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Economic Research Report Number 140

August 2012

Characteristics and Influential Factors of Food Deserts

Paula Dutko

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Characteristics and Influential Factors of Food Deserts

Paula Dutko

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Abstract

USDA's Economic Research Service previously identified more than 6,500 food desert tracts in the United States based on 2000 Census and 2006 data on locations of supermarkets, supercenters, and large grocery stores. In this report, we examine the socioeconomic and demographic characteristics of these tracts to see how they differ from other census tracts and the extent to which these differences influence food desert status. Relative to all other census tracts, food desert tracts tend to have smaller populations, higher rates of abandoned or vacant homes, and residents who have lower levels of education, lower incomes, and higher unemployment. Census tracts with higher poverty rates are more likely to be food deserts than otherwise similar low-income census tracts in rural and in very dense (highly populated) urban areas. For less dense urban areas, census tracts with higher concentrations of minority populations are more likely to be food deserts, while tracts with substantial decreases in minority populations between 1990 and 2000 were less likely to be identified as food deserts in 2000.

Keywords: food deserts, food access, low income, census tracts

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Summary

What Is the Issue?

USDA's Economic Research Service previously identified approximately 6,500 food desert tracts in the United States based on 2000 Census and 2006 data on locations of supermarkets, supercenters, and large grocery stores. These food deserts are areas where people have limited access to a variety of healthy and affordable food. As policymakers consider interventions to increase food access, it is important to understand the characteristics associated with these areas, such as income, vehicle availability, and access to public transportation. In this report, we examine the socioeconomic and demographic characteristics of these census tracts and also examine which of these characteristics distinguish food desert tracts from other low-income census tracts.

What Did the Study Find?

- Areas with higher levels of poverty are more likely to be food deserts, but for other factors, such as vehicle availability and use of public transportation, the association with food desert status varies across very dense urban areas, less dense urban areas, and rural areas.
- Areas with higher poverty rates are more likely to be food deserts regardless of rural or urban designation. This result is especially true in very dense urban areas where other population characteristics such as racial composition and unemployment rates are not predictors of food desert status because they tend to be similar across tracts.
- In all but very dense urban areas, the higher the percentage of minority population, the more likely the area is to be a food desert.
- Residents in the Northeast are less likely to live far from a store than their counterparts in other regions of the country with similar income levels.
- Rural areas experiencing population growth are less likely to be food deserts.

How Was the Study Conducted?

To provide a consistent, national-level estimate of the number of low-income areas in which a substantial number or share of residents is far from a supermarket or large grocery store, USDA's Economic Research Service applied a census tract-level definition of food deserts—areas with limited access to affordable and healthy food—to the contiguous United States using 2000 Census data. The 2000 Census data and 2006 store location data that were used for this analysis were the most recent demographic and store data available at the time this analysis was conducted.

This study uses data from the 1990 and 2000 Census, as well as 5-year average data from the 2005-2009 American Community Survey (ACS), to describe changes in characteristics of the 6,529 food desert census tracts over time, relative to changes in all other tracts. We focus particularly on population density, poverty rates, unemployment, education, race/ethnicity, income, and vehicle ownership status.

We first provide a statistical description of tracts classified as food deserts versus all other tracts to give a broad image of how food desert tracts differ. We then conduct regression analysis to determine which characteristics are most strongly associated with whether a low-income census tract is also a food desert. We model the probability that a census tract will be a food desert using a multivariate logit model to assess the impact of factors such as population and housing characteristics; racial and ethnic composition; unemployment; poverty; and changes in these characteristics from 1990 to 2000. Separate analyses are performed for urban areas and rural areas in order to accommodate different definitions of food deserts and systematic differences in tract characteristics between rural and urban areas. We also further distinguish very dense urban areas from less dense urban areas for the multivariate analysis.

Introduction

In the 2008 Food, Conservation and Energy Act (2008 Farm Act), Congress directed the U.S. Department of Agriculture (USDA) to assess the extent of areas in the United States where people have limited access to a variety of healthy and affordable food. Commonly referred to as "food deserts," these regions of the country often feature large proportions of households with low incomes, inadequate access to transportation, and a limited number of food retailers providing fresh produce and healthy groceries for affordable prices. In response to this directive, USDA published *Access to Affordable and Nutritious Food: Measuring and Understanding Food Deserts and Their Consequences* (USDA, 2009). The report measured the extent of limited food access in the United States, highlighted potential sources and consequences of the problem, and suggested general policy solutions. The report found, among other conclusions, that 23.5 million people live in low-income areas that are further than 1 mile from a large grocery store or supermarket, and that 11.5 million of these people have low incomes themselves.

Building on these findings, we examine what systematic socioeconomic and demographic differences exist between food deserts and other low-income areas.

Increased attention to national health issues, such as the rising incidence of obesity and the growing prevalence of diabetes and other weight-related diseases, especially in children, has made the concept of healthy food access increasingly important in the realm of public policy. New Orleans, New York City, and Pennsylvania have implemented or are developing programs to improve access in underserved areas. One national effort, First Lady Michelle Obama's *Let's Move!* campaign, considers access to healthy food one of five pillars in the effort to address childhood obesity. A plan, the Healthy Food Financing Initiative (HFFI), has been proposed in Congress to bring affordable, nutritious food to areas of low access and low income.

A working group comprised of staff from the U.S. Departments of the Treasury, of Health and Human Services, and of Agriculture is coordinating and sharing information about strategies to expand the availability of nutritious food in underserved areas. In cooperation with that working group, researchers from USDA's Economic Research Service (ERS) developed a census tract-level definition of food deserts in order to start identifying areas of the Nation that may be in need of improved food access. Census tracts are identified as food deserts if they meet both low-income and low-food-access criteria. Using the specific definitions of both low income and low access (as detailed in the subsequent discussion), 6,529 census tracts were identified as food deserts across the Continental United States and mapped through an online mapping tool.[1] These tracts were identified as food deserts based on 2000 Census data and 2006 data on locations of supermarkets, supercenters, and large grocery stores, which reflected the most recent demographic and store data available at the time of the analysis.

The relevance of food deserts to discussions of public health and food access policy nationwide makes critical the task of isolating potential causes of low-access areas. As a first step toward understanding this relationship, we explore over time the demographic characteristics of the 6,529 tracts identified as food deserts. Using data from the 1990 and 2000 decennial censuses, as well as

[1]See the Food Desert Locator: http://www.ers.usda.gov/data-products/food-desert-locator.aspx/.

from the 2005-2009 American Community Survey (ACS), we compare the economic and demographic traits of census tracts identified as food deserts with traits of all other tracts, as well as how these statistics may have changed between survey years. We first use descriptive statistics to provide a broad picture of how food desert tracts differ from all other census tracts, examining demographic, economic and employment, population density, and commuting patterns of census tracts. Next, we explore more specifically the characteristics associated with combined low income and low access, using multiple regression analysis to examine which of these characteristics are important in explaining whether a low-income tract is a food desert.

Our analysis has several practical motivations. First, we want to better understand this national measure of food deserts and how the designation of some low-income tracts as food deserts breaks down along population and economic characteristics. Second, by contrasting the population characteristics in areas of low access with those of other low-income areas, we can detect any systematic differences in the composition of food deserts. Identifying economic and demographic characteristics that are closely associated with low access to supermarkets and grocery stores will help policymakers better understand those neighborhoods with food access limitations, how they have changed over time, and potential barriers other than limited access to healthy food faced by residents of these areas. This is useful for providing surveillance for areas that may be at risk of becoming food deserts and can aid policymakers in formulating policies suited to the specific needs of these communities. Finally, results from this analysis can help policymakers and public health officials develop hypotheses to study further the mechanisms by which food deserts arise, thus allowing policymaking to address root problems rather than mere symptoms.

We next review the literature on both how community food access has been measured and the characteristics of areas with limited access. Then we describe how the census tract-based measures of food deserts were derived and implemented. This is followed by a presentation of the methods used in the analysis and, finally, by the results and conclusions.

Literature

Areas with limited access to healthy, affordable food often lack access to other services as well, such as banks, health care, transportation infrastructure, and parks or recreational areas. In addition to having poor access, residents of impoverished or deprived areas frequently face higher prices for food and other necessities. Poor education and limited health care services in conjunction with high prices for fresh produce and other healthy food may result in poor diet and adverse health outcomes for residents of these areas. Access to affordable and nutritious food may also be important for the effectiveness of government benefit programs: an analysis using data from an electronic benefits transfer (EBT) demonstration in Dayton, OH, concluded that improved access to large grocery stores can increase the welfare of Supplemental Nutrition Assistance Program (SNAP) recipients by an estimated value of $2.78 to $7.76 per month (Feather, 2003). SNAP is the name of the former Food Stamp Program. These issues have motivated researchers to attempt to characterize low-access areas and to determine what demographic and economic factors influence low access.

Past studies have typically considered the correlation between demographic and socioeconomic characteristics such as race, ethnicity, income, education, deprivation, and roadway connectivity, among other features of an area, with the level of food store access. Most of these studies have been conducted in localized areas such as neighborhoods or cities, but recently two noteworthy studies have been conducted at a national level (Powell et al., 2006; USDA, 2009). The localized and national studies varied in their measures of food store access, including distance to a supermarket, number of grocery stores or fast food restaurants per capita in a geographical area, vehicle ownership, and the ratio of stores that carry healthy food options to stores that only carry less healthy food options.

Perhaps because of the wide variety of measures used and places examined, study results have not reached a consensus on the characteristics of areas that lack access to healthy food. Studies have produced conflicting results as to the correlation among race, income, and access to healthy and affordable food. Many researchers have concluded that neighborhoods consisting primarily of minorities—in particular, African Americans—with low incomes have fewer supermarkets than wealthier, predominantly White neighborhoods (Berg and Murdoch, 2008; Powell et al., 2006; Block et al., 2008; Larson et al., 2009). Others, however, have found either no correlation, or that minority and low-income neighborhoods have a greater number of grocery stores and are closer to these stores than wealthier areas (Alwitt and Donley, 1997; Moore and Diez Roux, 2006; Opfer, 2010; and Sharkey and Horel, 2008). These mixed results may not be surprising because these studies are of localized areas. However, results from the two national-level studies are also inconclusive. Powell et al. (2006) found that ZIP Codes with more minorities and lower income populations had fewer chain supermarkets but more nonchain supermarkets. USDA (2009) found that, on average, low-income and minority populations were closer to supermarkets than higher income individuals and non-Hispanic Whites. Multivariate analysis techniques, however, showed that measures of income inequality and racial segregation were important predictors of low access in urban core areas; the

most important factor in rural areas was lack of transportation infrastructure (USDA, 2009).

The lack of consistent findings in this literature leads us to examine further the relationship between neighborhood characteristics and food access. Our analysis builds upon previous studies and, in particular, components of USDA (2009) but is unique, however, in other ways. First, the census tract-based definition of a food desert is based on the methods and data used in the 2009 USDA report but has been adapted to fit policy needs and to be consistent with multiple Federal agencies' programs. Unlike previous studies, our analysis uses multiple years of census data to understand how changes in the population are correlated with food deserts. By using data from the 1990 and 2000 Census and from the 2005-2009 American Community Survey, we will be able to assess how factors such as changes in an area's overall population or changes in the ethnic and racial composition of an area are correlated with food access. This information could help predict which areas may be at risk of becoming food deserts and which areas may see improvements in food access.

Method for Defining and Measuring Food Deserts

The 2009 USDA report measures the distance to the nearest healthy-food retailer, using the locations of supermarkets and large grocery stores as a proxy, by referencing 1-square-kilometer grids for geographical analysis. These grids come from the Socioeconomic Data and Applications Center (SEDAC) and are based on information from the 2000 Census of Population (SEDAC, 2006). These population data (including socioeconomic and demographic data), which are released at the block group level, are first allocated to blocks and then allocated aerially down to roughly 1-square-kilometer grids across the Continental United States. For each grid cell, the distance from its geographic center to the nearest supermarket or large grocery store is used to measure access for people who live in that grid. Grids that are farther than a specified distance from the nearest supermarket or large grocery store are considered areas of low access, and low-access areas with a large percentage of low-income population are noted in particular. Use of the grid-level data provides two important benefits for the analysis: first, the data provide greater accuracy in estimating where people and households are located than data on larger geographic areas, such as census tracts; thus, they provide better precision in measuring distance to stores. Second, the process of allocating census data to 1-square-kilometer grid cells transforms the irregular shapes and sizes of census geographies or other geographies, such as ZIP Codes, into regular grid cells.

While the 1-square-kilometer grid-based measures increase the precision in measuring where people are and how far they are from sources of healthy food and provide consistency in defining geographic areas across the country, the SEDAC grids are not widely used geographic units. Currently, no standardized nomenclature exists to identify a specific grid (as counties, ZIP Codes, or census tracts can be identified), and they cannot easily be linked to other geocoded data. For this reason, the area-based definition of a food desert uses the census tract as the geographic unit of analysis because it is more commonly used and has a standardized numbering system.

Census tracts are subdivisions of a county, containing between 1,000 and 8,000 people and ideally encompassing a population of about 4,000. In order to establish a consistent definition for national comparison, we define food deserts as low-income tracts in which a substantial number or proportion of the population has low access to supermarkets or large grocery stores. Low-income tracts are characterized by either a poverty rate equal to or greater than 20 percent, or a median family income that is 80 percent or less of the metropolitan area's median family income (for tracts in metropolitan areas) or the statewide median family income (for tracts in nonmetropolitan areas). This definition of low-income tracts is used to designate tracts that are eligible for the U.S. Department of the Treasury's New Markets Tax Credit (NMTC) program.[2] Low access is characterized by at least 500 people and/or 33 percent of the tract population residing more than 1 mile from a supermarket or large grocery in urban areas, and more than 10 miles in rural areas.[3]

[2]For additional information on the NMTC, see: http://www.cdfifund.gov/what_we_do/programs_id.asp?programID=5/.

[3]The 1-square-kilometer grids are still used to calculate the number of people who are more than 1 or 10 miles from a supermarket, which are then aggregated to the census tract level.

Information on supermarket and large grocery store locations comes from a directory of supermarkets and large grocery stores, defined as food stores with at least $2 million in sales that contain all the major food departments found in a traditional supermarket. The directory was developed from a list of stores authorized to receive Supplemental Nutrition Assistance Program (SNAP) benefits and was augmented by data from Trade Dimensions' TDLinx (a Nielsen company), a proprietary source of individual supermarket store listings. Both sets of data were provided for the year 2006.

Using this definition, we identified 6,529 census tracts that met the definition of "food desert" based on data from the 2000 Census of the Population, the most recent detailed demographic data available at the time of the analysis. Table 1 provides a breakdown of the number and percentage of all tracts that are food deserts over all census tracts, for tracts that are designated as NMTC low-income tracts, and separately for rural and urban areas. Our descriptive analysis compares the demographic characteristics of those 6,529 tracts relative to the characteristics of all census tracts that are not considered food deserts by rural and urban status. We also compare changes in these characteristics over time to explore how demographic shifts might be associated with food desert areas. Our multivariate analysis only considers census tracts that are designated as low-income tracts.

Table 1
Number and percentage of food desert tracts by rural and urban status and by low-income status

	Overall	Rural	Urban
Food desert tracts	6,529	2,204	4,175
Number of low-income tracts	24,927	6,519	17,940
Total number of tracts	64,999	13,827	50,784
		Percent	
Food desert tracts as percentage of low-income tracts	26.2	33.8	23.3
Food desert tracts as percentage of total tracts	10.0	15.9	8.2

Note: Totals for rural and urban sets exclude tracts with greater than 50 percent of the population living in group quarters, which eliminates 710 tracts—116 rural and 594 urban.
Low-income census tracts are those with: a poverty rate > 20 percent; median family income < 80 percent of statewide median family income (tracts outside metro areas) or median family income < 80 percent of the greater of statewide median family income (tracts outside metro areas) or the median family income of the metropolitan area.

Source: Authors' calculations using Census 1990 data and Census 2000 data from National Change Database as well as U.S. Department of Commerce, U.S. Census Bureau, American Community Survey 2005-09 data.

Key Terms

Food desert

A census tract that meets both low-income and low-access criteria including:

1. poverty rate is greater than or equal to 20 percent OR median family income does not exceed 80 percent statewide (rural/urban) or metro-area (urban) median family income;
2. at least 500 people or 33 percent of the population located more than 1 mile (urban) or 10 miles (rural) from the nearest supermarket or large grocery store.

Low-income area

A tract in which the poverty rate is greater than or equal to 20 percent; or in which median family income does not exceed 80 percent of the statewide or metro-area median family income

Low-income household

A household with income less than the Federal poverty level: $17,050 for a family of four in 2000.

Rural area

Includes areas defined by Rural-Urban Commuting Area codes as large rural, small rural, and isolated rural areas.

Descriptive Analyses

Tract-level data from the 1990 and 2000 Census of the Population as well as from the 2005-2009 American Community Survey are used for population characteristics. Food desert status is determined based on year 2000 population data and store location data as of 2006. At the time of this report, food desert status has only been identified for this one year and thus is constant from one survey year to the next; thus the group of food desert tracts and the group of non-food desert tracts consist of the same tracts in each survey year. Our analysis compares statistics for the tracts identified as food deserts based on the 2000 Census data and 2006 store locations with statistics for other tracts. We also calculate differences in characteristics of food deserts from 1990 to 2000, 2000 to 2005/2009, and over the entire period and compare these to changes in the same statistics for all other tracts. We use 5-year average data from the 2005-09 ACS to provide a recent picture of the demographics of food desert tracts.[4] We conduct and present these analyses separately for rural and urban tracts, as demographics tend to differ significantly between rural and urban areas. Rural Urban Commuting Area (RUCA) codes designate each tract as urban or rural.[5] RUCA codes use census tracts to identify urban cores and adjacent areas that are integrated with these urban cores. Ten primary codes and 33 secondary codes are assigned based on the designation of areas as metropolitan or micropolitan, and high-commuting or low-commuting. We use a 4-category classification that allocates the 33 RUCA secondary codes into urban, large rural, small rural, or isolated areas.[6] We then combine large rural, small rural and isolated areas to create a single, broad rural category.

Group quarters typically have institutional cafeterias and retail food facilities that are not counted in our list of supermarkets and large grocery stores. Some tracts that are dominated by university, prison, or military populations may appear to be food deserts, but because their populations are likely to be unique, we eliminate all tracts in which more than 50 percent of the total population resides in group quarters. This results in the exclusion of 105 rural and 557 urban tracts in 1990, 116 rural and 594 urban tracts in 2000, and 139 rural and 600 urban tracts in 2005/09.

For the purpose of comparing the same tracts over time, we convert data for 1990 census tracts to their corresponding Census 2000 tracts[7] using a set of correspondence codes provided by Census.[8] Tracts used in the 2005-09 ACS are generally the same tracts as identified in the 2000 Census and require little altering. A small number of tracts listed in the 2005-09 ACS data using their 2010 tract identification required reconciliation with their 2000 definitions.[9] We also convert all variables expressed in dollars to year 2000 dollar-equivalents using the Consumer Price Index for All Urban Consumers (CPI-U) provided by the Bureau of Labor Statistics.[10]

To compare food desert tracts with non-food desert tracts in each individual year, we conduct t-tests grouping variables by food desert status. For inter-year comparison, we aggregate each variable to its average value by food desert status and by survey year and perform t-tests comparing average values for food desert tracts with average values for other tracts for each survey. Differences in values between 1990 and 2000, between 2000 and

[4]The ACS replaces the long-form Census after 2000 and provides much of the same data as the Decennial Census long form. We use the 5-year data as they are the only increments for which tract-level data are available for most variables.

[5]For more information, see: http://www.ers.usda.gov/data-products/rural-urban-commuting-area-codes.aspx/.

[6]For more information, see: http://depts.washington.edu/uwruca/ruca-maps.php./

[7]Census tracts are delineated by local census statistical area committees and may be be revised or redefined due to physical changes to the area, such as major roadways dividing a tract, or population growth or decline.

[8]A detailed description of the methods used to convert tracts across years is available upon request.

[9]Tracts included in the ACS data using their 2010 tract numbers are listed with their corresponding 2000 tract number on the Census website, available at: http://www.census.gov/acs/www/Downloads/geography/areas_published/BlockGroupsTable.pdf/.

[10]For more information, see: ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt/.

2005/2009, and over the entire 1990-2005/2009 period are obtained as the difference calculated by each t-test. Changes reported are thus slightly different than those calculated by directly comparing variable means computed individually by year, as the Stata t-test command we used drops unmatched observations for each variable. Because tract boundaries change from one data year to another as the population changes, data from the year 2000 reflect more tracts than from 1990; and data from the 2005-09 ACS reflect more total tracts than in 2000. When Stata conducts t-tests for a particular statistic between 2 years, the observation for a tract will be omitted if it is not reported in both years.

Results: Comparing Food Desert Tracts With All Other Tracts

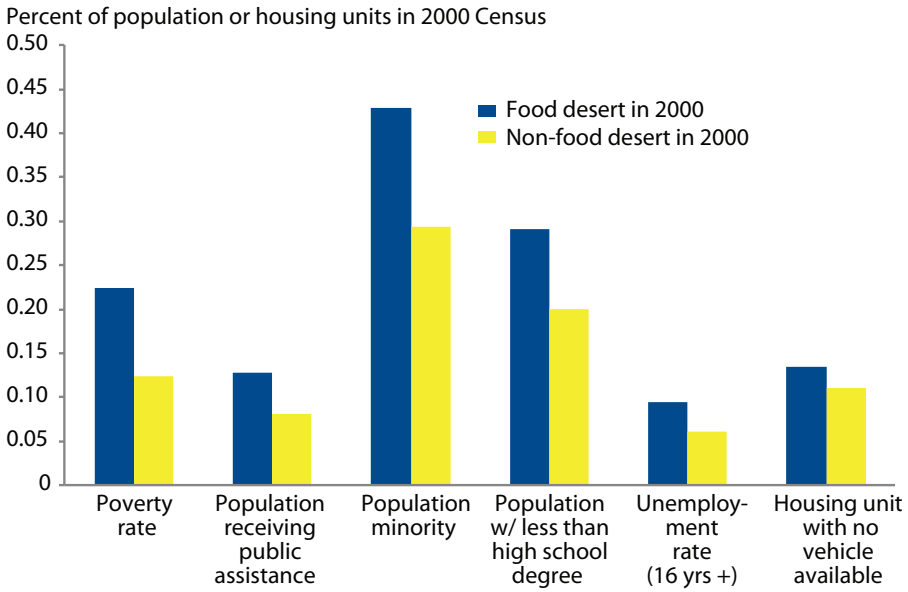
Our analysis compares economic and demographic characteristics of food desert tracts and non-food desert tracts separately for rural and urban areas to control for the differences between these two populations. For the most part, our results suggest that differences between food desert tracts and other tracts are consistent regardless of rural or urban designation. In general, food desert tracts tend to have smaller populations, and abandoned or vacant homes are more prevalent in these tracts than in their counterparts. Residents of food desert tracts also tend to have lower levels of education, to earn lower incomes, and to be unemployed. Some of these disadvantages are highlighted in figure 1, which illustrates mean characteristics for food deserts and all other tracts based on Census 2000 data. Such socioeconomic differences between food deserts and other areas suggest that demographics may play a role in determining food access.

Demographic Characteristics

In all 3 survey years of our analysis, census tracts categorized as food deserts have slightly smaller total populations: from 9 to 14 percent fewer people in rural food deserts than in other rural tracts (table 2) and 7 to 13 percent fewer people in urban food deserts than other urban tracts (table 3).

In both rural and urban areas, food desert tracts also have different ethnic and racial compositions than all other tracts. Non-Hispanic Whites comprise about 12 percentage points more of the population in non-food desert rural tracts relative to those that are food deserts. Food desert tracts have a greater concentration of all minorities, including Hispanics. In urban food deserts,

Figure 1
Mean characteristics of food deserts versus other tracts, Census 2000



Source: USDA, Economic Research Service calculations based on data from U.S. Census 2000.

Table 2

Characteristics of rural tracts by food desert status: 1990 Census, 2000 Census, and 2005-09 American Community Survey

	1990			2000			2005-09		
Variable	Food desert	Non-food desert	Percent difference	Food desert	Non-food desert	Percent difference	Food desert	Non-food desert	Percent difference
Demographic									
Total population	3,538.66 (1,878.267)	3,890.52 (1,828.165)	-0.09	3,608.12 (1,858.598)	4,020.54 (1,810.424)	-0.10	3,556.99 (1,984.479)	4,143.12 (2,102.12)	-0.14
Population density	0.59 (1.229)	0.59 (3.211)	0.00	0.56 (1.091)	0.48 (1.078)	0.15	N/A N/A	N/A N/A	N/A
				Percent of population					
Non-Hispanic White	0.77 (0.278)	0.87 (0.19)	-0.12	0.74 (0.29)	0.84 (0.213)	-0.13	0.77 (0.264)	0.87 (0.167)	-0.11
Non-Hispanic Black/African-American	0.11 (0.206)	0.07 (0.147)	0.54	0.11 (0.211)	0.07 (0.15)	0.55	0.11 (0.211)	0.07 (0.15)	0.53
Hispanic	0.06 (0.16)	0.04 (0.107)	0.70	0.08 (0.173)	0.05 (0.122)	0.53	0.09 (0.18)	0.07 (0.134)	0.38
Minority	0.23 (0.278)	0.13 (0.19)	0.81	0.26 (0.29)	0.16 (0.213)	0.66	0.29 (0.291)	0.17 (0.202)	0.64
Age > 25 w/ education less than high-school diploma	0.36 (0.122)	0.31 (0.12)	0.16	0.28 (0.112)	0.23 (0.104)	0.20	0.21 (0.107)	0.18 (0.095)	0.19
Age > 25 w/ bachelor's degree or higher	0.10 (0.0619)	0.13 (0.0778)	-0.20	0.12 (0.0683)	0.15 (0.0886)	-0.22	0.14 (0.081)	0.17 (0.098)	-0.20
Economic									
Median family income (dollars)	30,085.83 (6,971.205)	36,688.39 (9,265.964)	-0.18	33,281.30 (6,688.86)	40,698.43 (10,407.65)	-0.18	35,860.64 (8,931.062)	42,550.44 (11,301.7)	-0.16
				Percent					
Population w/ income < poverty	0.24 (0.118)	0.16 (0.093)	0.46	0.21 (0.108)	0.14 (0.08)	0.50	0.20 (0.108)	0.15 (0.083)	0.34
Households receiving public assistance	0.12 (0.078)	0.08 (0.0533)	0.42	0.12 (0.074)	0.09 (0.054)	0.39	0.03 (0.0436)	0.02 (0.024)	0.38
Vacant housing units	0.19 (0.139)	0.14 (0.132)	0.28	0.18 (0.128)	0.14 (0.12)	0.30	0.22 (0.137)	0.17 (0.125)	0.31
Population age 16+ in civilian labor force and unemployed	0.09 (0.0579)	0.07 (0.0401)	0.32	0.08 (0.0571)	0.06 (0.0383)	0.37	0.05 (0.037)	0.04 (0.025)	0.13
Transportation & Mobility									
Occupied housing units w/o vehicle access	0.11 (0.075)	0.09 (0.063)	0.24	0.09 (0.0642)	0.08 (0.0538)	0.25	0.06 (0.0514)	0.05 (0.0479)	0.15
Population age 16+ commuting < 25 minutes to work	0.74 (0.134)	0.74 (0.124)	-0.01	0.67 (0.147)	0.70 (0.132)	-0.03	0.65 (0.163)	0.68 (0.143)	-0.03
Population age 16+ commuting > 45 minutes to work	0.10 (0.0691)	0.10 (0.0629)	0.06	0.14 (0.085)	0.13 (0.072)	0.11	0.15 (0.096)	0.13 (0.081)	0.10

continued—

Table 2

Characteristics of rural tracts by food desert status: 1990 Census, 2000 Census, and 2005-09 American Community Survey—continued

	1990			2000			2005-09		
Variable	Food desert	Non-food desert	Percent difference	Food desert	Non-food desert	Percent difference	Food desert	Non-food desert	Percent difference
Population commuting to work by private vehicle	0.85 (0.098)	0.89 (0.073)	-0.04	0.88 (0.084)	0.91 (0.059)	-0.03	0.88 (0.088)	0.90 (0.069)	-0.03
Population commuting to work by public transport	0.01 (0.0122)	0.01 (0.0174)	0.22	0.01 (0.0115)	0.01 (0.0103)	0.19	0.01 (0.0199)	0.01 (0.0161)	0.05
Population commuting to work by foot/bike/other	0.08 (0.0575)	0.06 (0.0504)	0.31	0.06 (0.0502)	0.04 (0.0431)	0.35	0.11 (0.086)	0.09 (0.066)	0.29
Number of tracts	**2,211**	**11,476**		**2,204**	**11,472**		**2,202**	**11,451**	

N/A = A variable was not available for that data year. Standard errors are in parentheses.

Source: U.S. Department of Commerce, U.S. Census Bureau, Census of the Population, 1990 and 2000; and 2005-09 American Community Survey; authors' calculations of percentage differences.

this difference was nearly 70 percent in 1990, approximately 60 percent in 2000, and 53 percent in 2005-2009. The proportion of minorities in rural food desert tracts is around 65 percent greater than non-food desert tracts in the most recent two surveys, down from an 80-percent difference in 1990. The gap between rural food deserts and non-food deserts is of similar size for African Americans and Hispanics; the gap in the proportion of the population that is Hispanic appears to be diminishing more noticeably over the period. The percent of the population that is non-Hispanic Black is over twice as large in urban food deserts than in other urban areas.

Residents of food desert tracts have lower levels of education than their counterparts in non-food desert tracts. In rural food desert tracts, the proportion of the population with at least a bachelor's degree is 20 percent lower than in other rural areas; the difference is 47 percent for urban food deserts versus other urban tracts.

Economic Characteristics

Economic disparities between food desert tracts and other tracts is prevalent and noted in differences in median family income, unemployment rates, poverty rates, and the proportion of households receiving public assistance.

Median family income is around 18 percent lower in rural food deserts than in non-food desert rural tracts.[11] Data from the 2000 Census show a difference of less than 50 percent in the share of the population with income below the Federal poverty line from rural food deserts to all other rural tracts. Accordingly, a higher percentage of households receives some form of public assistance in rural tracts identified as food deserts than in other rural tracts. These trends persist throughout the three surveys. The gap between median family income in food deserts and non-food deserts is even larger in urban tracts than in rural areas. Likewise, poverty is more prevalent in tracts designated as food deserts, and a larger proportion of these households receive

[11]This difference appears smaller, at 15.7 percent, in the ACS data. ACS income and poverty data are not directly comparable to income and poverty data provided by the Census, however. While the Census measures income-related variables using the calendar year, ACS data are calculated based on the last 12 months. ACS data is adjusted for the month for which the data are provided. A study conducted by the Census Bureau found only few statistically significant differences between State-by-State poverty rates from the ACS compared with poverty rates from the Census data, and the statistically significant differences were not necessarily economically significant. As our discussion highlights differences between geographic areas, we discuss ACS income-related data along with Census data.

Table 3

Characteristics of urban tracts by food desert status: 1990 Census, 2000 Census, and 2005-09 American Community Survey

Variable	1990			2000			2005-09		
	Food desert	Non-food desert	Percent difference	Food desert	Non-food desert	Percent difference	Food desert	Non-food desert	Percent difference
Demographic									
Total population	4,679.15 (3,154.111)	5,082.05 (3,459.29)	-0.08	4,111.47 (2,161.978)	4,447.19 (2,186.521)	-0.08	4,204.80 (2,605.649)	4,834.18 (2,986.424)	-0.13
Population density	4.19 (6)	7.73 (15.163)	-0.46	3.51 (3.261)	6.87 (13.786)	-0.49	N/A N/A	N/A N/A	N/A
					Percent of population				
Non-Hispanic White	0.57 (0.329)	0.75 (0.293)	-0.23	0.48 (0.322)	0.68 (0.309)	-0.29	0.56 (0.299)	0.72 (0.265)	-0.22
Non-Hispanic Black/African American	0.29 (0.326)	0.12 (0.233)	1.37	0.32 (0.111)	0.14 (0.164)	1.27	0.31 (0.323)	0.14 (0.236)	1.19
Hispanic	0.11 (0.201)	0.09 (0.17)	0.21	0.16 (0.232)	0.13 (0.198)	0.28	0.20 (0.249)	0.15 (0.212)	0.28
Minority	0.43 (0.329)	0.25 (0.293)	0.69	0.52 (0.322)	0.32 (0.309)	0.60	0.56 (0.313)	0.36 (0.308)	0.53
Age > 25 w/ education less than high-school diploma	0.35 (0.146)	0.23 (0.151)	0.49	0.30 (0.133)	0.19 (0.143)	0.57	0.24 (0.124)	0.15 (0.125)	0.60
Age > 25 w/ bachelor's degree or higher	0.12 (0.102)	0.22 (0.156)	-0.47	0.13 (0.106)	0.26 (0.179)	-0.51	0.15 (0.116)	0.30 (0.189)	-0.49
Economic									
Median family income (dollars)	33,770.05 (11,418.21)	52,655.01 (22,236.19)	-0.36	33,709.76 (9,849.384)	56,105.42 (25,167.3)	-0.40	34,250.95 (12,809.35)	58,328.22 (27,833.14)	-0.41
					Percent				
Population w/ income < poverty	0.23 (0.147)	0.12 (0.121)	0.94	0.23 (0.124)	0.12 (0.114)	0.91	0.25 (0.136)	0.13 (0.114)	0.89
Households receiving public assistance	0.13 (0.096)	0.07 (0.0855)	0.72	0.13 (0.085)	0.08 (0.083)	0.67	0.04 (0.043)	0.03 (0.0365)	0.66
Vacant housing units	0.11 (0.079)	0.08 (0.0726)	0.42	0.10 (0.077)	0.07 (0.0673)	0.52	0.15 (0.095)	0.10 (0.0842)	0.53
Population age 16+ in civilian labor force and unemployed	0.10 (0.064)	0.06 (0.0531)	0.58	0.09 (0.06)	0.06 (0.0539)	0.57	0.07 (0.043)	0.05 (0.0323)	0.45
Transportation & Mobility									
Occupied housing units w/o vehicle access	0.17 (0.137)	0.12 (0.161)	0.38	0.16 (0.118)	0.12 (0.151)	0.33	0.11 (0.0879)	0.09 (0.1257)	0.24
Population age 16+ commuting < 25 minutes to work	0.69 (0.138)	0.62 (0.16)	0.12	0.65 (0.145)	0.59 (0.162)	0.11	0.65 (0.157)	0.57 (0.171)	0.13
Population age 16+ commuting > 45 minutes to work	0.10 (0.074)	0.13 (0.1056)	-0.27	0.13 (0.0855)	0.16 (0.1118)	-0.21	0.12 (0.0941)	0.16 (0.118)	-0.23

continued—

Table 3

Characteristics of urban tracts by food desert status: 1990 Census, 2000 Census, and 2005-09 American Community Survey —continued

	1990			2000			2005-09		
Variable	Food desert	Non-food desert	Percent difference	Food desert	Non-food desert	Percent difference	Food desert	Non-food desert	Percent difference
Population commuting to work by private vehicle	0.87 (0.111)	0.85 (0.164)	0.02	0.88 (0.099)	0.85 (0.162)	0.03	0.87 (0.111)	0.84 (0.171)	0.03
Population commuting to work by public transport	0.05 (0.0779)	0.07 (0.1354)	-0.27	0.05 (0.0709)	0.07 (0.1323)	-0.30	0.05 (0.0747)	0.07 (0.138)	-0.33
Population commuting to work by foot/bike/other	0.06 (0.067)	0.05 (0.0607)	0.25	0.05 (0.058)	0.04 (0.0578)	0.22	0.08 (0.077)	0.08 (0.0715)	-0.05
Number of tracts	**4,197**	**46,331**		**4,175**	**46,316**		**4,166**	**46,320**	

N/A = A variable was not available for that data year. Standard errors are in parentheses.

Source: U.S. Department of Commerce, U.S. Census Bureau, Census of the Population, 1990 and 2000; and 2005-09 American Community Survey; authors' calculations of percentage differences.

public assistance income. This gap between urban food deserts and other urban tracts appears to narrow slightly over the time period. All 3 survey years show persistently higher incidences of poverty in the population of food deserts, ranging from 94 percent higher in 1990 to 89 percent higher in the most recent survey.

Unemployment rates also differ markedly between food desert tracts and other tracts. Unemployment among rural food desert residents is anywhere from 13 to 37 percent higher than in non-food desert tracts. The gap between unemployment rates in food deserts and in other tracts is even larger for urban areas than for rural: unemployment was about 60 percent higher in food deserts than other urban tracts in 2000. Also, the proportion of housing units that are vacant is higher in rural food desert tracts than in other rural areas. In conjunction with lower population numbers, this may reflect a general movement of population out of these tracts, leaving behind smaller populations and abandoned neighborhoods.

Transportation and Mobility Characteristics

Access to a private vehicle plays a large role in determining the ease of obtaining sufficient, healthy, and affordable food. Vehicle ownership rates are typically higher in rural areas than in urban areas as a result of the greater dispersion of residences, retailers, schools, and places of work in rural areas. Comparisons between food desert tracts and other areas suggest that the disadvantaged status of food deserts is also reflected in lower vehicle access rates. Data from the two decennial censuses suggest that 25 percent more of all occupied housing units report having no access to a vehicle in rural food deserts than in most rural tracts. The difference in vehicle access between rural food deserts and other rural tracts is smaller in the ACS data, at about 15 percent. For urban food deserts, the percentage of households without access to vehicles is anywhere from 24 to 38 percent higher than in other urban areas.

Time spent commuting between home and work, as well as the mode of transportation used for this commute, may also reveal the distance residents must travel from home to supermarket. A bigger share of the working population in rural food deserts has longer commutes (spends 45 minutes or more traveling to work) than in other rural tracts—around 10 percent greater in the most recent two surveys. Differences in work commute times between residents of rural food deserts and other rural areas could also reflect differences in modes of transportation used by workers. Private vehicles are used by a greater proportion of the working population in non-food desert rural tracts, while public transportation use is slightly higher in rural food desert tracts. Alternative methods of commuting (by foot, bicycle, or other) are substantially higher for residents of rural food desert tracts. Transportation patterns are reversed in urban areas: workers living in food deserts, despite lower access to private vehicles, report commuting to work by private vehicle in slightly greater proportion—a difference of 3 percent—than those in other urban areas. Meanwhile, residents of non-food desert tracts use public transportation in greater proportions than their food desert counterparts. This could be explained by a greater number of workers in food desert tracts using alternative forms of transportation, such as walking or biking, instead of private vehicles or mass public transit. Further, it could partly be responsible for the difference in commute times to work between food desert residents and other urban populations. A higher proportion of workers in urban food deserts has a short commute to work (less than 25 minutes) compared with workers in other urban tracts. The proportion of residents in urban food desert tracts with a commute to work shorter than 25 minutes is approximately 12 percent higher than in non-food desert urban tracts.

Changes in Food Desert Tract Characteristics Over Time

The food desert tracts appear economically and socially disadvantaged relative to other tracts, and these differences seem to be relatively stable over time. Food desert tracts and other tracts change in many of the same ways throughout the period of study (table 4 for rural and table 5 for urban). Many of these changes reflect general trends in national socioeconomic composition, such as rising urban poverty as a result of multiple recessions since the year 2000. Interestingly, food desert tracts in both rural and urban areas show fewer statistically significant changes over the 30-year period than other tracts, and rural food desert tracts show fewer statistically significant changes than urban food desert tracts. This may reflect a relative stagnation in the characteristics of food desert tracts despite substantial changes in the economic climate, or it may simply be a manifestation of the smaller sample size of food desert tracts. Characteristics that did not change significantly across survey periods may be important in determining why certain tracts become food deserts and indicate tracts experiencing persistent deprivation.

Demographic Changes

Over the period surveyed, urban food desert areas experienced population loss of 10 percent, while other urban areas experienced a loss of 4.8. Rural areas, however, experienced small growth in population overall—less than 1 percent in food deserts and 6.8 percent in non-food deserts. Population loss is likely to discourage the entry of stores in an area and may contribute to the absence of stores. Population gain may indicate that a new store could be supported but that there is a lag in the development of such stores. Our regression analysis will explore this further.

Observing changes in racial and ethnic composition may help explain how the populations of each area have shifted. The percent of the population reporting race as non-Hispanic White decreased in all urban tracts over the period, reflecting larger U.S. trends as minorities gained in number relative to the total population. Interestingly, the relative increase in minority population was larger in both rural and urban non-food desert tracts than in food desert tracts. However, in rural food deserts, the non-Hispanic White population increased very slightly.

Over the course of the 20-year period studied, educational attainment appears to have increased, with a growing percentage of the population age 25 and older having obtained at least a bachelor's degree. This proportion increased from 11.8 percent to 15 percent of the urban food desert population over the period, and from 22.4 percent to 29.6 percent of the non-food desert urban population. In rural food desert tracts and non-food desert tracts, the proportion of the population with at least a college degree grew from 10.2 to 14 percent and from 12.7 to 17.4 percent, respectively, between 1990 and 2005/2009. Concomitantly, the proportion of the same population having completed less than a full high school education has dropped.

Table 4

Changes in characteristics of rural tracts by food desert status, 1990 to 2005-09

	Food desert						Non-food desert					
	1990-2000		2000-09		1990-2009		1990-2000		2000-09		1990-2009	
Variable	Level change	Percent change	Level change	Percent change	Level change	Percent change	Level change	Percent change	Level change	Percent change	Level change	Percent change
Demographic												
Total population	64.12	1.8	-44.76	-1.2	20.64	0.6	143.01	3.7	118.49	2.9	262.86	6.8
Population density	-0.04	-6.4	N/A	N/A	N/A	N/A	-0.10	-17.2	N/A	N/A	N/A	N/A
						Percent of population						
Non-Hispanic White	-0.03	-4.2	0.04	4.8	0.00	0.4	-0.03	-3.4	0.02	2.1	-0.01	-0.9
Non-Hispanic Black/ African American	0.01	6.3	0.00	-1.5	0.00	4.3	0.00	5.9	0.00	-1.1	0.00	5.5
Hispanic	0.02	28.5	0.01	14.1	0.03	47.1	0.02	43.9	0.01	24.6	0.03	82.0
Minority	0.03	14.0	0.02	8.4	0.05	23.4	0.03	22.8	0.02	16.2	0.05	39.9
Age ≥ 25 w/ education less than high-school diploma	-0.08	-23.2	-0.06	-22.1	-0.14	-40.2	-0.08	-25.4	-0.05	-22.0	-0.13	-41.8
Age ≥ 25 w/ bachelor's degree or higher	0.02	18.2	0.02	15.7	0.04	36.9	0.03	21.4	0.02	13.1	0.05	37.4
Economic												
Median family income (dollars)	3,209.36	10.7	2,540.86	7.6	5,739.83	19.1	4,074.95	11.1	1,417.03	3.4	5,742.10	15.6
						Percent						
Individuals w/ income < poverty	-0.03	-12.6	0.00	-1.9	-0.03	-14.3	-0.02	-14.7	0.01	9.4	-0.01	-6.6
Households receiving public assistance	0.00	-0.9	-0.09	-71.7	-0.09	-72.0	0.00	1.9	-0.06	-71.9	-0.06	-71.2
Vacant housing units	0.00	-1.4	0.03	18.6	0.03	16.7	0.00	-2.7	0.02	17.6	0.02	14.6
Population age 16+ in civilian labor force and unemployed	-0.01	-11.7	-0.03	-40.5	-0.04	-47.4	-0.01	-15.0	-0.02	-28.5	-0.03	-38.8
Transportation & Mobility												
Occupied housing units w/o vehicle access	-0.01	-12.5	-0.03	-34.1	-0.05	-42.4	-0.01	-12.6	-0.02	-27.6	-0.03	-37.2

continued—

Table 4

Changes in characteristics of rural tracts by food desert status, 1990 to 2005-09—continued

	Food desert						Non-food desert					
	1990-2000		2000-09		1990-2009		1990-2000		2000-09		1990-2009	
Variable	Level change	Percent change	Level change	Percent change	Level change	Percent change	Level change	Percent change	Level change	Percent change	Level change	Percent change
Population age 16+ commuting < 25 minutes to work	-0.06	-8.3	-0.02	-3.1	-0.08	-11.1	-0.05	-6.4	-0.02	-2.8	-0.07	-9.0
Population age 16+ commuting ≥ 45 minutes to work	0.04	36.9	0.01	3.7	0.04	41.6	0.03	31.1	0.00	3.6	0.03	35.9
Population commuting to work by private vehicle	0.03	3.6	0.00	-0.2	0.03	3.3	0.02	2.4	-0.01	-0.6	0.02	1.8
Population commuting to work by public transport	0.00	-10.1	0.00	-14.3	0.00	-17.8	0.00	-3.5	0.00	3.0	0.00	-1.4
Population commuting to work by foot/bike/ other	-0.02	-24.4	0.06	95.8	0.04	48.5	-0.02	-26.5	0.05	103.7	0.03	50.9

N/A = A variable was not available for that data year. Standard errors are in parentheses.

Source: U.S. Department of Commerce, U.S. Census Bureau, Census of the Population, 1990 and 2000; and 2005-09 American Community Survey; authors' calculations of percentage differences.

Economic Changes

In rural food deserts, the proportion of the population that is poor fell from 24 percent to 20 percent; in urban food deserts, it grew by 2 percentage points, from 23 percent to 25 percent.[12] At the same time, the percent of households receiving public assistance also decreased over the period for all tracts, rural and urban. The universality of the latter trend may reflect lower cash assistance caseloads and stricter standards enacted during welfare reform in the 1990s. Combined with rising urban poverty rates, lower public assistance may compound food access issues in cities and other urban areas during this period.

Patterns in unemployment rates between 1990 and 2009 do not directly reflect the general economic downturn. For all areas—food desert and non-food desert, rural and urban—the unemployment rate has actually dropped over the period. In rural food deserts, the apparent decrease in unemployment is the largest, having fallen 47.4 percent from 1990 to 2009. This reduction in unemployment rates may not lead to accurate conclusions about economic health, though. The change in labor force participation may be a much more accurate indicator of economic well-being, as unemployment numbers will drop when discouraged workers cease searching for jobs and thus are no longer counted in the civilian labor force.

[12]Income and poverty estimates are calculated differently by the ACS than by the Current Population Survey (CPS): CPS uses a calendar year reference period, while ACS uses a rolling 12-month reference period. Because of this difference, direct comparison of poverty and income estimates between the Census and the ACS are inaccurate. We present changes over the entire period, as opposed to only those between the 2 Census years in order to capture the dramatic changes in national economic welfare that occurred between 2000 and 2009.

Table 5

Changes in characteristics of urban tracts by food desert status, 1990 to 2005-09

	Food desert						Non-food desert					
	1990-2000		2000-09		1990-2009		1990-2000		2000-09		1990-2009	
Variable	Level change	Percent change	Variable	Level change	Percent change	Variable	Level change	Variable	Level change	Percent change	Variable	Percent change
Demographic												
Total population	-566.23	-12.1	92.91	2.3	-479.93	-10.2	-632.02		387.32	8.7	-245.33	-4.8
Population density	-0.69	-16.4	N/A	N/A	N/A	N/A	-0.86		N/A	N/A	N/A	N/A
						Percent of population						
Non-Hispanic White	-0.09	-15.8	0.07	15.4	-0.02	-3.0	-0.07	-9.5	0.04	6.0	-0.03	-4.0
Non-Hispanic Black/African American	0.03	11.2	0.00	-1.5	0.03	9.6	0.02	16.1	0.00	2.4	0.02	19.1
Hispanic	0.05	44.8	0.03	20.1	0.08	74.1	0.03	37.3	0.02	19.2	0.06	63.9
Minority	0.09	21.3	0.04	7.9	0.13	31.1	0.07	28.3	0.04	13.5	0.11	45.8
Age ≥ 25 w/ education less than high-school diploma	-0.05	-13.2	-0.06	-19.1	-0.10	-29.7	-0.04	-17.7	-0.04	-20.5	-0.08	-34.5
Age ≥ 25 w/ bachelor's degree or higher	0.01	9.8	0.02	15.8	0.03	27.2	0.04	18.2	0.03	12.0	0.07	32.3
Economic												
Median family income (dollars)	-45.99	-0.1	321.94	1.0	352.46	1.0	3,436.46	6.5	2,015.88	3.6	5,466.73	10.3
						Percent						
Individuals w/ income < poverty	0.00	-0.6	0.02	8.8	0.02	7.8	0.00	0.8	0.01	9.8	0.01	10.7
Households receiving public assistance	0.01	5.6	-0.09	-67.4	-0.08	-65.5	0.01	8.7	-0.05	-67.2	-0.05	-64.3
Vacant housing units	-0.01	-8.0	0.05	45.4	0.04	33.2	-0.01	-13.9	0.03	44.4	0.02	24.2
Population age 16+ in civilian labor force and unemployed	-0.01	-7.4	-0.02	-25.6	-0.03	-31.2	0.00	-7.0	-0.01	-19.6	-0.02	-25.1
Transportation & Mobility												
Occupied housing units w/o vehicle access	-0.01	-6.3	-0.04	-26.1	-0.05	-31.0	0.00	-3.0	-0.03	-21.5	-0.03	-24.0

continued—

Table 5

Changes in characteristics of urban tracts by food desert status, 1990 to 2005-09—continued

	Food desert						Non-food desert					
	1990-2000		2000-09		1990-2009		1990-2000		2000-09		1990-2009	
Variable	Level change	Percent change	Variable	Level change	Percent change	Variable	Level change	Variable	Level change	Percent change	Variable	Percent change
Population age 16+ commuting < 25 minutes to work	-0.04	-5.7	-0.01	-0.9	-0.04	-6.5	-0.03	-5.3	-0.01	-2.3	-0.05	-7.5
Population age 16+ commuting ≥ 45 minutes to work	0.03	28.9	0.00	-1.3	0.03	26.8	0.03	19.5	0.00	1.0	0.03	20.8
Population commuting to work by private vehicle	0.01	1.3	-0.01	-1.0	0.00	0.2	0.00	0.4	-0.01	-1.5	-0.01	-1.1
Population commuting to work by public transport	0.00	-5.0	0.00	-1.7	0.00	-7.1	0.00	-1.9	0.00	2.4	0.00	0.4
Population commuting to work by foot/bike/ other	-0.01	-16.6	0.03	55.5	0.02	29.8	-0.01	-14.8	0.04	96.9	0.03	67.7

N/A = A variable was not available for that data year. Standard errors are in parentheses.

Source: U.S. Department of Commerce, U.S. Census Bureau, Census of the Population, 1990 and 2000; and 2005-09 American Community Survey; authors' calculations of percentage differences.

An increasing number of vacant housing units seems at odds with a growing population in rural tracts but may imply families moving in with one another to ease financial stress. Growth in vacant housing units may also reflect market conditions: overproduction during the housing boom in the late 1990s and early 2000s left many units vacant in high-growth areas after the real estate bubble popped. These additional unoccupied housing units would be reflected in the later data years.

Transportation and Mobility Changes

Despite these indications of declining economic conditions, data suggests that vehicle access for housing units has improved. The proportion of households with no access to a vehicle decreased from 10.8 percent to 6.2 percent for rural food deserts and from 16.6 percent to 11.5 percent in urban food deserts over the period. These statistics reflect documented increases in vehicle ownership by low-income and single female-headed families over the past decade as public assistance programs have relaxed vehicle ownership rules (Baum and Owens, 2010; Hurst and Ziliak, 2004; and Sullivan, 2004) and the Earned Income Tax Credit has expanded (Goodman-Bacon and McGranahan, 2008; Romich and Weisner, 2000; and Smeeding et al., 2000).

Data from the two censuses and the ACS show a growing number of workers with longer commute times (45 minutes or more). In 1990, 9.7 percent of workers in urban food deserts spent at least 45 minutes commuting to work, compared to 12.4 percent in 2005/2009; in other urban tracts, this proportion grew from 13.3 percent to 16 percent. In rural food desert tracts, the average proportion of workers commuting longer than 45 minutes expanded from 10.3 percent to 14.6 percent; in other rural areas, from 9.7 percent to 13.2 percent. The increase is larger for rural workers than for urban workers, but these shifts in commuting patterns are consistent over all tracts, regardless of food desert status. Working residents of both urban and rural food deserts increasingly rely on active or alternative commutes, as opposed to public transit or private vehicles. Changes in the proportion of workers using public transportation to commute to work are generally small and not statistically significant, while fewer urban non-food desert residents are using private vehicles and all workers in rural areas are barely increasing their use of privately owned cars, trucks, and vans.

Regression Analysis: Methodology

The descriptive statistics in tables 1-5 illustrate broadly how food desert tracts differ economically and demographically from other areas. They do not, however, allow us to draw any conclusions regarding what characteristics most strongly distinguish food desert tracts from other low-income tracts. The census tract food desert definition only includes tracts that meet low-income criteria as possible food deserts. To better understand what distinguishes food desert tracts from other low-income tracts, we estimate logistic regressions of the probability that a low-income census tract is a food desert. Our analysis focuses on characteristics as of the year 2000, as well as changes from the 1990 Census to the 2000 Census. The regression analysis includes these years because we are interested in determining what characteristics and changes in tracts may have influenced conditions prior to the designation of food desert status based on 2000 Census data. The outcome of interest is binomial with a value of 1 if the area is a food desert and 0 if otherwise. The regression analysis only examines the food desert status of the census tracts that are classified as low income as defined earlier, because low income is a criterion for defining a food desert. Examining only low-income tracts allows us to isolate the characteristics that distinguish tracts with low income and low access from other low-access tracts.

Selection of Independent Variables

We expect food desert status to be influenced by population characteristics, economic and employment characteristics, population density, and commuter and travel patterns, and by trends in these characteristics over time. All of the tract-level characteristics included in the descriptive analysis above were considered for inclusion in the logistic regressions. However, after considering correlation matrices of these variables, we eliminate some of the variables because they were too highly correlated with other variables. Instead, we considered the demographic, economic, and other geographic variables for which supermarket access may be most affected and considered findings from previous research. For example, areas with greater population density are likely to support a greater number of grocery stores and more likely to have stores close by. And even among low-income areas, those with higher levels of poverty, lower incomes in general, and more vacant housing units may not be able to support as many stores. Previous studies have emphasized the role of race and ethnicity as well. Changes in these variables (for example, population loss or decreasing incomes) may also reflect a community's food retail prospects as firms consider where to locate and whether to improve or eliminate poorly performing stores. Regional dummy variables were included to control for broad differences in geographic characteristics. We use food desert status as the dependent variable in three different specifications. The first regression, which is our basic model, includes static measures of census tract demographic and economic characteristics, along with regional indicator variables:

- median family income in thousands of dollars;
- percent of housing units vacant;
- percent of population of minority race/ethnicity;

- percent of population age 16 or older that is unemployed;
- percent of the population with income below the Federal poverty line;
- indicator variables for each of the four Census regions of the United States; and
- population density, measured as thousands per square mile.

We next test the effect of adding variables to reflect changes in demographics. The second model includes the above regressors, as well as indicator variables for an increase in population greater than 10 percent; a decrease in population greater than 10 percent; an increase in the minority percent of the population greater than one standard deviation of the change in percent minority; and a corresponding variable for decrease in percent minority population. For very dense urban areas, we replace the variables for significant increase and significant decrease in the percent of the population that is of minority race/ethnicity with an indicator for any significant change, regardless of direction, in percent minority. A change in percent minority with an absolute value of at least 10 percent is considered significant in defining this variable.

The third specification tests the effects of variables indicating tract-level economic changes between 1990 and 2000 in the regression. Variables for an increase in the poverty rate greater than one standard deviation of the average change in poverty rate across all tracts, and a corresponding variable for a decrease in the poverty rate of the same scale are added.

We run an initial regression on the set of all tracts, both rural and urban, that qualify as low income, using the following independent variables:

- median family income in thousands of dollars;
- percent of vacant housing units;
- percent of population of minority race/ethnicity (percent non-Hispanic White);
- percent of population age 16 or older that is unemployed;
- percent of population with income below the Federal poverty line;
- indicator variables for each of the four Census regions of the United States (Northeast is omitted); and
- a variable to indicate whether each tract is rural or urban.

To determine whether separate regressions should be run for urban and rural tracts, we fully interact the model using the binary urban indicator and perform a Chow test to determine whether these interaction terms are jointly significantly different from zero. The Chow test results in a chi-squared value of 540.01 and a p-value of 0.000, confirming that the socioeconomic factors above interact differently with food desert status depending on whether a tract is rural or urban. As a result, we run separate models for rural tracts and for urban tracts.

The variety of tracts that fall into the urban category varies widely—from very dense central city tracts, to suburban tracts, to small city and large

town tracts. Retail development, population density, and other area characteristics could be very different in densely populated tracts than in the less dense urban areas. We also consider the possibility that the factors that affect food desert status in very dense urban areas differ from those in less dense urban areas. We define very dense urban areas as those in which the population per square mile (in 1,000s) is at or above the 90th percentile of population density for all urban tracts. We perform a similar Chow test to determine whether all urban areas should be grouped together for purposes of the regression or if very dense areas should be estimated separately from less dense urban areas. This test produces a chi-squared value of 370.50 and a p-value of 0.000. Therefore, we create separate data sets for urban areas with high population density ("very dense") and all other ("less dense") urban tracts. There are 6,519 rural low-income tracts in our sample. The total sample of urban tracts is 17,940, of which 14,385 tracts are considered less dense and 3,555 tracts fall into our dense category, with population density in the 90th percentile or higher.

For each set of rural tracts, very dense urban tracts, and less dense urban tracts, we perform three logistic regressions based on the models outlined above. To further control for differences among less dense urban tracts, we add a variable for population density—thousands of people per square mile.

Regression Results

For both urban and rural regressions, minority population, poverty rates, and region of the country are consistently significant predictors of food desert status. We now discuss the most consistent and policy-relevant results, while detailed results are presented in tables 6 and 7.

In rural areas, the percent of vacant housing units within a tract is a significant predictor of food desert status with a consistently large odds ratio. The percent of the tract population that is poor is also a consistently strong predictor of food desert status; tracts with higher poverty rates are more likely to be food deserts than otherwise similar low-income tracts. As some of the previous studies have found, we also find that the racial/ethnic composition of a tract is correlated with food desert status. The percent of the tract population that is minority is a consistently positive predictor of food desert status. Unexpectedly, higher rates of unemployment decrease the odds a tract fits the definition of a food desert. This result, while counterintuitive, is robust across specifications. Rural tracts located in the West, Midwest, and South are also much more likely to be food deserts than rural tracts located in the Northeast. This might reflect the relative proximity of rural tracts in the Northeast to urban tracts (that contain grocery stores), compared with the more sparsely populated rural areas in the South, Midwest, and West.

Many of the same demographic factors are important predictors of food deserts in less dense urban areas as in rural areas, although some differences exist. Notable differences also exist between very dense and less dense urban tracts (table 7).

Table 6

Logistic regression odds ratios and 95-percent confidence intervals for rural low-income tracts

Rural low-income tracts	Basic model: all rural tracts	Basic model w/ demographic change: all rural tracts	Basic model w/ demographic & economic change: all rural tracts
Median family income	0.99 (0.979 - 1.000)	0.991 (0.981 - 1.001)	0.992 (0.981 - 1.002)
Vacant housing units (percent)	14.152** (8.532 - 19.773)	14.678** (8.653 - 20.702)	14.187** (8.346 - 20.028)
Population minority (percent)	2.351** (1.816 - 2.886)	2.434** (1.851 - 3.016)	2.361** (1.786 - 2.936)
Population age 16+ in civilian labor force and unemployed (percent)	0.027** (-0.006 - 0.060)	0.028** (-0.006 - 0.063)	0.028** (-0.006 - 0.062)
Individuals w/ income < poverty (percent)	3.312* (0.628 - 5.997)	3.185* (0.599 - 5.772)	3.224* (0.514 - 5.934)
West Census region	2.574** (2.046 - 3.101)	2.681** (2.120 - 3.241)	2.648** (2.094 - 3.202)
Midwest Census region	2.827** (2.308 - 3.347)	2.863** (2.336 - 3.390)	2.799** (2.278 - 3.320)
South Census region	1.270* (1.023 - 1.517)	1.303* (1.048 - 1.559)	1.282* (1.029 - 1.535)
Population density	0.981 (0.942 - 1.019)	0.983 (0.944 - 1.022)	0.983 (0.944 - 1.022)
Substantial increase in population		0.889 (0.794 - 0.983)	0.888 (0.793 - 0.983)
Substantial decrease in population		1.009 (0.874 - 1.144)	1.006 (0.872 - 1.141)
Substantial increase in percent minority		0.91 (0.796 - 1.025)	0.918 (0.799 - 1.036)
Substantial decrease in percent minority		1.541* (1.057 - 2.025)	1.512* (1.036 - 1.987)
Substantial increase in poverty rate			1.103 (0.902 - 1.303)
Substantial decrease in poverty rate			1.114 (0.998 - 1.230)
Observations	6,519	6,519	6,519

95-percent confidence intervals in parentheses. * significant at 5 percent. ** significant at 1 percent.

Low-income census tracts are those with: a poverty rate > 20 percent; median family income < 80 percent of statewide median family income (tracts outside metro areas) or median family income < 80 percent of the greater of statewide median family income (tracts outside metro areas) or the median family income of the metropolitan area.

Source: Regression output created using statistical software Stata, based on U.S. Department of Commerce, U.S. Census Bureau, Census 1990 and Census 2000 data from National Change Database.

Table 7

Logistic regression odds ratios and 95-percent confidence intervals for urban low-income tracts

Urban low-income tracts: Odds ratios	Basic model: less dense urban tracts	Basic model: very dense urban tracts	Basic model w/ demographic change: less dense urban tracts	Basic model w/ demographic change: very dense urban tracts	Basic model w/ demographic & economic change: less dense urban tracts	Basic model w/ demographic & economic change: very dense urban tracts
Median family income	1.003	0.991	1.003	0.995	1.003	0.997
Vacant housing units (percent)	0.502*	44.846	0.545*	53.162	0.569*	17.749
Population minority (percent)	1.557**	0.332	1.534**	0.428	1.567**	0.419
Unemployed (percent)	0.357**	0.014	0.361**	0.02	0.364*	0.01
Individuals w/ income < poverty (percent)	0.853	29.813*	0.912	37.749*	0.903	82.138**
West Census region	0.737**	2.576*	0.745**	2.899*	0.746**	3.015**
Midwest Census region	1.028	2.904*	1.024	2.901*	1.036	2.141
South Census region	1.113	4.821**	1.117	4.965**	1.119	4.599**
Population density	0.817**	Omitted	0.815**	Omitted	0.815**	Omitted
Substantial increase in population 1990-2000			0.921	0.351*	0.923	0.340*
Substantial decrease in population 1990-2000			0.987	0.543	0.989	0.532
† Substantial increase in percent minority 1990-2000			1.054	1.648	1.044	2.084*
Substantial decrease in percent minority 1990-2000			0.585**		0.596**	Omitted
Observations	14,385	3,555	14,385	3,555	14,385	3,555

95-percent confidence intervals in parentheses; * significant at 5 percent; ** significant at 1 percent.

† Substantial change in either direction for very dense urban tracts.

Low-income census tracts are those with: a poverty rate > 20 percent; median family income < 80 percent of statewide median family income (tracts outside metro areas), or median family income < 80 percent of the greater of statewide median family income (tracts outside metro areas) or the median family income of the metropolitan area.

Source: Regression output created using statistical software Stata, based on U.S. Department of Commerce, U.S. Census Bureau, Census 1990 and Census 2000 data from National Change Database.

As is the case with rural tracts, the percent of the tract that is minority is a strong predictor of food desert status in the less dense urban tracts. In these tracts, a 1-percentage-point increase in the percent minority is associated with about a 50-percent increase in the odds of being a food desert. In less dense urban areas, the model that includes changes in demographic characteristics over time indicates that a large decrease in minority status also lowers the odds that a tract is a food desert in less dense urban areas. Interestingly, the percent of the population of minority race or ethnicity in a tract is not a significant predictor of food desert status in very dense urban tracts, nor are the variables for changes in the percentage minority between 1990 and 2000.

The extent of poverty in very dense urban tracts is an important predictor of food deserts, but it is not a predictor of food desert status in less dense urban areas. The model that includes a measure of the change in poverty rates between census years shows that poverty changes in less dense urban areas are not related to the odds that a tract is a food desert. However, in very dense urban areas, a substantial decrease in a tract's poverty rate increases the odds that a tract is a food desert. This result is counterintuitive. It is possible that the few very dense tracts with large swings in poverty rates may be in a state of flux with respect to residential and retail development.

Among less dense urban tracts, those in the West are less likely to be food deserts than their counterparts in the Northeast. And as expected, higher population density within the less dense areas reduces the odds of a food desert slightly. Dense urban areas located in the West, Midwest, and South are also more likely to be food deserts than dense areas in the Northeast. This may reflect the difference between very dense cities in the Northeast (e.g., New York and Philadelphia) where few neighborhoods are more than 1 mile from a supermarket and very dense urban tracts in other cities that may be surrounded by slightly less densely populated tracts and, thus, people and stores are more spread out. The characteristics that predict food desert status in less dense urban tracts are notably different than those that predict food desert status in dense urban areas. This may be partly due to the fact that less dense urban areas include a wide range of tracts, from suburbs to small cities to small towns, all of which may have very different characteristics. This variation in the socioeconomics of the tracts in the less dense urban areas may make difficult the detection of any meaningful links between economic and demographic characteristics and the existence of food deserts. Very dense urban tracts, however, are much more likely to resemble one another in terms of composition. In these areas, we find a strong link between poverty and the presence of food deserts.

Some common factors can be traced between the presence of rural food deserts and urban food deserts. Tracts that have larger representations from minority groups are more likely to be food deserts in rural, less dense urban, and dense urban areas. This is true even after controlling for income and other tract-level characteristics. High poverty rates are usually positive predictors of a food desert tract, and regions in the South, Midwest, and West tend to be more likely to be food deserts than tracts in the Northeast. Vacant housing is also often important in increasing the probability of the existence of a food desert, although the predicted odds ratios for dense urban tracts are not statistically significant.

Conclusion

Our study confirms poverty's primary role in the evolution of food deserts. Our statistical analyses build on previous research by examining the characteristics of food deserts, defined on a national level. The analyses also provide additional insight by investigating changes in these characteristics over time. Results from our descriptive analysis contrasting food desert tracts and other tracts support much of the previous research, concluding that minority status and poverty are more prevalent in areas with limited access to healthy and affordable food. Observation of three survey periods also illuminates the persistence of low-access and low-income conditions in food deserts. As community development and infrastructure investment are neglected, residents remain in impoverished conditions.

While we find a number of characteristics that are associated with low access and low income, econometric analysis isolates only a few of these as strong, consistent predictors of food deserts. Different factors are more important in rural areas than in urban areas, and in very dense versus less dense urban areas. For both the descriptive and multivariate analysis, concentrated poverty is a significant predictor of low access. This is true even as our set of tracts is limited to those already designated as low income, implying that even among poor tracts, those areas with greater levels of poverty are more likely to be food deserts. The predictive strength of poverty rate is most strongly observed among the set of densely populated urban tracts, where other demographic factors are likely to be more uniform across tracts. As opposed to the poverty rate itself, changes in tract poverty rate are not statistically significant in most cases. When viewed in conjunction with the importance of the poverty rate at a single point in time, this insignificance provides further argument for the persistent effects of poverty: a tract with high poverty rates at a given point is much more likely to be a food desert despite any changes in the poverty rate over time.

Another important factor affecting food desert status in rural and less dense urban areas is the percent of minority population in a tract. This finding partially corroborates the conclusions from the econometric analysis in *Access to Affordable and Nutritious Food: Measuring and Understanding Food Deserts and Their Consequences—Report to Congress* (USDA, 2009) and indicates that racial/ethnic aspects influence retail development across a wide range of neighborhoods. Food desert tracts have a greater concentration of all minorities, including Hispanics. In urban food deserts, this difference was nearly 70 percent in 1990, approximately 60 percent in 2000, and 53 percent in 2005-09. The proportion of minorities in rural food desert tracts is around 65 percent greater than in non-food desert tracts in 2005-09 and in 2000, down from an 80-percent difference in 1990.

Our findings also imply that low-income tracts in the Northeast are less vulnerable to access problems than low-income tracts in other regions of the country. As described in the introduction of this report, the census-tract food desert definition is based upon distance from the nearest grocery store. This may translate into relatively fewer food deserts in the Northeast, where development is more densely distributed.

Identifying further characteristics that influence the development and persistence of food deserts across rural, urban, and very dense urban areas is

difficult. In less densely populated urban areas and in rural areas, economic and demographic heterogeneity from tract to tract obfuscates the most important causal factors of low access. For example, high vacant-housing rates affect the probability of a food desert differently in rural areas than in less dense urban areas, and they have a statistically insignificant effect in very dense urban areas. This suggests that abandoned property and movement of population is more detrimental to already dispersed rural populations. The insignificant impact of vacant-housing rates in very dense urban areas is likely a result of a still highly concentrated population.

Concentrated poverty and minority populations emerge from our study as the critical factors in determining low access. As impoverished and minority populations are already more likely to have poor access to health care and fitness facilities, limited access to healthy food may compound the effects of this deprivation. These environments, plagued with low income, low education levels, and high unemployment, may well be unattractive markets for supermarkets and grocery stores. Difficulty in training and retaining staff from such a population, as well as low demand resulting from poverty, pose significant disincentives for retailers to operate in these areas (Food Marketing Institute, 1998). If profit potential to attract these retailers does not exist, effective policy may focus on lowering other barriers to access, such as providing better public transportation to enable access to retailers in surrounding areas or addressing education and employment shortcomings directly. It may also be feasible to encourage smaller stores in food deserts to carry healthier products. Policies that emphasize community development and infrastructure investment in areas of concentrated poverty may also be effective options to remove barriers to food retail development and to create healthier living environments in these areas. Tailoring solutions to specific communities may be more efficient than a one-size-fits-all approach, as different infrastructure failures are at fault in urban areas than rural areas, and even in very densely populated areas than in other areas. Recognizing these differences will be crucial to the success of any policy option.

Potential for future research exists in identifying connections between low access and poor health outcomes. Such a relationship is difficult to identify in a national-level study, as very little in the way of specific health data exists at such a level. Disentangling consumers' preferences regarding location and diet from market forces can also help further shape effective policy in addressing access problems.

This study considers supermarkets, supercenters, and large grocery stores in measuring access to healthful and affordable foods. We focus on these store types because they tend to carry a wide variety of food products at lower prices than many other food retailers. In addition, national data on these stores are readily available, while such data are less detailed for smaller outlets. But there are other outlets where fresh, healthy foods may be obtained, such as farmers' markets, mobile markets, or corner stores with expanded healthy options. Further research accounting for other means of accessing nutritious food could provide a different perspective on food access.

Food deserts have currently only been defined for one time period. ERS is planning to update the estimates of food desert census tracts using more recent population and store location data. Two estimates of food desert status will allow us to explore in more detail the determinants of food deserts and how food desert status is associated with changes in these characteristics over the two time periods.

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