. The area term, however, does not account for developments that occur upwards as establishments are adding more levels instead of outwards where they take up more square mileage. A possible increase in skyward expansion could explain the decreasing number of stores in Denver as they start to move in and up together. The Pueblo term, however, is becoming more positive and decreasing in magnitude of change. This may be attributed to a growth in the city which is influenced by the state's overall growth. As more people move in, the negative fixed effect of the county is offset by the positive effect of the total household and population density variables.

The decade specification regression also provides the important result that most significant explanatory variables are consistent across time. Even as the macroeconomics of the state changes, characteristics of a county, such as race and income, demonstrate similar effects in magnitude on establishment count over time. There are also no characteristics that turn up to be significant in more recent years that have not been significant in prior decades. This alludes to the idea that while food retail establishment counts change, decision criteria for the establishment owners to invest in a new store do not.

To address the issue of causality previously mentioned, one more regression is run with a 5-year specification to test how well pre-dated demographic data can explain current changes in establishments. Running individual 5-year regressions illustrates how well explanatory variables can predict retail store changes as the time offset between the two sources of data increases within the decade. If one-way causality is to be established, explanatory variables must be consistently significant both halves of a decade. Year fixed effects for this specification can be found in the appendix.

Table 6: 5-Year Increment Regression with Time and County Fixed Effects

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	1990- 1994	1995-1999	2000-2004	2005-2009	2010-2014	2015-2016
Total population	-0.000315	-0.000231	-0.000172	-0.000171	-0.000348*	-0.000111
	(0.000201)	(0.000200)	(0.000200)	(0.000200)	(0.000205)	(0.000202)
Population square	2.23e-10	1.71e-10	1.08e-10	1.08e-10	2.99e-10	7.35e-11
	(2.02e-10)	(2.01e-10)	(2.03e-10)	(2.02e-10)	(2.07e-10)	(2.04e-10)
Total households	0.00398***	0.00394***	0.00389***	0.00389***	0.00403***	0.00387***
	(0.000596)	(0.000592)	(0.000598)	(0.000596)	(0.000596)	(0.000598)
Household square	-2.63e-10	-2.13e-10	-2.15e-10	-2.13e-10	-2.06e-10	-1.75e-10
	(2.02e-10)	(2.01e-10)	(2.03e-10)	(2.02e-10)	(2.02e-10)	(2.02e-10)
Adults over 25	-0.000401	-0.000604*	-0.000683*	-0.000685*	-0.000456	- 0.000836**
	(0.000364)	(0.000362)	(0.000360)	(0.000359)	(0.000366)	(0.000362)
Adult over 25 square	-8.14e-10*	-6.67e-10	-5.04e-10	-5.06e-10	-9.95e-10**	-4.04e-10
	(4.91e-10)	(4.88e-10)	(4.92e-10)	(4.91e-10)	(5.04e-10)	(4.95e-10)
Population density per square mile	0.0247**	0.0251**	0.0237**	0.0237**	0.0284***	0.0241**
	(0.0101)	(0.0101)	(0.0102)	(0.0102)	(0.0102)	(0.0102)

Black	-4.23e-05***	-4.70e-05***	-4.81e-05***	-4.81e-05***	-4.52e-05***	-5.16e-05***
	(1.29e-05)	(1.28e-05)	(1.28e-05)	(1.28e-05)	(1.28e-05)	(1.28e-05)
American Indian	0.000466***	0.000512***	0.000497***	0.000498***	0.000544***	0.000535***
	(0.000128)	(0.000127)	(0.000128)	(0.000128)	(0.000127)	(0.000127)
Hispanic	-7.58e-05*	-6.77e-05	-7.02e-05	-7.00e-05	-6.23e-05	-6.35e-05
	(4.60e-05)	(4.57e-05)	(4.62e-05)	(4.61e-05)	(4.59e-05)	(4.61e-05)
Asian	0.00194***	0.00198***	0.00193***	0.00193***	0.00208***	0.00197***
	(0.000500)	(0.000496)	(0.000502)	(0.000501)	(0.000500)	(0.000502)
Other race	0.000411	0.000372	0.000394	0.000396	0.000316	0.000363
	(0.000522)	(0.000518)	(0.000524)	(0.000523)	(0.000521)	(0.000524)
9-12, no diploma	0.00318***	0.00321***	0.00325***	0.00325***	0.00315***	0.00327***
	(0.000501)	(0.000497)	(0.000503)	(0.000501)	(0.000501)	(0.000503)
HS diploma and equiv.	0.000873*	0.000981**	0.000926*	0.000930*	0.00110**	0.00102**
	(0.000480)	(0.000477)	(0.000483)	(0.000482)	(0.000479)	(0.000481)
Some college	0.000602*	0.000541	0.000564	0.000562	0.000490	0.000512
	(0.000359)	(0.000357)	(0.000361)	(0.000360)	(0.000358)	(0.000360)
Associate degree	-0.00226***	-0.00205***	-0.00214***	-0.00214***	-0.00183**	-0.00196***
	(0.000729)	(0.000723)	(0.000733)	(0.000731)	(0.000725)	(0.000728)
Bachelors	0.00265***	0.00274***	0.00273***	0.00273***	0.00274***	0.00280***
	(0.000480)	(0.000477)	(0.000482)	(0.000481)	(0.000479)	(0.000481)
Graduate/professional	-0.000515	-0.000447	-0.000462	-0.000461	-0.000401	-0.000408
	(0.000435)	(0.000432)	(0.000437)	(0.000436)	(0.000434)	(0.000436)
10-14,999	-0.00695***	-0.00632***	-0.00615***	-0.00614***	-0.00663***	-0.00568***
	(0.00177)	(0.00176)	(0.00177)	(0.00176)	(0.00177)	(0.00177)
15-24,999	-0.00461***	-0.00485***	-0.00486***	-0.00487***	-0.00483***	-0.00505***
	(0.00108)	(0.00107)	(0.00108)	(0.00108)	(0.00108)	(0.00108)
25-49,999	-0.00379***	-0.00373***	-0.00366***	-0.00366***	-0.00386***	-0.00361***
	(0.000543)	(0.000540)	(0.000545)	(0.000544)	(0.000545)	(0.000546)
50k+	-0.00405***	-0.00403***	-0.00398***	-0.00398***	-0.00412***	-0.00397***
	(0.000604)	(0.000600)	(0.000607)	(0.000605)	(0.000605)	(0.000607)
Poverty Count	0.00162***	0.00168***	0.00170***	0.00170***	0.00165***	0.00175***
	(0.000209)	(0.000207)	(0.000209)	(0.000208)	(0.000208)	(0.000209)
Area of County	-0.00360	-0.00356	-0.00353	-0.00354	-0.00351	-0.00352
	(0.00370)	(0.00368)	(0.00372)	(0.00371)	(0.00370)	(0.00372)
county==Alamosa	-17.87	-17.89	-17.94	-17.97	-17.34	-17.99
	(15.16)	(15.07)	(15.23)	(15.19)	(15.15)	(15.23)
county==Arapahoe	27.66***	29.41***	29.25***	29.30***	29.93***	30.67***
	(6.981)	(6.935)	(7.003)	(6.983)	(6.953)	(6.985)
county==Archuleta	-13.21	-13.05	-13.02	-13.04	-12.72	-12.93
	(13.07)	(12.98)	(13.12)	(13.09)	(13.06)	(13.12)
county==Baca	-10.18	-10.06	-10.04	-10.05	-9.850	-9.975
	(8.678)	(8.622)	(8.717)	(8.692)	(8.672)	(8.713)
county==Bent	-14.71	-14.58	-14.53	-14.56	-14.32	-14.47
	(12.37)	(12.29)	(12.43)	(12.39)	(12.36)	(12.42)
county==Boulder	-3.651	-3.754	-3.928	-3.932	-3.195	-4.008

	(7.923)	(7.872)	(7.958)	(7.936)	(7.918)	(7.955)
county==Broomfield					-63.21***	-56.41***
					(15.64)	(15.67)
county==Chaffee	-12.35	-11.98	-11.80	-11.83	-11.93	-11.57
	(13.90)	(13.81)	(13.96)	(13.92)	(13.88)	(13.95)
county==Cheyenne	-13.14	-13.01	-12.97	-12.99	-12.75	-12.91
	(11.65)	(11.58)	(11.71)	(11.67)	(11.64)	(11.70)
county==Clear Creek	-16.94	-16.64	-16.49	-16.52	-16.47	-16.32
	(16.50)	(16.40)	(16.58)	(16.53)	(16.49)	(16.57)
county==Conejos	-15.58	-15.59	-15.59	-15.62	-15.19	-15.64
	(13.27)	(13.18)	(13.33)	(13.29)	(13.26)	(13.32)
county==Costilla	-16.10	-16.01	-15.97	-15.99	-15.68	-15.94
	(13.62)	(13.53)	(13.68)	(13.64)	(13.61)	(13.67)
county==Crowley	-18.64	-18.41	-18.33	-18.35	-18.14	-18.20
	(15.07)	(14.97)	(15.14)	(15.10)	(15.06)	(15.13)
county==Custer	-16.65	-16.42	-16.34	-16.37	-16.13	-16.21
	(15.45)	(15.35)	(15.52)	(15.47)	(15.43)	(15.51)
county==Delta	-14.27	-13.91	-13.74	-13.76	-13.87	-13.50
	(12.77)	(12.68)	(12.82)	(12.78)	(12.75)	(12.82)
county==Denver	-77.52**	-79.14**	-77.60**	-77.62**	-83.36**	-78.83**
	(33.29)	(33.07)	(33.45)	(33.36)	(33.28)	(33.43)
county==Dolores	-15.60	-15.34	-15.29	-15.31	-15.02	-15.14
	(14.35)	(14.26)	(14.42)	(14.37)	(14.34)	(14.41)
county==Douglas	-11.20	-10.23	-10.14	-10.16	-9.935	-9.430
	(14.20)	(14.10)	(14.26)	(14.22)	(14.18)	(14.25)
county==Eagle	-0.808	-0.396	-0.430	-0.448	0.0564	-0.139
	(11.88)	(11.81)	(11.94)	(11.90)	(11.87)	(11.93)
county==El Paso	53.27***	53.15***	52.80***	52.83***	53.69***	52.76***
	(7.542)	(7.493)	(7.576)	(7.554)	(7.538)	(7.572)
county==Elbert	-12.18	-11.83	-11.77	-11.79	-11.63	-11.53
	(11.07)	(10.99)	(11.12)	(11.08)	(11.06)	(11.11)
county==Fremont	-14.68	-13.72	-13.41	-13.42	-14.00	-12.71
	(10.49)	(10.42)	(10.53)	(10.50)	(10.48)	(10.53)
county==Garfield	0.578	0.885	0.860	0.850	1.144	1.086
	(6.383)	(6.341)	(6.411)	(6.393)	(6.377)	(6.408)
county==Gilpin	-19.64	-19.50	-19.47	-19.39	-19.30	-19.37
	(17.43)	(17.32)	(17.51)	(17.46)	(17.42)	(17.50)
county==Grand	-6.736	-6.526	-6.446	-6.467	-6.352	-6.322
	(11.14)	(11.07)	(11.19)	(11.16)	(11.13)	(11.19)
county==Gunnison	-5.235	-5.205	-5.321	-5.331	-4.775	-5.305
	(6.296)	(6.255)	(6.324)	(6.306)	(6.292)	(6.321)
county==Hinsdale	-15.48	-15.34	-15.29	-15.32	-15.01	-15.23
	(14.15)	(14.06)	(14.22)	(14.18)	(14.14)	(14.21)
county==Huerfano	-13.43	-13.21	-13.14	-13.16	-13.00	-13.01
	(12.11)	(12.04)	(12.17)	(12.13)	(12.10)	(12.16)
county==Jackson	-13.28	-13.14	-13.11	-13.13	-12.82	-13.04
	(12.29)	(12.21)	(12.34)	(12.31)	(12.28)	(12.34)
county==Jefferson	29.19***	30.94***	30.71***	30.77***	31.46***	32.15***
	(9.060)	(9.003)	(9.094)	(9.069)	(9.035)	(9.078)
county==Kiowa	-13.54	-13.42	-13.38	-13.40	-13.16	-13.32
	(11.65)	(11.57)	(11.70)	(11.67)	(11.64)	(11.70)
county==Kit Carson	-8.353	-8.210	-8.169	-8.187	-7.993	-8.090

	(10.00)	(9.937)	(10.05)	(10.02)	(9.994)	(10.04)
county==La Plata	-6.317	-5.963	-6.055	-6.072	-5.420	-5.798
	(11.19)	(11.12)	(11.24)	(11.21)	(11.18)	(11.24)
county==Lake	-18.77	-18.59	-18.52	-18.55	-18.24	-18.43
	(16.57)	(16.47)	(16.65)	(16.60)	(16.56)	(16.64)
county==Larimer	7.631**	7.619**	7.086**	7.094**	8.788**	7.123**
	(3.411)	(3.389)	(3.433)	(3.424)	(3.427)	(3.430)
county==Lincoln	-10.51	-10.36	-10.33	-10.35	-10.17	-10.24
	(8.532)	(8.476)	(8.570)	(8.545)	(8.525)	(8.566)
county==Logan	-10.44	-10.26	-10.17	-10.19	-10.12	-10.06
	(10.64)	(10.57)	(10.69)	(10.66)	(10.63)	(10.68)
county==Mesa	0.268	0.877	0.860	0.861	0.998	1.339
	(2.446)	(2.430)	(2.453)	(2.446)	(2.437)	(2.448)
county==Mineral	-16.66	-16.49	-16.42	-16.45	-16.18	-16.34
	(15.04)	(14.95)	(15.11)	(15.07)	(15.03)	(15.10)
county==Moffat	-1.413	-1.344	-1.417	-1.416	-1.170	-1.357
	(1.262)	(1.254)	(1.269)	(1.265)	(1.262)	(1.267)
county==Montezuma	-13.37	-13.14	-13.16	-13.18	-12.79	-13.01
	(9.933)	(9.868)	(9.977)	(9.949)	(9.925)	(9.972)
county==Montrose	-10.48	-10.20	-10.13	-10.15	-10.05	-9.938
	(8.725)	(8.668)	(8.764)	(8.739)	(8.718)	(8.759)
county==Morgan	-9.003	-8.817	-8.811	-8.833	-8.460	-8.702
	(12.52)	(12.44)	(12.58)	(12.54)	(12.51)	(12.57)
county==Otero	-15.39	-15.32	-15.27	-15.29	-15.07	-15.26
	(12.76)	(12.68)	(12.82)	(12.78)	(12.75)	(12.81)
county==Ouray	-14.36	-14.14	-14.05	-14.08	-13.84	-13.93
	(16.19)	(16.09)	(16.26)	(16.22)	(16.18)	(16.26)
county==Park	-10.71	-10.38	-10.25	-10.27	-10.32	-10.03
	(9.800)	(9.736)	(9.843)	(9.815)	(9.792)	(9.839)
county==Phillips	-15.88	-15.70	-15.61	-15.64	-15.42	-15.52
	(15.57)	(15.47)	(15.64)	(15.59)	(15.56)	(15.63)
county==Pitkin	-13.37	-12.91	-12.76	-12.78	-12.77	-12.46
	(14.73)	(14.63)	(14.79)	(14.75)	(14.71)	(14.78)
county==Prowers	-11.62	-11.58	-11.60	-11.62	-11.18	-11.60
	(11.69)	(11.62)	(11.75)	(11.71)	(11.68)	(11.74)
county==Pueblo	-8.399*	-8.317*	-8.325*	-8.334*	-8.215*	-8.267*
	(4.471)	(4.442)	(4.491)	(4.478)	(4.467)	(4.489)
county==Rio Blanco	-5.016	-4.940	-4.955	-4.966	-4.718	-4.913
	(6.265)	(6.224)	(6.293)	(6.275)	(6.260)	(6.290)
county==Rio Grande	-13.36	-13.25	-13.21	-13.24	-12.88	-13.17
	(14.54)	(14.44)	(14.60)	(14.56)	(14.53)	(14.60)
county==Routt	-5.131	-4.861	-4.825	-4.840	-4.641	-4.643
	(9.368)	(9.307)	(9.409)	(9.383)	(9.360)	(9.405)
county==Saguache	-9.356	-9.319	-9.351	-9.362	-9.060	-9.338
	(6.468)	(6.426)	(6.497)	(6.478)	(6.463)	(6.494)
county==San Juan	-18.53	-18.39	-18.22	-18.34	-18.02	-18.15
	(16.86)	(16.75)	(16.93)	(16.88)	(16.84)	(16.92)
county==San Miguel	-11.79	-11.56	-11.49	-11.52	-11.27	-11.35
	(13.55)	(13.46)	(13.61)	(13.57)	(13.54)	(13.60)
county==Sedgwick	-17.83	-17.63	-17.54	-17.57	-17.34	-17.44
	(16.14)	(16.03)	(16.21)	(16.16)	(16.13)	(16.20)
county==Summit	-11.72	-11.40	-11.26	-11.29	-11.22	-11.07

	(15.77)	(15.67)	(15.84)	(15.80)	(15.76)	(15.84)
county==Teller	-14.57	-14.13	-13.93	-13.96	-14.05	-13.65
	(15.60)	(15.50)	(15.67)	(15.62)	(15.59)	(15.66)
county==Washington	-10.69	-10.59	-10.56	-10.58	-10.38	-10.51
	(8.810)	(8.752)	(8.849)	(8.824)	(8.803)	(8.845)
county==Weld	4.751	4.093	3.277	3.283	5.673	2.843
	(3.846)	(3.821)	(3.861)	(3.850)	(3.883)	(3.868)
county==Yuma	-7.967	-7.846	-7.808	-7.825	-7.647	-7.745
	(9.217)	(9.157)	(9.258)	(9.231)	(9.209)	(9.253)
Constant	20.86	20.84	20.97	21.00	20.72	20.70
	(18.30)	(18.18)	(18.38)	(18.33)	(18.29)	(18.37)
R-squared	0.990	0.991	0.990	0.990	0.990	0.990

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

When looking at regressions from both halves of the decade, there are no changes in which explanatory variables and individual fixed effects are significant. These terms also returned similar magnitudes and the same sign across the three decades of regression. The motivation behind running this regression specification is to determine whether the effect of availability of stores attracting people or the converse is stronger. By using the same demographic data for each century and allowing the number of stores to change year after year, this regression measures how the composition of people changes the number of stores that will exist in a county. At the beginning of the decade, there is more concern about an overlap in effects because the displacement of time between the two data sets is relatively small. There is a combination of influence from stores and county demographics. As the decade moves on, if the composition of people changes because of the anticipation of new stores, the regression results are expected to show fewer significant explanatory variables. The county demographics form the beginning of the decade would no longer accurately reflect the county at a time that is far displaced in the future, so the regression specification will not be able to capture the explanatory variable drivers. The regression results, however, violate this expectation and remain consistent throughout all years of data. The resilience of the explanatory variable patterns provide proof that the composition of people in the counties has a more profound impact on the total amount of food retail establishments in the county. This relationship also makes more practical sense. It is unrealistic to assume that residents will be able to anticipate the food retail landscape of a county several years into the future and make plans to relocate based on those assumptions. It is more reasonable to assume that food retail corporations will make strategic choices on where to expand or contract their businesses based on the current market that is available. This specification provides evidence that county characteristics are more reliable predictors of food retail provisions than the converse relationship.

A by-year regression was also run. However, these results proved to be erratic due to the relatively few observations available compared to the wide range of explanatory variables in the regression specification. These results are included in the appendix, but will not be analyzed

Summary and Conclusions

This thesis examines the retail food establishment environment in the state of Colorado from 1990-2016 to determine if the current expectations of a food desert are meaningful. This is achieved by performing regressions on the dependent variable of food retail establishment count with independent explanatory variables that encompass race, educational attainment, and income characteristics of every county.

Upon review, the race expectations of a food desert are consistent with the regression results that were produced. Black and American Indian residents consistently exhibit significant, negative coefficient terms while compared to white residents across the entire time span of the data set. This reinforces claims in the literature that minority groups are more susceptible to being in areas with lower levels of food resources than groups of white residents. It is also found that Asians, although technically a racial minority, do not share the same trends with other minority groups. They are more in line with the trends of white residents which is also consistent with current literature on racial relations in the United States.

Income expectations do not align with what current food desert literature contends. The results from this analysis show that households with higher annual median income face less food retail establishments than lower median income households. This relationship, however, may be due to a difference in the size of stores that can be supported by each income level. Higher income areas may have fewer, but larger and more diversified stores than a larger quantity of lower quality stores in lower income neighborhoods.

A relationship between county infrastructure and count of food retail establishments was also discovered. Suburban areas tend to have an additional positive effect on the number of retail establishments available. This could potentially be attributed to an increase of demand for food access from working families and families with school children. In contrast, counties with metropolis areas returned an additional negative effect on the total count of retail food establishments. This could be attributed to strategic location of a few number of stores. If stores are in a central area in which a large majority of the county can be served at a time, there is no need for additional locations.

The research in this paper was limited in the number of observations available in the dataset. With the inclusion of data from more state counties, a comprehensive year by year regression could have been run to precisely track changes in the effects of explanatory variables. Only using Colorado data provides a limited viewpoint into the food retail establishment industry in the United States as many states may have different relationships between county characteristics and the number of establishments in the area. Another limitation of this study is the lack of information on the types of food retail establishments in each area. Current SIC and NAICS code specifications do not break down grocery stores into distinct categories, for example a local chain store or a national organic produce brand. This limits the ability for regressions to specify what kinds of stores are affected by different county characteristics. This is significant to determine because the additional benefit of a chain supermarket may not be equal to the additional benefit of a farmer's market stand.

Food access research is critical to offset the detrimental health effects leveraged onto residents where nutritious foods are limited. While there is evidence that race and income characteristics of an area contribute to the shaping overall food supply, there is need for further research to determine strict causal relationships to uncover the cause of low food supplies and implement measures to begin resolving the foundational issues.

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Appendix

Appendix 1: Year Fixed Effects for Pooled Year Regression

VARIABLES	(1) Establishment count
year== 1991.0000	0.210
	(0.677)
year== 1992.0000	0.790
	(0.677)
year== 1993.0000	0.113
	(0.677)
year== 1994.0000	0.306
	(0.677)
year== 1995.0000	0.419
	(0.677)
year== 1996.0000	0.903
	(0.677)
year== 1997.0000	1.214*
	(0.674)
year== 1998.0000	-2.457***
	(0.677)
year== 1999.0000	-1.341**
	(0.674)
year== 2000.0000	-2.049***
	(0.703)
year== 2001.0000	-1.335*
	(0.703)
year== 2002.0000	-2.089***
	(0.705)
year== 2003.0000	-2.015***
	(0.708)
year== 2004.0000	-2.439***
	(0.705)
year== 2005.0000	-1.633**
	(0.705)
year== 2006.0000	-1.149
	(0.705)
year== 2007.0000	-1.327*
	(0.708)
year== 2008.0000	-3.138***
	(0.705)
year== 2009.0000	-2.622***
	(0.705)
year== 2010.0000	-2.900***
	(0.722)

year== 2011.0000	-2.964***
	(0.722)
year== 2012.0000	-2.609***
	(0.718)
year== 2013.0000	-1.328*
	(0.718)
year== 2014.0000	-0.921
	(0.718)
year== 2015.0000	-0.812
	(0.718)
year== 2016.0000	-0.656
	(0.718)
R-squared	0.991

Appendix 2: Year Fixed Effects for Decade Regression

VARIABLES	(1) 1990-1999	(2) 2000-2009	(3) 2010-2016
year== 1990.0000	1.902***		
	(0.538)		
year== 1991.0000	2.112***		
	(0.538)		
year== 1992.0000	2.692***		
	(0.538)		
year== 1993.0000	2.015***		
	(0.538)		
year== 1994.0000	2.208***		
	(0.538)		
year== 1995.0000	2.321***		
	(0.538)		
year== 1996.0000	2.805***		
	(0.538)		
year== 1997.0000	3.117***		
	(0.533)		
year== 1998.0000	-0.550		
	(0.537)		
year== 1999.0000	0.562		
	(0.533)		
year== 2000.0000		-1.193**	
		(0.521)	
year== 2001.0000		-0.479	
		(0.521)	
year== 2002.0000		-1.229**	
		(0.525)	
year== 2003.0000		-1.161**	
		(0.529)	
year== 2004.0000		-1.592***	

		(0.525)	
year== 2005.0000		-0.786	
		(0.525)	
year== 2006.0000		-0.302	
		(0.525)	
year== 2007.0000		-0.473	
		(0.529)	
year== 2008.0000		-2.278***	
		(0.525)	
year== 2009.0000		-1.761***	
		(0.525)	
year== 2010.0000			-1.507***
			(0.537)
year== 2011.0000			-1.570***
			(0.537)
year== 2012.0000			-1.225**
			(0.532)
year== 2013.0000			0.0562
			(0.532)
year== 2014.0000			0.462
			(0.532)
year== 2015.0000			0.572
			(0.532)
year== 2016.0000			0.728
			(0.532)
R-squared	0.991	0.990	0.990

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix 3: Year Fixed Effects for Five Year Regression

VARIABLES	(1) 1990-1994	(2) 1995-1999	(3) 2000-2004	(4) 2005-2009	(5) 2010-2014	(6) 2015-2016
year== 1990.0000	0.999*					
	(0.519)					
year== 1991.0000	1.209**					
	(0.519)					
year== 1992.0000	1.789***					
	(0.519)					
year== 1993.0000	1.112**					
	(0.519)					
year== 1994.0000	1.306**					
	(0.519)					
year== 1995.0000		1.132**				
		(0.515)				
year== 1996.0000		1.616***				

		(0.515)				
year== 1997.0000		1.939***				
		(0.512)				
year== 1998.0000		-1.733***				
		(0.516)				
year== 1999.0000		-0.616				
		(0.512)				
year== 2000.0000			-0.733			
			(0.511)			
year== 2001.0000			-0.0183			
			(0.511)			
year== 2002.0000			-0.765			
			(0.515)			
year== 2003.0000			-0.695			
			(0.519)			
year== 2004.0000			-1.131**			
			(0.515)			
year== 2005.0000				-0.318		
				(0.514)		
year== 2006.0000				0.166		
				(0.514)		
year== 2007.0000				-0.00114		
				(0.518)		
year== 2008.0000				-1.810***		
				(0.514)		
year== 2009.0000				-1.293**		
				(0.514)		
year== 2010.0000					-1.699***	
					(0.523)	
year== 2011.0000					-1.762***	
					(0.523)	
year== 2012.0000					-1.416***	
					(0.519)	
year== 2013.0000					-0.135	
					(0.519)	
year== 2014.0000					0.271	
					(0.519)	
year== 2015.0000						0.955*
						(0.511)
year== 2016.0000						1.111**
						(0.511)
R-squared	0.990	0.991	0.990	0.990	0.990	0.990

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix 4: Year Specific Regressions

VARIABLES	(1) 1990emp	(2) 1991	(3) 1992	(4) 1993	(5) 1994	(6) 1995	(7) 1996	(8) 1997	(9) 1998	(10) 1999
Total population	0.0744	0.0502	0.0119	0.0349	0.0449	0.0749**	0.0422	-0.0539	0.644*	-0.237*
	(0.125)	(0.0712)	(0.0298)	(0.0531)	(0.0440)	(0.0340)	(0.0391)	(0.0565)	(0.174)	(0.0856)
Population square	-4.38e-07	-2.34e-07	-1.28e-07**	1.38e-08	-1.90e-07**	-1.91e-07***	-3.90e-08	1.04e-07	-1.93e-06*	2.57e-07
	(3.77e-07)	(1.58e-07)	(4.82e-08)	(1.58e-07)	(6.24e-08)	(5.98e-08)	(7.45e-08)	(9.95e-08)	(5.32e-07)	(2.10e-07)
Total households	-0.642	-0.180	-0.0669	0.232	-0.253	0.136	0.248	-0.516	3.661*	-3.209*
	(0.824)	(0.431)	(0.278)	(0.721)	(0.423)	(0.349)	(0.376)	(0.489)	(1.127)	(1.282)
Household square	2.14e-06	1.03e-06	3.18e-08	6.00e-07	-5.52e-08	3.16e-08	-4.89e-07	2.51e-08	-2.69e-06	2.63e-06
	(2.72e-06)	(1.12e-06)	(1.30e-07)	(4.74e-07)	(2.01e-07)	(1.80e-07)	(7.00e-07)	(2.55e-07)	(9.69e-07)	(1.86e-06)
Adults over 25	-0.362	-0.166	-0.0853	-0.183	-0.227*	-0.157	-0.111	-0.0277	-0.864*	0.368
	(0.440)	(0.231)	(0.0853)	(0.154)	(0.110)	(0.105)	(0.114)	(0.173)	(0.286)	(0.226)
Adult over 25 square	6.43e-07	3.39e-07	2.74e-07**	-1.42e-07	4.38e-07**	4.14e-07**	1.61e-07	-2.85e-07	4.77e-06*	-1.09e-06
	(5.85e-07)	(2.70e-07)	(1.16e-07)	(4.23e-07)	(1.59e-07)	(1.46e-07)	(1.62e-07)	(1.99e-07)	(1.31e-06)	(6.18e-07)
Black	-0.108	-0.0357	-0.0625***	-0.00966	-0.0486	-0.0825**	-0.0612	-0.00947	-0.624*	0.121
	(0.131)	(0.0630)	(0.0202)	(0.0740)	(0.0321)	(0.0284)	(0.0530)	(0.0291)	(0.177)	(0.118)
American Indian	-1.128	-0.527	0.0108	0.177	0.209**	0.102	0.283	-0.0216	-1.297*	-0.797
	(1.371)	(0.598)	(0.0490)	(0.137)	(0.0716)	(0.0620)	(0.377)	(0.170)	(0.368)	(0.736)
Hispanic	0.0957	0.0361	0.00623	0.0622	0.0695**	0.0432*	0.0172	0.0425	-0.159	0.172
	(0.0735)	(0.0332)	(0.0173)	(0.0514)	(0.0262)	(0.0213)	(0.0241)	(0.0263)	(0.0591)	(0.0862)
Asian	0.749	0.253	0.352***	-0.173	0.161	0.323***	0.177	-0.0623	4.102*	-0.492
	(0.833)	(0.337)	(0.0752)	(0.407)	(0.126)	(0.102)	(0.164)	(0.110)	(1.128)	(0.611)
Other race	-2.017	2.391	-0.00793	1.876	2.462	0.259	-0.356	2.379	-17.41*	13.48*

	(5.232)	(2.450)	(1.258)	(1.998)	(1.972)	(1.356)	(1.375)	(2.127)	(5.244)	(5.029)
9-12, no diploma	0.561	0.229	0.0625	0.390	0.373**	0.188	0.110	0.223	-0.427	-0.161
	(0.655)	(0.345)	(0.123)	(0.311)	(0.146)	(0.155)	(0.181)	(0.274)	(0.420)	(0.481)
HS diploma and equiv.	0.245	0.0955	0.0670	0.0437	0.107	0.0163	0.0426	0.122	0.156	0.163
	(0.245)	(0.127)	(0.0428)	(0.0770)	(0.0622)	(0.0523)	(0.0757)	(0.0889)	(0.219)	(0.106)
Some college	0.358	0.165	0.0863	0.139	0.0828	0.0851	0.0166	0.0375	0.791	-0.138
	(0.311)	(0.151)	(0.0640)	(0.175)	(0.107)	(0.0951)	(0.0956)	(0.140)	(0.282)	(0.176)
Associate degree	0.811	0.395	0.223*	0.438	0.448**	0.198	-0.0219	0.127	-2.424*	0.657
	(0.592)	(0.288)	(0.117)	(0.326)	(0.146)	(0.136)	(0.189)	(0.198)	(0.690)	(0.838)
Bachelors	0.409	0.161	0.135	0.239	0.275**	0.173*	0.263**	0.325*	0.399	0.0704
	(0.405)	(0.193)	(0.0772)	(0.141)	(0.100)	(0.0905)	(0.0984)	(0.163)	(0.316)	(0.156)
Graduate/professional	0.624	0.297	0.0277	0.471	0.376***	0.134	-0.0728	0.0472	-1.061*	0.528
	(0.530)	(0.274)	(0.0733)	(0.265)	(0.0914)	(0.0916)	(0.155)	(0.169)	(0.315)	(0.572)
10-14,999	1.604	0.402	0.134	0.311	0.685	0.116	-0.253	0.609	-5.924*	5.091*
	(1.420)	(0.589)	(0.425)	(1.191)	(0.650)	(0.524)	(0.578)	(0.711)	(1.775)	(2.032)
15-24,999	0.414	0.0629	0.0669	-0.360	0.461	0.0155	-0.0347	0.615	-2.873	3.104*
	(1.017)	(0.509)	(0.345)	(0.992)	(0.539)	(0.451)	(0.505)	(0.601)	(1.082)	(1.244)
25-49,999	0.620	0.157	0.142	-0.149	0.281	-0.144	-0.187	0.613	-3.993*	3.279*
	(0.860)	(0.452)	(0.291)	(0.718)	(0.436)	(0.358)	(0.372)	(0.516)	(1.223)	(1.244)
50k+	-0.113	-0.129	-0.0611	-0.561	0.0348	-0.356	-0.368	0.407	-4.164*	2.746*
	(1.050)	(0.549)	(0.311)	(0.765)	(0.466)	(0.386)	(0.405)	(0.547)	(1.261)	(1.120)
				-						-
Poverty Count	-0.183	-0.0971	0.00149	0.272**	-0.193*	-0.227***	-0.125*	-0.0122	-0.391	0.00980
	(0.264)	(0.142)	(0.0654)	(0.104)	(0.0934)	(0.0709)	(0.0699)	(0.0986)	(0.211)	(0.128)
		-						-		
Area of County	-0.0310	0.00668	-0.00160	-0.0129	-0.00923	-0.00470	0.00557	0.00109	-0.117	0.00602
	(0.0395)	(0.0208)	(0.0149)	(0.0330)	(0.0177)	(0.0159)	(0.0158)	(0.0198)	(0.0768)	(0.0312)
Constant	-5.108	24.06	-3.899	61.12	43.63	18.85	-10.75	20.96	46.22	-156.4*
	(98.33)	(39.47)	(22.23)	(66.64)	(33.80)	(30.21)	(29.01)	(50.90)	(88.96)	(61.10)
R-squared	1.000	1.000	1.000	0.999	1.000	0.999	1.000	0.999	1.000	1.000

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

VARIABLES	(1) 2000emp	(2) 2001	(3) 2002	(4) 2003	(5) 2004	(6) 2005	(7) 2006	(8) 2007	(9) 2008	(10) 2009
Total population	0.0757	0.0581	0.0168	0.0392*	-0.249	-0.114	-1.000	-0.0297	0.0493	0.0398
	(0.0426)	(0.0245)	(0.0264)	(0.00374)	(0.424)	(0.0818)	(0)	(0.0356)	(0.0520)	(0.0338)
Population square	-2.12e-07	8.40e-08	-2.07e-08	-1.38e-07**	2.47e-07	1.72e-07	1.41e-06	1.40e-07*	-3.21e-08	5.72e-08
	(1.05e-07)	(6.89e-08)	(4.44e-08)	(7.64e-09)	(5.47e-07)	(1.42e-07)	(0)	(5.97e-08)	(9.64e-08)	(5.79e-08)
Total households	-0.785	1.577	-0.582	-0.702	0.712	1.310	2.161	-0.646**	1.052*	0.643
	(1.539)	(0.758)	(0.266)	(0.125)	(1.103)	(0.905)	(0)	(0.228)	(0.544)	(0.332)
Household square	-3.60e-07	-1.20e-06*	-1.19e-07	-2.49e-07*	-4.03e-07	-1.70e-07	7.85e-07	1.13e-07	-4.15e-08	-1.05e-07
	(9.29e-07)	(3.53e-07)	(7.75e-08)	(3.16e-08)	(8.68e-07)	(1.73e-07)	(0)	(9.27e-08)	(5.30e-08)	(5.03e-08)
Adults over 25	-0.176	-0.171	-0.616	-0.00396	0.617	0.361*	2.382	0.111	-0.0215	-0.0653
	(0.106)	(0.0873)	(0.283)	(0.0162)	(0.706)	(0.117)	(0)	(0.125)	(0.201)	(0.139)
Adult over 25 square	4.95e-07*	-3.86e-08	1.27e-08	2.85e-07**	-5.62e-07	-3.72e-07	-3.23e-06	-3.47e-07**	4.53e-08	-1.29e-07
	(1.57e-07)	(1.17e-07)	(1.00e-07)	(1.44e-08)	(1.22e-06)	(3.03e-07)	(0)	(1.37e-07)	(2.16e-07)	(1.28e-07)
Black	-0.0374	-0.0223	0.159**	-0.00108	0.0191	0.0236	0.568	0.291***	0.124**	0.152***
	(0.0451)	(0.0267)	(0.0328)	(0.00404)	(0.203)	(0.0785)	(0)	(0.0488)	(0.0521)	(0.0296)
American Indian	-0.0627	0.813	-0.721	-1.154*	-0.0856	-0.0207	-0.00573	0.134**	0.245**	0.142*
	(0.665)	(0.293)	(0.313)	(0.122)	(0.262)	(0.0695)	(0)	(0.0495)	(0.0846)	(0.0529)
Hispanic	0.0230	0.00748	0.101**	0.0230	0.124	0.0347	-0.0958	-0.0208	-0.0269	-0.0240
	(0.0294)	(0.0135)	(0.0298)	(0.00393)	(0.234)	(0.0425)	(0)	(0.0165)	(0.0214)	(0.0173)
Asian	0.123	-0.122	-0.204	0.253**	0.233	0.177	2.039	0.444**	0.0330	-0.212
	(0.191)	(0.110)	(0.145)	(0.0172)	(0.200)	(0.107)	(0)	(0.122)	(0.159)	(0.107)
Other race	0.432	-0.153	-0.328	0.273	-0.736	-0.635	-7.237	-1.687***	-1.020*	-0.858**
	(0.374)	(0.219)	(0.183)	(0.0501)	(2.265)	(0.767)	(0)	(0.355)	(0.515)	(0.302)
9-12, no diploma	0.129	0.299	0.757	-0.227*	-1.090	-0.589	-3.448	-0.586**	0.169	0.0887

	(0.227)	(0.147)	(0.373)	(0.0236)	(1.247)	(0.231)	(0)	(0.212)	(0.280)	(0.235)
HS diploma and equiv.	0.104	-0.0131	0.665*	0.0921*	-0.150	-0.161	-0.370	0.186*	-0.159	0.0929
	(0.0635)	(0.0367)	(0.262)	(0.0143)	(0.109)	(0.0981)	(0)	(0.0826)	(0.140)	(0.0870)
Some college	-0.0145	0.0350	0.700*	-0.0367	0.293	0.208	0.625	-0.0946	-0.131	-0.280
	(0.149)	(0.0966)	(0.251)	(0.0167)	(0.933)	(0.334)	(0)	(0.111)	(0.161)	(0.207)
Associate degree	-0.0449	0.0175	0.389	-0.159*	-1.171	-0.979	-2.712	-0.218*	0.582	0.513*
	(0.122)	(0.0746)	(0.271)	(0.0242)	(1.482)	(0.375)	(0)	(0.0893)	(0.376)	(0.225)
Bachelors	0.167	0.241*	0.522	-0.0863*	-0.462	-0.283*	-1.730	0.0663	-0.0511	0.186*
	(0.0908)	(0.0655)	(0.267)	(0.00862)	(0.505)	(0.0880)	(0)	(0.0686)	(0.146)	(0.0835)
Graduate/professional	0.0388	0.0432	0.810*	0.0126	0.138	0.0152	-0.177	-0.114	0.107	-0.0202
	(0.160)	(0.0767)	(0.256)	(0.0222)	(0.543)	(0.199)	(0)	(0.109)	(0.160)	(0.172)
10-14,999	0.849	-1.297	-0.185	2.041*	-4.471	-3.408	-6.275	1.047	-3.417**	-1.914*
	(1.492)	(0.825)	(0.609)	(0.196)	(6.710)	(2.306)	(0)	(0.555)	(1.372)	(0.887)
15-24,999	0.942	-1.070	2.034**	0.0694	0.277	-0.801	-3.342	0.856*	-0.694	-0.388
	(1.632)	(0.879)	(0.634)	(0.148)	(1.862)	(0.674)	(0)	(0.407)	(0.983)	(0.561)
25-49,999	0.875	-1.560	0.150	0.767*	-0.330	-1.153	-1.008	0.725**	-0.981*	-0.677*
	(1.605)	(0.779)	(0.183)	(0.120)	(0.898)	(0.878)	(0)	(0.212)	(0.423)	(0.273)
50k+	0.797	-1.479	0.696*	0.747	-0.827	-1.403	-2.640	0.571*	-1.081*	-0.617
	(1.386)	(0.703)	(0.294)	(0.124)	(1.182)	(0.933)	(0)	(0.239)	(0.567)	(0.342)
Poverty Count	-0.0529	-0.361*	-0.114*	-0.0543	-0.133	-0.0781	0.862	0.109*	-0.000356	0.0213
	(0.143)	(0.0870)	(0.0474)	(0.00977)	(0.256)	(0.0716)	(0)	(0.0540)	(0.0714)	(0.0547)
Area of County	0.0188	0.0237	0.0987**	0.0160*	0.0319	0.0174	0.0337	-0.0278	-0.102	-0.0537
	(0.0309)	(0.0256)	(0.0218)	(0.00182)	(0.0510)	(0.0241)	(0)	(0.0221)	(0.0597)	(0.0436)
Constant	-28.75	-95.47	-153.1**	-9.395	-227.9	-130.9	-761.8	-52.33	173.0	82.41
	(57.58)	(35.43)	(45.52)	(3.711)	(378.0)	(108.8)	(0)	(50.93)	(111.2)	(68.49)
R-squared	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.998	1.000

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

VARIABLES	(1) 2010emp	(2) 2011	(3) 2012	(4) 2013	(5) 2014	(6) 2015	(7) 2016
Total population	0.112	0.0157	-0.00304	0.0293	-0.0144	0.00720	0.00579
	(0.100)	(0.0841)	(0.0204)	(0.0332)	(0.0156)	(0.0161)	(0.0180)
Population square	-4.86e-08	1.10e-07	3.50e-08*	-5.33e-08	-2.73e-08	2.76e-08**	8.36e-09
	(4.42e-08)	(2.11e-07)	(1.73e-08)	(3.82e-08)	(1.80e-08)	(1.21e-08)	(1.35e-08)
Total households	0.453	0.284	0.0344	-0.0675	-0.122	0.0411	-0.0407
	(0.641)	(0.751)	(0.194)	(0.398)	(0.183)	(0.184)	(0.206)
Household square	-1.46e-07	2.41e-07	2.33e-07**	4.11e-08	1.17e-07	8.75e-08	1.10e-07
	(2.63e-07)	(2.91e-07)	(8.07e-08)	(1.62e-07)	(7.61e-08)	(6.24e-08)	(6.92e-08)
Adults over 25	-0.262	-0.0847	0.0938	0.0128	0.188**	0.105	0.0890
	(0.470)	(0.517)	(0.0799)	(0.132)	(0.0621)	(0.0672)	(0.0749)
Adult over 25 square	1.14e-07	-2.62e-07	-9.58e-08**	1.25e-07	4.78e-08	-6.58e-08**	-3.13e-08
	(1.10e-07)	(4.25e-07)	(4.03e-08)	(8.64e-08)	(4.16e-08)	(2.37e-08)	(2.65e-08)
Black	0.0250	0.0204	-0.0207**	0.00181	-0.000375	-0.0155***	-0.0215***
	(0.0199)	(0.0276)	(0.00603)	(0.0175)	(0.00877)	(0.00410)	(0.00464)
American Indian	0.160	-0.0164	-0.0604*	-0.130**	-0.115***	-0.0483	-0.0710**
	(0.129)	(0.124)	(0.0307)	(0.0553)	(0.0262)	(0.0289)	(0.0324)
Hispanic	-0.0659	0.00795	0.00321	-0.0847	0.0137	0.0359	0.00511
	(0.142)	(0.121)	(0.0377)	(0.0570)	(0.0263)	(0.0278)	(0.0310)
Asian	0.178	0.537*	-0.131**	0.216	0.265*	0.170***	0.0763
	(0.181)	(0.240)	(0.0515)	(0.248)	(0.120)	(0.0421)	(0.0471)
Other race	-0.878	-1.284	0.294	0.263	0.115	-0.367*	0.0584
	(0.688)	(1.947)	(0.212)	(0.448)	(0.221)	(0.195)	(0.218)

9-12, no diploma	0.201	-0.518	-0.328*	-0.311	-0.685***	-0.677***	-0.535***
	(0.885)	(0.852)	(0.160)	(0.275)	(0.131)	(0.127)	(0.141)
HS diploma and equiv.	0.118	0.276	0.000477	-0.0577	-0.147*	0.0197	0.0249
	(0.460)	(0.671)	(0.0760)	(0.151)	(0.0695)	(0.0738)	(0.0823)
Some college	0.184	0.0855	-0.0913	0.0583	-0.109**	-0.0738	-0.0970*
	(0.250)	(0.424)	(0.0633)	(0.0902)	(0.0420)	(0.0432)	(0.0486)
Associate degree	-0.185	-0.341	-0.131	-0.388**	-0.270***	-0.174***	-0.138**
	(0.333)	(0.328)	(0.0841)	(0.145)	(0.0701)	(0.0587)	(0.0653)
Bachelors	0.0757	0.141	-0.0278	0.0747	-0.0623	-0.0180	0.00897
	(0.368)	(0.474)	(0.0663)	(0.107)	(0.0511)	(0.0462)	(0.0516)
Graduate/professional	0.264	0.00464	0.00925	-0.172	-0.299**	-0.0879	-0.0684
	(0.523)	(0.648)	(0.0935)	(0.203)	(0.0941)	(0.0894)	(0.1000)
10-14,999	1.917	0.726	-0.0853	0.766	-0.180	-0.392	-0.749**
	(1.527)	(1.625)	(0.486)	(0.785)	(0.364)	(0.263)	(0.293)
15-24,999	-0.689	-0.120	0.00985	0.387	0.158	0.0566	0.124
	(0.893)	(0.773)	(0.261)	(0.494)	(0.229)	(0.241)	(0.270)
25-49,999	-0.508	-0.381	0.0411	0.213	0.306	0.108	0.262
	(0.662)	(1.035)	(0.207)	(0.403)	(0.191)	(0.196)	(0.221)
50k+	-0.543	-0.419	-0.0720	-0.0452	0.0491	-0.120	-0.0182
	(0.666)	(0.777)	(0.198)	(0.401)	(0.184)	(0.192)	(0.215)
Poverty Count	-0.132	0.0675	-0.0272	-0.00759	0.0783*	0.0153	0.0169
	(0.160)	(0.176)	(0.0384)	(0.0775)	(0.0356)	(0.0293)	(0.0328)
Area of County	0.0694	0.0730	0.0241	0.0891***	0.0289*	0.0224*	0.0172
	(0.106)	(0.0693)	(0.0196)	(0.0269)	(0.0125)	(0.0126)	(0.0139)
Constant	-32.29	-68.84	-34.21	-198.4**	-107.4**	-90.72***	-80.54**
	(159.3)	(133.1)	(41.58)	(66.84)	(31.84)	(31.41)	(33.48)
R-squared	0.999	0.998	1.000	0.999	1.000	1.000	0.999

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1