Did the American Recovery and Reinvestment Act Increase in SNAP Benefits

Reduce the Impact of Food Deserts?

Margaret Andrews,[1] Rhea Bhatta,[2] Michele Ver Ploeg[1]

Did the American Recovery and Reinvestment Act Increase in SNAP Benefits

Reduce the Impact of Food Deserts?

ABSTRACT: Public policy discussion of the problem of food deserts has concentrated on proximity to retail food stores providing nutritious, affordable foods. Because they offer a wide array of healthful products at lower prices, physical access to a supermarket or supercenter has come to be the standard of adequacy. Less attention has been given to how economic incentives influence access to retail food stores in the wider food environment. The American Recovery and Reinvestment Act (ARRA) enacted a sizable increase in SNAP benefits effective April 2009. Though the primary purpose of the increase was to stimulate the economy, we argue that it had a secondary effect of encouraging SNAP participants to redeem more of their benefits at larger, lower-priced retailers.

To investigate the effect of this policy change, we use county-level, administrative data on SNAP redemptions at different types of authorized food stores from May 2007 to May 2010. Data from the Economic Research Service's Food Desert Locator are used to classify counties according to the percent of their population residing in food deserts. Results show that the SNAP benefit increase is associated with a greater percentage of redemptions at superstores. Estimates are stable across a number of specifications that also control for gas prices and store-type density. Within our sample of counties, we show that an $80 maximum SNAP benefit increased the percentage of benefits redeemed at supermarkets by 1.4 percentage points. In order to achieve a similar increase in redemptions at superstores, store density would have to increase from one superstore every 24 square miles to 1 superstore every 15 square miles. Impacts of the benefit increase were positive, but somewhat smaller in areas with more of their population residing in food deserts.

[1]Economic Research Service, USDA; [2] Lehigh University

Introduction

Residents of food desert communities may be more reliant on the offerings of stores in their community, which could mean they have fewer choices for healthy foods and face higher prices. If residents travel to stores with better selection or lower prices outside their neighborhoods, they may incur greater transportation and time costs. Several policy initiatives have been implemented to make healthy foods more accessible to such communities. Most of these efforts encourage the development of new or modified retailers in existing food desert communities. An alternative could provide assistance for people to access sources of healthy foods outside of their neighborhoods. Thus far, there is little research or evaluation to guide which approach may be more effective in addressing access barriers. The increase in Supplemental Nutrition Assistance Program (SNAP) benefits through the American Recovery and Reinvestment Act (ARRA) provides a unique opportunity to understand how an increase in the amount of money available to spend on food may affect food shopping behavior. Beginning in April 2009, monthly SNAP benefits increased by 13.6 percent through ARRA, or about $80 for a family of four. This increase in benefits may make it feasible for households who face access barriers to travel farther to stores (with presumably lower food prices) because the increase in benefits indirectly acts to offset travel costs.

The objective of this study is to examine how the increase in SNAP benefit levels from the ARRA affected SNAP redemptions at supermarkets and supercenters (henceforth referred to as superstores). Controlling for the availability of stores by type, benefit increases are hypothesized to increase incentives for participants to shop at superstores, where prices tend to be lower, but which may be farther away or require greater travel costs. Because gas and food prices were also subject to significant variation over our study period, we control for their influence. The research is important for understanding how SNAP participants' shopping patterns may change with an increase in resources through the SNAP program.

Our theoretical approach is an extension of the standard consumer demand analysis to accommodate travel costs for buying food, store choice, and income that includes an in-kind transfer. We use indifference curve analysis to illustrate a relevant choice problem for a representative SNAP household**.**

The percentage of SNAP redemptions at superstores is modeled as a function of maximum monthly benefits levels (deflated by food prices), store density by store type, county-level store access variables, and controls for gas prices. The county is the unit of analysis, which is the smallest level of geography in our dataset. The analysis uses monthly county-level data on SNAP redemptions (in dollars) by store type from May 2007 to May 2010. County-fixed effects are used to control for any unobserved, time-invariant characteristics of counties that are correlated with our independent variables of interest.

SNAP benefit increases are associated with a greater percentage of redemptions at superstores. Estimates are stable across a number of specifications that control for gas prices, store-type density, and measures of food store access. According to our estimates, an $80 increase in the maximum SNAP benefit increases the percentage of benefits redeemed at superstores by 1.4 percent. Preliminary estimates indicate that in order to achieve a similar increase in redemptions at superstores, store density would have to increase from one superstore every 24 square miles to one superstore every 15 square miles. When we subset our data based on the percentage of the population residing in food deserts, an increase in real benefit levels has a positive, but smaller effect in counties with higher proportions of their populations in food deserts.

Relevant Literature and Contribution

The United States Department of Agriculture (USDA) estimates that between 2-5 percent of households, or between 4-8 percent of individuals in the U.S. face barriers in access to supermarkets and large grocery stores (2009). Ver Ploeg, Nulph and Williams (2011) estimate that 13.6 million people live in food deserts, 82 percent residing in urban areas. The relationship between this lack of access and diet and health outcomes has been the focus of much of the literature on food access and food deserts, primarily because obesity and diet-related health have become such pressing public health problems in the U.S. A number of studies have shown that limited access to healthy food options is associated with lower intake of some foods like fruits and vegetables and even to less proximate outcomes such as higher rates of obesity (Larson, 2009). But studies that use methods that go beyond associations to show a causal link find either no effect of healthy food store access on dietary intake or body weight (Block et al., 2011; Boone-Heinonen et al., 2011; Cummins et al., 2005) or a small effect (Chen et al., 2011; Wrigley et al., 2003).

Even if the effect of food deserts on diet and health is not large, store access barriers may affect consumer shopping patterns—leading to consequences such as higher food costs and lower variety in the diet. In general, there has been little research in the food desert literature on the economic factors that drive food shopping and how they may operate differently in different food environments. Much of what we know about these possible effects comes from studies of low-income and SNAP-participating populations. The Food and Nutrition Service (FNS) of the USDA has continuously tracked SNAP benefit redemption by store type. In FY2010, 83.5 percent of SNAP benefits were redeemed at supermarkets or superstores where prices tend to be the lowest (USDA, 2011). The remaining percentage was redeemed at smaller stores. Evidence from the 1996-1997 National Food Stamp Participant Survey (NFSPS) suggests that SNAP participants may not shop at the nearest supermarket. NFSPS respondents reported the modes of transportation used, the out-of-pocket costs incurred, and the amount of time taken to travel to stores where they usually shopped for food (Ohls et al., 1999). Though these estimates refer to a representative population, not just one located in food deserts, they give some insight into travel costs. Among program participants, the average distance to the nearest supermarket was 1.8 miles but the average number of miles to the store most often used by participants and eligible nonparticipants was 4.9 miles.

This shopping behavior may be motivated by price considerations. Superstores, supercenters and other nontraditional food outlets (such as dollar stores and warehouse club stores) have been found to offer lower prices than traditional supermarkets and grocery stores (Leibtag, 2006) and have been credited with lowering grocery prices in general with greater store competition (Hausman and Leibtag, 2007). Broda et al. (2009) find that low- and middle-income households are more likely to purchase foods at supercenters than higher income households. This study also found that most, but not all, low-income consumers pay less for the same grocery items than higher income consumers--those with annual incomes between $8,000 to $30,000 tended to pay the least while the poorest of the poor, those with incomes less than $8,000 paid 0.5 to 1.3 percent more for the same items.

Getting to these stores that offer the lower prices may have travel and time cost implications. USDA (2009) estimated the time spent traveling to stores for grocery shopping trips using American Time Use Survey data. Estimates show that shoppers who lived in low-income areas with low access to a supermarket or large grocery stores spent an average of 19.5 minutes on one-way grocery shopping trips, which is significantly larger than the U.S. average of 15.0 minutes. NFSPS respondents reported the modes of transportation and out-of-pocket costs used to travel to stores where they usually shopped for food and about how much time it took to travel to food stores, although for the general SNAP population, not specifically for those in food desert areas (Ohls et al., 1999). Close to 76 percent of participants and 85 percent of eligible nonparticipants reported use of a car to shop.[1] Average round trip travel time to the most frequently used store was 23-24 minutes for participants and eligible nonparticipants. Among the 22 percent of participants who reported some transportation expenses, the average cost per shopping trip was $6.54.

Using the NFSPS survey data and data from the Louisiana Neighborhood Environment and Consumption Survey (LANECS), Rose et al. (2009) estimate travel costs for different transportation modes and across areas in New Orleans. This exploratory exercise considered both out-of-pocket travel costs and time costs for the different travel options for grocery shopping.[2] Estimates ranged from a high of $66.60 per month for a taxi to $5.90 per month for driving one's own car.[3] The study also considered differences in time costs for New Orleans residents living in areas with poor access to supermarkets (defined as census tracts more than 2 kilometers from a supermarket), compared with the time costs for those living in areas with good access (defined as census tracts within 2 kilometers of a supermarket). The average difference in travel cost between areas with poor access and areas with good access was $10.58 per month; in other words, SNAP participants in poor-access areas of New Orleans had total travel costs (both time and out-of-pocket costs) that were on average (across mode of transportation) almost $11 higher than those in areas with good access.

[1] Among SNAP participants, 45 percent drove themselves and 31 percent received a ride with family or friends.
[2] The time cost estimates use the hourly minimum wage to value time. See table 5 in Rose et al., 2009, for details.
[3] Costs are to the nearest supermarket by mode of transport based on approach by Feather, 2003, and weighted using the distributional data on the mode of transportation.

Conceptual Model

A simple model of consumer behavior predicts that access to food stores, or lack of it, has two effects on the budget constraint. The direct effect is an income effect--- transportation costs reduce the income available for food expenditures. The indirect effect is a price effect---relative access to different types of food stores determines shopping destinations and the nominal prices paid for food. Households trade off travel costs and price differentials so that economizing on travel may imply acceptance of higher nominal prices or a limited range of goods. The fact that SNAP benefits are restricted to the purchase of food items complicates the analysis somewhat. To illustrate the behavioral effects of a SNAP benefit increase, we use indifference curve analysis to illustrate a simplified choice problem for a representative SNAP household**.** We assume a choice between food and nonfood items and a choice between two stores— a convenience store with small travel costs and a superstore with lower prices for food, but significant travel costs. We assume no travel costs for purchasing the nonfood commodity. As illustrated in Panel **1a**, if no food is purchased, the amount **I** of the nonfood commodity can be purchased. If all available income is spent to purchase food the amount **B** can be purchased from the superstore or **J** from the convenience store. To purchase food requires the household incur travel costs. On the horizontal axis the amount **HI** is the travel cost of reaching the nearest convenience store (normalized by the price of the nonfood item) and **FI** the cost of reaching the nearest superstore. If any food is purchased, the maximum amount of the nonfood commodity that can be obtained is reduced by the travel costs for buying food.

Without participating in the SNAP, the budget constraint **JH** shows the combination of food and nonfood commodities that can be obtained by the representative, low-income household when food is bought at a convenience store. Likewise, the budget line **BF** shows the food-nonfood combinations possible when the superstore is used to buy food. A combination of these budget lines results in a nonconvex budget set (**BKHI**) illustrating the boundary of alternative combinations of food and nonfood purchases for a nonparticipating household.

Participation in SNAP substantially complicates the budget set. The amount of food that can be purchased with a given budget can vary substantially depending on the type of food retailer chosen. With lower food prices available at superstores, we assume that the representative household can obtain an amount of food **C** with its SNAP allotment as illustrated in Panel 1b. At the convenience store, the amount of food that can be acquired is illustrated by point **D**. Differing food prices also account for the difference in slopes of the store budget lines. The resulting combined budget set (**GMNAHI**) can have several kinks.

In this indifference curve analysis, the choice problem for the representative household involves the allocation of income (net travel costs) between food and nonfood. This is achieved by selection of the segment of the budget set (food store shopping location) and the point on that segment where utility is maximized. Panel 2a shows a case where utility is optimized at level L" at the kink point A. The SNAP benefit is used at a convenience store, travel costs of HI are incurred, and only SNAP income is used to purchase food.

An increase in SNAP benefits will generate a larger shift in the budget line for the superstore as opposed to a convenience store, thereby encouraging a change in shopping destination. This is illustrated in Panel 2 where, without any change in travel costs or prices, the benefit increase generates a shift from A to A''. Panel 3 illustrates the importance of travel costs where a reduction in travel costs to superstores of the amount **F-F**' would induce the representative SNAP household to shift to the superstore budget segment and allocate income (net travel costs) at point **V**, with a higher utility level and a higher level of food purchasing (**B**).

This analysis can be generalized to the travel cost model that is used frequently in recreational and transportation demand analysis (Feather, 2003). In that approach, an individual chooses which store to visit based on the conditional indirect utility functions for the competing stores. In most applications multinomial logit models are used to estimate the utility parameters. Because of data limitations, we take a simpler approach focusing explicitly on the choice to shop at superstores.

Data

Data for SNAP redemptions come from the USDA Food and Nutrition Service (FNS). This data set provides county-level redemptions (in dollars) by store type for each month during the period from May 2007 to May 2010. The data also includes each county's total SNAP redemptions (in dollars) and the number of redeeming retailer types. For protection of confidentiality, FNS redacted county-level SNAP redemption data for any store type with less than four authorized stores in a county.

FNS assigns one of 17 store types to retailers that are authorized to redeem benefits. Our analysis focuses on three major store types: superstores; combination stores; and convenience stores. These stores are the most commonly occurring store types. FNS defines a supermarket category to include establishments commonly known as supermarkets, food stores, grocery stores and food warehouses that offer an extensive variety of grocery and other store merchandise where customers normally make large volume purchases. These stores typically have ten or more checkout lanes and are equipped with registers, bar code scanners, and conveyor belts.[4] The FNS supercenter category includes very large supermarkets, "big box" stores, super stores and food warehouses primarily engaged in the retail sale of a wide variety of grocery and other store merchandise. It includes stores that are large food/drug combo stores and mass merchandisers under a single roof, and membership retail/wholesale hybrids offering a limited variety of products in a warehouse-type environment (Wal-Mart, Super Kmart, Target, Meijer, Fred Meyer, Sam's, Costco, BJ's).

For our analysis, we combine the FNS supermarket and supercenter categories into a single superstore category (SS) to consolidate those establishments most likely to have a wide variety of food

[4] FNS includes three other categories for grocery stores--- "large" "medium" and "small". Stores classified as such were too infrequent to allow for inclusion in our dataset.

sold at low prices. We also use the FNS combination store (CO) and convenience store (CS) categories. The CO category encompasses general merchandise stores that also sell a variety of food products; stores such as independent drug stores, dollar stores and general stores that often offer low food prices but a more restricted variety of products. Convenience stores (CS) offer a limited line of convenience items; are typically open long hours and offer a variety of canned goods, dairy products, pre-packaged meats and other grocery items in limited amounts. They also usually sell a large variety of products ineligible for SNAP purchases such as hot coffee, alcohol, or tobacco products.

For our analysis sample, we select counties with non-missing data for the entire 37-month period. This initial sample consists of 533 counties (hitherto referred to as the "full sample").   Figure 2 shows the regional distribution of the sample of full data counties. Included counties are concentrated in the Pacific region, particularly California, as well as the Middle Atlantic, parts of East North Central, and the South Atlantic regions. The 533 counties are located across 45 states, and 465 are located within a Metropolitan Statistical Area (MSA), 62 are within a Micropolitan Statistical Area, and the remaining six are located outside either Metro- or Micropolitan areas.

The dependent variable of interest is the percentage of redemptions at superstores (SS). We compute this monthly measure by first summing each county's redemptions at stores categorized by FNS as supermarkets or supercenters, and then dividing this sum by the county's total SNAP redemptions. We multiply this quotient by 100 to obtain a percentage. Figure 2 illustrates the percentage of SS redemptions, averaged over the entire 37-month period, for each county in the full dataset.[5]

---

[5] To obtain each county's average percentage, we first sum SS redemptions and total redemptions in the county over all 37 months, and then we divide the grand total of SS redemptions by the grand total of redemptions.

To control for food and gas price inflation, we utilize the Bureau of Labor Statistics metropolitan area and regional CPI data for food-at-home and gasoline (all types) prices, respectively. We assigned monthly CPIs based on the county's MSA. If CPI data were missing for a particular MSA, we assigned a regional CPI based on the county's Census division and population size class.[6]

SNAP maximum benefits vary according to household size and are uniform across states in the continental US.[7] The maximum benefit is annually adjusted for inflation based on the cost of the Thrifty Food Plan for a family of four, so we use the maximum benefit for a four person household as a proxy for the benefit structure. This parameter is a primary policy lever which is exogenous to behavioral effects associated with the changing composition of the SNAP caseload. Since food prices vary substantially across regions and over time, we deflate the maximum benefit by the county's assigned monthly food-at-home CPI and then multiply this quotient by 100. This yields a measure of the purchasing power of participants' benefits, and it facilitates comparison of benefits over time. For a particular county, the purchasing power of SNAP benefits will be higher during months for which the index value is smaller and vice versa.

Since the geographic distribution of the population and the availability of stores are likely to affect superstore redemptions within a county, we construct population and store density measures using each county's land area (in square miles).[8] First, using the Census Bureau's yearly county-level population estimates (in 1000s), we create a measure for population density (population estimate divided by the county's total land area). This measure generates yearly, rather than monthly, variation in population densities for each county. Additionally, we construct three store density measures: the

[6] The four Census divisions are Northeast, Midwest, South, and West. Population size classes are defined as follows: "A" if population exceeds 1.5 million; "B/C" if between 50,000 and 1.5 million; and "D" if under 50,000.
[7] The benefit standard is higher in Alaska and Hawaii.
[8] Land area is based on Census 2000 data.

number of CO per square mile; the number of CS per square mile; and the number of SS per square mile. The number of redeeming retailers varies, though not substantially, on a month-to-month basis.

Finally, we want to explore the effect of benefit increases on redemptions at SS, specifically in areas where access to such stores is more limited. We expect that if the benefit increases do encourage redemptions at SS, the effect will depend on relative travel costs and store-density within the local food environment. Ideally we would have data that identified how many people in the county experienced food access barriers, but such data is not available. Instead, we use information on the proportion of a county's population residing within a food desert. We utilize tract-level food desert data from ERS' Food Desert Locator. The Locator defines low-income census tracts as food deserts if a substantial number or share of residents live far from supermarkets or large grocery stores.[9] Tracts where more than 20 percent of people have incomes below Federal poverty levels or where the tract's median income is at or below 80 percent of the larger area's median income are designated as low-income tracts. Low-income urban areas are designated as food deserts if at least 33 percent of the tract population or if 500 people are more than 1 mile from a supermarket or large grocery store; in low-income rural areas, a 10-mile designation is used.[10]

Just over 6,500 tracts are designated as food deserts in the US. For each food desert tract, the data contains information regarding the number of individuals living in food deserts. We use this along with the county population estimate to calculate the proportion of the population residing in food deserts.[11] The median of this variable is used to subset the counties into those with lower and higher food access problems, with those counties that have a greater number of people in food deserts than

---

[9] The Food Desert Locator uses a 2006 list of supermarkets and large grocery stores as well as data from the 2000 Census of the Population.

[10] See the documentation section of the Food Desert Locator for more details at: http://www.ers.usda.gov/data/fooddesert/documentation.html.

[11] We use county-level measures of food access limitations because the SNAP redemptions data are only available at the county-level. However, these county measures are likely to mask significant variation in food access within a county, and thus, are weak measures of food access limitations.

the median for the full sample as higher food desert counties and those with less than the median as lower food desert counties

Table 1 shows summary statistics for each sample for the key variables used in our analysis. Redemptions at superstores averaged about 87.2 percent for the full data sample, 87.8 percent for the higher food desert subsample, and 86.6 for the lower food desert subsample. The deflated maximum benefit (averaged over the sample) is smaller for the full data sample ($417) than for the higher food desert subset ($429), which may indicate lower food CPI values (and lower food price inflation) for this subsample of counties. We also observe that store densities are nearly double for counties in the lower food desert subsample as compared to the higher food desert data sample. Similarly, the average population density in the lower food desert subsample is nearly triple that of the higher food desert counties.

Empirical Model

The main purpose of our analysis is to examine how the increase in SNAP benefits due to ARRA affects redemptions at different store types. We hypothesize that the increase in benefits increases incentives for participants to shop at superstores, where prices tend to be lower, but may require greater travel costs. Additionally, we explore how food access barriers play a role in shopping behavior.

Unobserved heterogeneity across counties potentially confound estimates of the effect of the ARRA benefits increase, but the availability of a panel data set enables us to employ a fixed effect framework. Using county-specific fixed effects, we control for any unobserved, time-invariant characteristics of counties that are correlated with our independent variables of interest. The key assumption is that the unobserved county-specific effects are time-invariant once we control for observables. Under this framework, we exploit variation within counties over time.

Our baseline specification (Model 1) incorporates our key variables of interest as well as measures of store availability:

$$ss_{jt} = \gamma_j + \alpha * maxben_{jt} + \theta * ARRA + \delta * (maxben_{jt} * ARRA) + \beta * \mathrm{x}_{jt} + d + \varepsilon_{jt}\,,$$

where ss_{jt} indicates the ratio of superstore (supermarket and supercenter) redemptions to total redemptions in county *j* at time *t* (each month from May 2007 to May 2010); γ_j represents the county-specific fixed effect; $maxben_{jt}$ is the state maximum benefit deflated by *j*'s food-at-home CPI at *t*; *ARRA* is a dummy equal to one for periods from April 2009 onward; x_{jt} is a vector of county characteristics likely to be associated with superstore redemptions, including population density, store densities (numbers of supermarkets and supercenters, combination stores, and convenience stores per square mile), and time dummies; *d* is a time trend; and ε_{jt} is an i.i.d. error term by assumption.[12]

The coefficients of interest are α, δ, and the β's. We would expect that $\alpha > 0$, i.e. a higher maximum benefit is associated with an increase in the percentage of superstore redemptions. The direction of δ is ambiguous. For $\delta > 0$, a higher maximum benefit has a larger effect on superstore redemptions following the ARRA; if $\delta < 0$, a higher maximum benefit has a smaller effect on superstore redemptions following the ARRA. With respect to the β's, we expect negative coefficients for the CO and CS densities, since their availability is likely to reduce the likelihood of visiting superstores and thus the percentage of superstore redemptions. For the SS densities, we might expect positive coefficients since a greater availability of such stores is likely to increase the percentage of redemptions.

Since gas prices are likely to affect travel costs, and therefore the decision of whether or not to travel to a superstore, the next set of specifications (Models 2 and 3) include county *j*'s regional gas CPI as well as its interactions with each of the store density measures (included in x_{jt}):

[12] Since the errors are likely to be serially correlated, all of our specifications cluster at the county-level to obtain robust estimates of the standard errors.

$$ss_{jt} = \gamma_j + \alpha * maxben_{jt} + \theta * ARRA + \delta * (maxben_{jt} * ARRA) + \beta * x_{jt} + d + \pi * gascpi_{jt} + \varepsilon_{jt} .$$

The expected sign of π is ambiguous given previous literature. Increases in gas prices will increase travel costs which may decrease spending at SS given they tend to be more sparsely distributed. However, as research from Gicheva et al.(2007) and Ma et al. (2011) suggests, higher gas prices may lead to shifts in less food away from home and more grocery shopping in general and toward shopping at the lowest cost stores such as SS. With respect to the β's for the interactions of gas price with store densities, we expect negative coefficients for the interactions with CO and CS densities and positive coefficients for interactions with SS densities. In areas with high CO or CS densities, higher gas prices are likely to reduce the percentage of superstore redemptions. Conversely, in areas with high SS densities, higher gas prices may increase superstore redemptions due to the greater availability of such stores.

Results

Table 2 includes the parameter estimates from the three specifications for the full sample (all selected) counties and the higher and lower food desert subsamples. In general the results are significant and signs as expected. For Model 1, an additional dollar in the real (deflated) maximum SNAP benefit increases the amount of benefits redeemed at superstores by about 0.02 percentage points for the full and subset samples. The parameter estimate associated with the ARRA dummy variable is insignificant while its interaction with the maximum SNAP benefit (deflated) is negative and highly significant.[13] The effect of additional CO and CS stores per square mile is as expected with the addition of one of these stores per square mile reducing the percentage of redemptions at superstores by between 2.5 and 7.2 percentage points. These effects are notably larger for additional CS stores in counties with higher food desert populations. An increase in the number of superstores per square mile

[13] The three parameters (maximum benefit (deflated), ARRA, and the interaction term) are jointly significant at the 0.001 level.

has the opposite and magnified effects with the marginal effect of a new store per square mile equal to 22 percentage points for the full sample and 48 percentage points for the subsample with higher proportions of population in food deserts. Somewhat unexpectedly, the effect of increasing population density in higher food desert counties differs in sign compared with the same variable in the full sample and low food desert counties, for which higher population density was associated with lower proportions of SNAP benefits redeemed at superstores. That is, controlling for store density (and other characteristics), population density has a different relationship to the share of redemptions at superstores in high food desert counties than in other counties.

When controlling for gas prices (Model 2), the size of the effect of an increase in the maximum benefit (deflated) is diminished, most notably in the subsample of higher food desert counties. Gas price changes, as measured by the assigned gas CPI indices, have some effect in the full sample and higher food desert counties, but do not appear to affect superstore redemptions in lower food desert counties. Interaction of the gas CPI indices with store density measures (Model 3) produces coefficients that behave as expected and add some explanatory power to the model.

Table 3 provides further elaboration of the estimated effects associated with the ARRA benefit increases. The $80 real increase in the maximum benefit for a family of 4 is estimated to have increased the percent of redemptions in superstores by 1.421 percentage points in the full sample (1.52 percentage points in the absence of ARRA). Unexpectedly the ARRA benefit increase is estimated to have a larger impact in lower food desert counties. We compare this percentage point effect with the changes in the density of stores and gasoline prices that would be needed in order to generate a similar effect on superstore redemptions. For the full sample, superstore density would have to be increased by 59 percent---from approximately 1 store every 24 square miles to 1 store every 15 square miles. For the higher food desert counties, the proportion increase is estimated at 38 percent from 1 store every

34 square miles to 1 every 28 miles. A policy of reducing gas prices by 50 percent is estimated to have minimal effects---increasing superstore redemptions by 0.12 percent in the full sample; 0.24 percent in the higher food desert sample, and not at all in the lower food desert sample.

Policy Implications

The obesity epidemic in the United States, along with persistent disparities in health outcomes across racial, ethnic, and socioeconomic lines that cannot be explained by individual factors alone, have led to increased attention to the role of environmental factors in explaining health differences. One environmental factor that is particularly relevant to obesity and diet-related health is the food environment—what food stores, restaurants and other food vendors are available, what products they sell and for what prices. The term food desert has been used to describe communities, particularly low-income areas, that lack food retailers that sell a full range of foods needed for a healthy diet. Such communities may contain some food stores, but often do not offer healthy foods at all, or if they do, not of the same level of quality, selection, or price as full service grocery stores.

Residents of food desert communities may rely on the offerings of stores in their community, which could mean they have fewer choices for healthy foods, such as fruits and vegetables, and face higher prices. If residents travel to stores with better selection or lower prices outside their immediate neighborhoods, they may incur greater transportation and time costs. With greater travel and time costs, residents of food desert communities may also shop less frequently, which in turn, may affect the types of foods purchased (fewer perishable items) and may require budgeting and meal planning for longer periods.

The potential diet and budget consequences for residents of food deserts have led to several policy initiatives to make healthy foods more accessible to such communities. Access to healthy food is one of four pillars of First Lady Michelle Obama's Let's Move campaign to reduce childhood obesity.

Funding from existing programs from three Federal departments, Treasury, Health and Human Services, and Agriculture will be used to develop sources of healthy food in underserved neighborhoods as part of this initiative.[14] The Federal effort builds upon other state and local efforts to develop retail options in underserved areas in cities such as Philadelphia, New Orleans, and New York, as well as in Pennsylvania and California.

These efforts share a common goal of bringing healthy food to the underserved communities in that they encourage the development of new retailers or modify the offerings in existing retailers in food desert communities. An alternative approach, that has received much less policy consideration, could provide assistance for people to access sources of healthy foods outside of their immediate neighborhoods.. Our results indicate that the ARRA increase in SNAP maximum benefits produced a positive impact on superstore redemptions in a range of diverse counties. Though the estimated impact is smaller in those counties with higher proportions of their populations in food deserts, it could possibly be more cost efficient than supporting the development of an average of 14 new stores in such counties.

The ARRA SNAP benefit increase was designed to diminish in real terms and twilight as food prices rise by 13.6 percent to bring the cost of the Thrifty Food Plan for a family of four to $668 (the current nominal value of the ARRA boosted maximum SNAP benefit.) If the TFP does not reach this value by November 2013 the maximum benefit will revert to the cost of the TFP at that time. Given current federal budget realities, expiration of the benefit increase is likely even though a case can be made that higher SNAP benefits provide needed stimulus to the economy and contribute an incentive for residents of food deserts to overcome access barriers. Further exploration of other alternatives,

[14] See http://apps.ams.usda.gov/fooddeserts/.

such as allowing recipients to use a portion of their benefits as "access dollars" to fund transportation costs to more economical shopping venues, is warranted.

Several caveats need to be recognized that may limit the validity of our findings and conclusions. First, we do not have SNAP redemptions for every county in the U.S. or a random sample of counties. We conducted sensitivity analysis for 206 counties that had at least 300,000 people because the coverage of counties with populations over 300,000 was virtually complete in our dataset.[15] Separately estimated models using only these counties achieved similar results.

Second, there may be economic or other factors which we have not measure that may be partially driving some of the increase in redemptions at superstores. For example, we have taken, as exogeneous, the store density measures. Store authorizations did increase over our study period, primarily in the CO and CS categories. Our results on the impact of ARRA on superstore redemptions could possibly be strengthened if we take into account the changing store environment at the county level.

Further, with the Great Recession, the composition of the SNAP caseload could change greatly and in ways that may be correlated with increased redemptions at superstores. For example, if the recession translated into a SNAP caseload that had slightly higher incomes or resources such as vehicles, we might expect that more of the caseload can access superstores that are farther away. In unreported estimates, we used county-level unemployment statistics and state-level SNAP rule variation to control for such economic conditions and a change in the caseload. Our results did not differ substantially.

[15] Only eight counties with population over 300,000 had missing values and were not included in the dataset.

References

Amanor-Boadu, V. 2009. In Search of a Theory of Shopping Value: The Case of Rural Consumers. *Applied Economic Perspectives and Policy* 31 (3): 589-603.

Block, J.P., N.A. Christakis, J. O'Malley, and S.V. Subramanian. 2011. "Proximity to food establishments and body mass index in the Framingham Heart Study Offspring Cohort over 30 years," *American Journal of Epidemiology* 174(10): 1108-1114.

Boone-Heinonen, J., P. Gordon-Larsen, C.I. Kiefe, J.M. Shikany, C.E. Lewis, and B.M. Popkin. 2011. Fast food restaurants and food stores: longitudinal associations with diet in young to middle-aged adults: The CARDIA Study. *Archives of Internal Medicine*, 171(13): 1162-1170.

Broda, C., E. Leibtag, D.E. Weinstein. 2009. The Role of Prices in Measuring the Poor's Living Standards. *Journal of Economic Perspectives* 23 (2): 77–97.

Chen, S., R.J.G.M. Florax, and S.D. Snyder. 2010. Does Where You Live Make You Fat? Obesity and Access to Chain Grocers. *Economic Geography*, 86(4): 431-452.

Cummins, S.A. Findlay, M. Petticrew, and L. Sparks. 2005. Healthy Cities: The Impact of Food Retail-led Regeneration on Food Access, Choice and Retail Structure. *Built Environment* 31 (4): 288–301.

Feather, P.M. 2003. Valuing Food Store Access: Policy Implications for the Food Stamp Program. *American Journal of Agricultural Economics*, 85(1): 162-172.

Gicheva, D., J. Hastings, and S. Villa-Boas. 2010. Investigating Income Effects in Scanner Data: Do Gasoline Prices Affect Grocery Purchases? *American Economic Review: Papers & Proceedings,* 100): 480–484.

Hausman, J. and E. Leibtag. 2007. Consumer benefits from increased competition in shopping outlets: Measuring the effect of Wal-Mart. *Journal of Applied Econometrics* 22(7): 1157-1177.

Hurst, E. and J.P. Ziliak. 2006. Do Welfare Asset Limits Affect Household Saving? Evidence from Welfare Reform. *Journal of Human Resources* 41(1): 46-71.

Larson, N., M. Story, and M. Nelson. 2009. Neighborhood Environments: Disparities in Access to Healthy Foods in the U.S. *American Journal of Preventive Medicine* 36 (1), 74–81.

Leibtag, E. 2006. The impact of big-box stores on retail food prices and the Consumer Price Index. Economic Research Report No. 33. Economic Research Service, U.S. Department of Agriculture, December, 2006.

Ohls, J.C., M. Ponza, L. Moreno, A. Zambrowski, A., and R. Cohen. 1999. Food Stamp Participants' Access to Food Retailers. Report submitted to U.S. Department of Agriculture, Food and Nutrition Service, by Mathematica Policy Research, Inc.

Rose, D. and R. Richards. 2004. Food Store Access and Household Fruit and Vegetable Use among Participants in the US Food Stamp Program. *Public Health Nutrition* 7(8): 1081-1088.

Rose, D., J.N. Bodor, C.M. Swalm, J.C. Rice, T.A. Fraley, and P.L. Hutchinson 2009. Deserts in New Orleans? Illustrations of Urban Food Access and Implications for Policy, National Poverty Center Working Paper, http://www.npc.umich.edu/news/events/food-access/index.php.

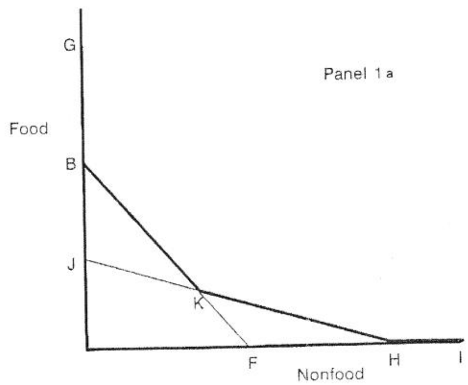
Sullivan, J.X. 2006. Welfare Reform, Saving, and Vehicle Ownership: Do Asset Limits and Vehicle Exemptions Matter? *Journal of Human Resources* 41: 72-105.

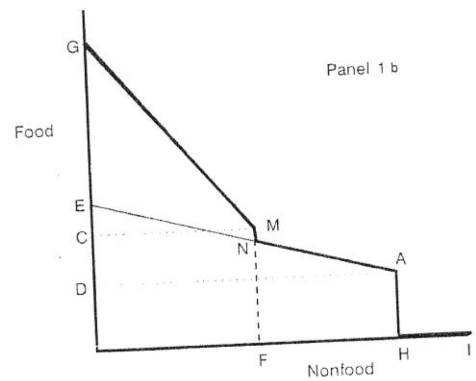
USDA. 2011. Supplemental Nutrition Assistance Program, Benefit Redemption Division 2010 Annual Report. Food and Nutrition Service, Alexandria, VA, May 3, 2011: http://www.fns.usda.gov/snap/retailers/pdfs/2010-annual-report.pdf. USDA. 2009. Access to Affordable and Nutritious Food: Measuring and Understanding Food Deserts and Their Consequences. Report to Congress, Economic Research Service, US Department of Agriculture, Washington, DC.

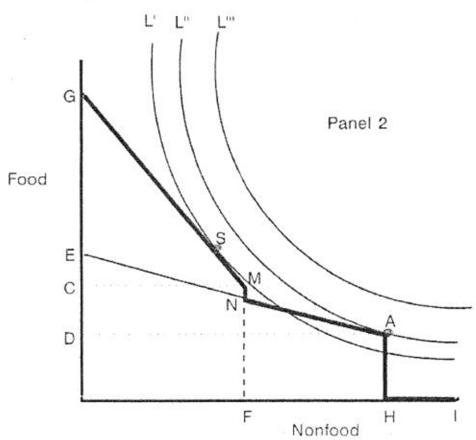
Ver Ploeg, M., D. Nulph, and R. Williams. 2011. Mapping Food Deserts in the U.S. *Amber Waves* 9 (4): 46-49.

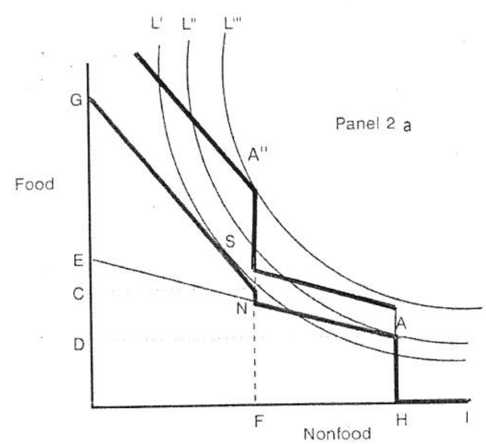
Wrigley, N., D. Warm, and B. Margetts. 2003. Deprivation, diet and food-retail access: findings from the Leeds food deserts study. *Environment and Planning* A 35 (1): 151–188.

Yu Ma, K.L . Ailawadi, K. G. Dinesh, and D. Grewal. 2011. An Empirical Investigation of the Impact of Gasoline Prices on Grocery Shopping Behavior. Journal of Marketing 75(2):18-35.


Panel 1 a
Food
Nonfood
G
B
J
K
F
H
I


Panel 1 b
Food
Nonfood
G
E
C
D
M
N
A
F
H
I


Panel 2
Food
Nonfood
L'
L''
L'''
G
E
C
D
S
M
N
A
F
H
I


Panel 2 a
Food
Nonfood
L'
L''
L'''
G
A''
S
E
C
N
D
A
F
H
I

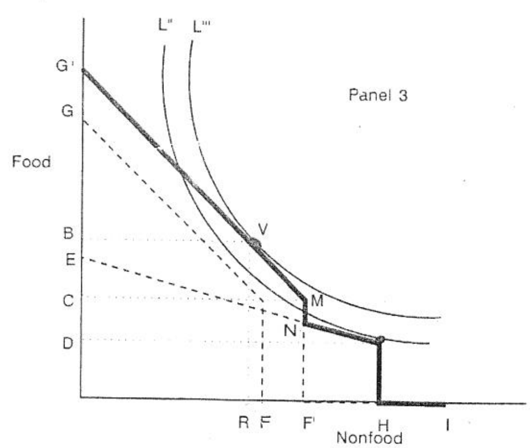

Panel 3
Food
Nonfood
L''
L'''
G'
G
B
E
C
D
V
M
N
R
F
F'
H
I

Figure 2

Percentage of SM/SS redemptions for full data counties, averaged over entire period

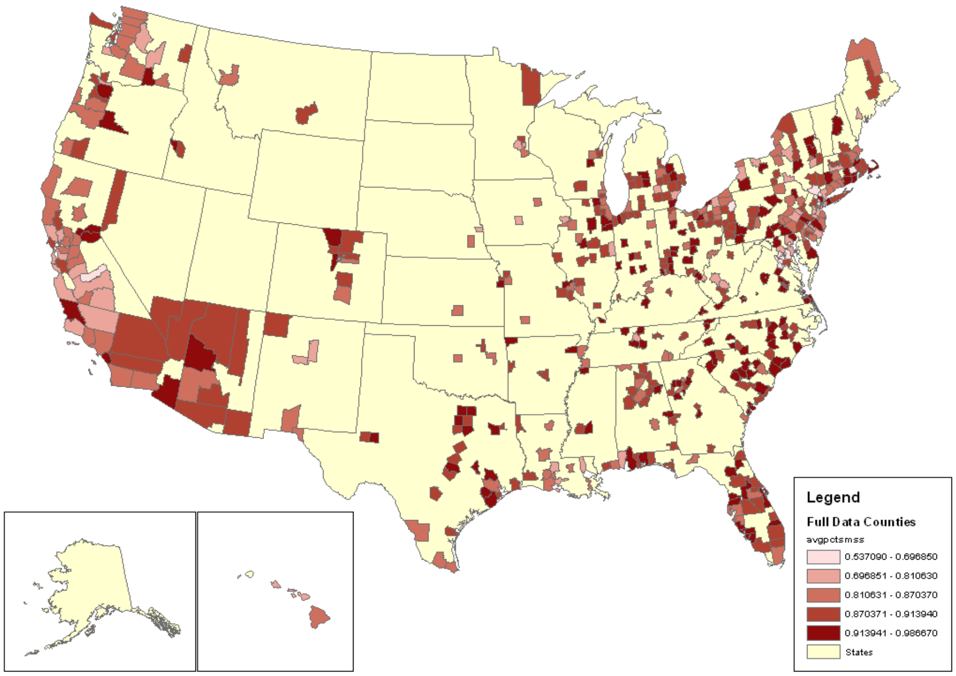


Table 1 : Descriptive statistics for time series data in models of SNAP superstore redemptions

	Full Sample		High Food Desert		Low Food Desert	
	Mean	Std. Err.	Mean	Std. Err.	Mean	Std. Err.
Maximum benefit (deflated)	417.321	2.917	428.688	0.685	405.912	0.844
ARRA benefit boost in effect	0.378	0.005	0.378	0.005	0.378	0.005
Combination (CO) stores per square mile	0.114	0.020	0.074	0.001	0.155	0.007
Convenience (CS) stores per square mile	0.187	0.024	0.130	0.002	0.244	0.007
Super stores (SS)per square mile	0.116	0.018	0.066	0.001	0.166	0.006
Population per square mile (000s)	1.124	0.178	0.573	0.008	1.676	0.057
Gasoline CPI	241.376	0.564	241.301	0.504	241.451	0.511
Interaction terms						
Maximum benefit x ARRA	175.543	1.222	180.238	2.356	170.831	2.267
Gas CPI x co_sqmi	26.829	4.461	17.766	0.237	35.926	1.473
Gas CPI x cs_sqmi	44.168	5.372	31.437	0.578	56.947	1.699
Gas CPI x ss_sqmi	27.280	3.983	16.077	0.211	38.525	1.308
Number of Counties		533	267		266	

Table 2 : Parameter estimates from models of SNAP superstore redemptions

	All Available Counties		Higher Food Desert Counties		Lower Food Desert Counties	
Model 1 Variables	Parameter	Std. Err.	Parameter	Std. Err.	Parameter	Std. Err.
Maximum SNAP benefit (deflated)	0.023 ***	(0.002)	0.020 ***	(0.003)	0.024 ***	(0.002)
ARRA benefit boost in effect	0.311	(0.471)	0.4410	(0.687)	0.3028	(0.603)
Maximum SNAP benefit x ARRA	-0.005 ***	(0.001)	-0.005 ***	(0.001)	-0.005 ***	(0.001)
Combination (CO) stores per square mile	-4.138 **	(1.860)	-4.398 **	(1.786)	-3.474 *	(1.845)
Convenience (CS) stores per square mile	-2.881 ***	(0.985)	-7.159 ***	(2.340)	-2.507 **	(0.954)
Super stores (SS)per square mile	21.987 **	(9.366)	48.463 **	(11.963)	17.914 **	(8.772)
Population per square mile (000s)	8.586 **	(3.355)	-10.568 **	(4.759)	9.672 ***	(3.474)
Constant	67.926 ***	(3.872)	84.532 ***	(2.871)	59.990 ***	(6.094)
Time trend	-0.031 ***	(0.004)	-0.029 ***	(0.005)	-0.027 ***	(0.006)
Observations	19,721		9,879		9,842	
R-squared	0.157		0.233		0.126	
Model 2 Variables	Parameter	Std. Err.	Parameter	Std. Err.	Parameter	Std. Err.
Maximum SNAP benefit (deflated)	0.019 ***	(0.003)	0.013 **	(0.005)	0.023 ***	(0.004)
ARRA benefit boost in effect	0.292	(0.468)	0.3911	(0.684)	0.299	(0.599)
Maximum SNAP benefit x ARRA	-0.005 ***	(0.001)	-0.004 **	(0.002)	-0.005 ***	(0.001)
Combination (CO) stores per square mile	-4.133 **	0.001	-4.509 **	(1.781)	-3.470 *	(1.848)
Convenience (CS) stores per square mile	-2.877 ***	(0.989)	-7.137 ***	(2.340)	-2.504 ***	(0.956)
Super stores (SS)per square mile	21.921 **	(9.379)	48.088 ***	(11.954)	17.894 **	(8.788)
Population per square mile (000s)	8.599 **	(3.358)	-10.489 **	(4.709)	9.671 ***	(3.477)
Gasoline CPI	-0.001 *	(0.001)	-0.002 ***	(0.001)	0.000	(0.001)
Constant	69.606 ***	(4.295)	87.766 ***	(3.5325)	60.411 ***	(6.660)
Time trend	-0.031 ***	(0.004)	-0.029 ***	(0.0047)	-0.028 ***	(0.006)
Observations	19,721		9,879		9,842	
R-squared	0.157		0.235		0.126	

Table 2 : Parameter estimates from models of SNAP superstore redemptions (Continued)

Model 3 Variables	All Available Counties			Higher Food Desert Counties			Lower Food Desert Counties		
	Parameter		Std. Err.	Parameter		Std. Err.	Parameter		Std. Err.
Maximum SNAP benefit (deflated)	0.019	***	(0.003)	0.013	**	(0.005)	0.023	***	(0.004)
ARRA benefit boost in effect	0.301		(0.466)	0.426		(0.684)	0.318		(0.596)
Maximum SNAP benefit x ARRA	-0.005	***	(0.001)	-0.004	**	0.002	-0.005	***	(0.001)
Combination (CO) stores per square mile	-3.247		(2.155)	-5.539		(3.535)	-2.114		(2.071)
Convenience (CS) stores per square mile	-2.131	**	(1.026)	-4.732	**	(2.107)	-1.993	*	(1.057)
Super stores (SS)per square mile	20.817	**	(10.195)	45.542	***	(11.824)	15.965		(9.678)
Population per square mile (000s)	8.455	**	(3.436)	-10.092	**	(4.855)	9.737	***	(3.574)
Gasoline CPI	-0.001	*	(0.001)	-0.002	**	(0.001)	0.000		(0.001)
Gas CPI x co_sqmi	-0.004		(0.003)	0.002		(0.011)	-0.006	**	(0.003)
Gas CPI x cs_sqmi	-0.004	**	(0.002)	-0.011	**	(0.005)	-0.003		(0.002)
Gas CPI x ss_sqmi	0.009	**	(0.004)	0.019	*	(0.012)	0.010	**	(0.004)
Constant	69.721	***	(4.305)	87.611	***	(3.549)	60.408	***	(6.661)
Time trend	-0.031	***	(0.004)	-0.028	***	(0.005)	-0.027	***	(0.006)
Observations	19721			9,879			9,842		
R-squared	0.159			0.238			0.127		

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3. Estimated impacts of SNAP benefit increases, superstore development, and gas price subsidy

	Full Sample Under ARRA		High Food Desert Under ARRA		Low Food Desert Under ARRA	
	Yes	No	Yes	No	Yes	No
SNAP benefit increase	(Percentage increase in SNAP redemptions at superstores, average county)					
$80 real increase in maximum benefit for a family of 4	1.421	1.520	1.146	1.040	1.758	1.800
Superstore development	(Number of new superstores, average county)					
Increase in number of superstores needed for equivalent change in SNAP redemptions	27 (from 1 every 24 sq. miles to 1 every 15 sq. miles)		14 (from 1 every 34 sq. miles to 1 every 28 sq. miles)		36 (from 1 every 16 sq. miles to 1 every 10 sq. miles)	
Gas price subsidy	(Percentage increase in SNAP redemptions at superstores, average county)					
Reducing gasoline prices by 50 percent	0.115		0.244		0.000	