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Does Healthy Food Cost More in Poor Neighborhoods? An Analysis of Retail Food Cost and Spatial Competition

Patrick L. Hatzenbuehler, Jeffrey M. Gillespie, and Carol E. O'Neil

The organization of the Baton Rouge, Louisiana, retail food industry was analyzed to determine whether spatial competition influenced the cost and availability of food items. Using a spatial competition gravity variable, the costs of two separate market baskets were analyzed in January 2009, and the factors influencing spatial competition were determined. Store type (chain or supercenter) was found to be the most significant determinant of food costs, validating findings of past studies. Although food was not found to be more expensive in low-income areas, results suggest that residents in low-income and rural areas have disincentives to purchase affordable, available healthy food due to the spatial organization of their local food market.

Key Words: retail food cost, food availability, spatial retail competition

In recent years, low-income U.S. consumers' health-related concerns associated with diet quality and obesity have been highlighted. Poor diet quality has persisted despite government initiatives designed to educate the public about nutrition [e.g., Dietary Guidelines for Americans (DGA) (U.S. Department of Health and Human Services and U.S. Department of Agriculture 2005)] and to provide food assistance (e.g., the Supplemental Nutrition Access Program). This has led researchers and policymakers to question whether structural economic considerations exist that, until recently, had not been emphasized as potential contributors to poor food choices among low-income people. We seek to determine whether inherent structural conditions such as food pricing, competition, and food availability make healthy diets less accessible to the poor in Baton Rouge, Louisiana, using results from a grocery store survey conducted in January 2009.

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Monsivais, Maclain, and Drewnowski (2010) determined that less healthy, more energy-dense food items cost less than healthier, more nutrient-dense food items, which are consumed by higher-income individuals. We go the next step in determining whether spatial dimensions of food costs further impact access of the poor to healthy, affordable food. If lower competition in low-income retail food markets were to lead low-income consumers to face higher food prices, then lower accessibility and affordability would cause the poor to face relatively high food budget constraints. Specific objectives of this study were to determine (i) whether the poor face higher food costs due to less investment by low-cost food outlets in low-income neighborhoods, and (ii) whether there is less retail food market competition in low-income neighborhoods. We focus on "healthy" market baskets, i.e., those that meet nutritional guidelines such as the DGA, and the Baton Rouge, Louisiana, food retail market.

While this study is of relevance to wide national and international audiences, where diet quality of the poor and obesity have been of significant concern, it is of particular interest in the region where the research was conducted: Baton Rouge, Louisiana. In 2009, Louisiana was ranked second in the U.S. for prevalence of obesity, at a rate of 33 percent (Centers for Disease Control

and Prevention 2010), and the percentage of persons below the poverty level in Baton Rouge, 24 percent, was higher than the U.S. average (U.S. Census Bureau 2011). In response to diet quality concerns, the Healthy Retail Food Act had the goal of increasing access to fruit and vegetables in underserved areas. The Act—Louisiana State Senate Bill 299—was signed by the Governor on July 1, 2009, allowing for potential funding of grants or loans to food providers in underserved areas (Louisiana Legislature 2009). On a national level, Wal-Mart recently announced a campaign to sell more healthful foods in its grocery stores and to locate more stores in underserved areas (Wilgoren and Mui 2011).

Previous Literature

Studies have addressed strategies that low-income consumers use to economize on food, including buying larger packages, using coupons, and devoting more time to finding lower prices (Kaufman et al. 1997). Broda, Leibtag, and Weinstein (2009) found that low-income consumers were more likely to shop at high-cost food outlets such as convenience stores, but also to patronize low-cost food outlets for primary grocery shopping.

Marion et al. (1979) studied the configuration of the U.S. retail food industry and the effects of increased market concentration on food prices and competition. This research was possible due to the availability of comprehensive industry data acquired via congressional subpoena. Most retail food distribution and marketing researchers have been more constrained, without access to such internal, sometimes classified, data sources. Lamm (1981) described the factors influencing retail food costs as being either supply or demand-related, but explained that data limitations often make it difficult to differentiate between the two sets.

A number of cross-sectional exploratory analyses on food price disparities have been conducted. Kaufman et al. (1997), Wendt, Kinsey, and Kaufman (2008), and the USDA June 2009 report to Congress on food access (USDA 2009a) list summaries of food price related studies from the last half-century. Major themes of the studies have been determination of (i) whether retail food price disparities exist between higher and lower-income neighborhoods, (ii) whether neighborhood demographics are associated with price differ-

ences, and (iii) where consumers of varying demographic characteristics shop. Studies have found higher food prices in smaller stores (MacDonald and Nelson 1991, Bell and Burlin 1993, Kaufman et al. 1997, Chung and Myers 1999, Woo et al. 2001) and lower prices at chain stores and supercenters (Bell and Burlin 1993, Kaufman et al. 1997, Chung and Myers 1999, Woo et al. 2001), suggesting that consumers in areas without larger supermarkets, chain stores, or supercenters face price disadvantages.

Two recent analyses have examined consumer purchases to determine whether the poor pay more for food. Beatty (2010) found that, in the United Kingdom, the share of expenditures on food items with quantity discounts decreased as income increased. Broda, Leibtag, and Weinstein (2009) determined that low-income consumers did not pay more than higher-income consumers for food since they were more likely to patronize low-cost stores and supercenters.

Several analyses of food availability and access have been recently undertaken. Rose et al. (2009) and the USDA June 2009 report to Congress on food access (USDA 2009a) examined the challenges facing policymakers who seek to ensure that citizens have sufficient access to nutritious food. Both described the issue of ensuring food access as heterogeneous across regions and neighborhoods due to varying local retail food industry structures. Other recent studies on “food deserts” have included Moreland, Wing, and Diez Roux (2002), Moore and Diez Roux (2006), and Powell et al. (2007), which have found different availability of supermarkets by socioeconomic demographics such as income and ethnicity. Furthermore, Moreland, Wing, and Diez Roux (2002) found increased consumption of fruit and vegetables to be associated with greater supermarket availability.

Overall, previous literature has provided mixed results on whether the poor face different food prices than other consumers. Our analysis of the influence of spatial retail food competition, as well as other demographic and store-specific characteristics on the affordability of retail food, allows for better understanding of low-income consumers’ incentives to purchase healthy food market baskets. We use a unique dataset specifically collected for the purposes of analyzing the cost of a market basket that meets the 2005 DGA while also appealing to the tastes of local consumers. Our study area, the nine-parish (county) Baton

Rouge, Louisiana, metropolitan area, has wide arrays of income levels and supermarket competition, and areas with rural, suburban, and urban status.

Economic Theory and Model

Lamm (1981, p. 69) outlined five determinants of retail food prices to be “demand controls, marginal costs, market concentration, barriers to entry, and operational scale in any retail food market.” The economic model for our study was constructed based on these five factors, with market concentration and barriers to entry variables being considered as part of the spatial competition variable. The basic economic model is

$$(1) \quad \text{Comp}_i = f(D_i)$$

$$(2) \quad \text{Cost}_i = f(MC_i, \text{Comp}_i),$$

where Comp_i is a spatial competition index for store i , a proxy for market concentration and entry barriers; D_i are demand conditions for store i ; Cost_i is the cost of a market basket purchased at store i ; and MC_i are marginal costs for store i . Since competition is impacted by demand factors, Stewart and Davis (2005) presented a similar two-equation system to separate demand and supply-side cost factors. Comp serves as a supply variable, which Stewart and Davis (2005) measured as the count of stores within a zip code. Our Comp is constructed such that stores in closer proximity to one another are weighted more heavily than those further away, discussed in greater detail in the next section. However, Cost_i and Comp_i are likely to be simultaneously determined; thus both are endogenous and Comp_i would be correlated with the error term in equation (2). Given this, a reasonable solution is to estimate equation (1) and use the predicted values for Comp_i as an instrumental variable in equation (2). Since in the second stage a predicted rather than a measured variable is used, heteroskedasticity-consistent robust standard errors are estimated. A reduced-form model that is a hybrid including both demand and supply effects, borrowing heavily from Binkley and Connor (1998) and Stewart and Davis (2005), would be

$$(3) \quad \text{Cost}_i = f(D_i, MC_i).$$

Data and Methods

Food cost and store-specific data used in estimating equations (1)–(3) were acquired via a three-week survey of 60 supermarkets in the Baton Rouge, Louisiana, metropolitan area during January 2009. Items priced in the survey included (i) all foods in the “Recipes and Tips for Healthy, Thrifty Meals” (TFP) menu developed by Pennsylvania State University in conjunction with the USDA Center for Nutrition Policy and Promotion (USDA 2000), designed as a low-cost two-week menu intended for short-term use, (ii) all foods in a two-week menu meeting the food recommendations of the 2005 Dietary Guidelines for Americans (DGA) that was designed to be representative of diets in Southern Louisiana (Stewart 2006), hereafter called the Stewart DGA market basket, and (iii) other items commonly consumed by low-income individuals in Louisiana, determined based on 24-hour diet recalls (Smith 2002). Hatzenbuehler (2010) provides complete lists of food items included in each menu and the survey.

The TFP menu is considered to be a healthy, affordable menu that can be purchased by a low-income family of four using USDA Food and Nutrition Service, Supplemental Nutrition Assistance Program (SNAP) benefits (USDA 2011). Though it was designed to meet the 1995 DGA (U.S. Department of Health and Human Services and U.S. Department of Agriculture 1995), it does not meet the 2005 DGA, with Jetter and Cassady (2006) pointing out that it is low in the leanest meats and whole grains. A criticism of past studies has been that assumed market baskets have not been representative of those that consumers would actually purchase, considering regional differences. Jetter and Cassady (2006) and Andrews et al. (2001) used the TFP market basket in their analyses, the latter stating that, although unrepresentative, the TFP market basket was useful for comparison of costs across a cross-section of stores. Block and Kouba (2006) analyzed the TFP market basket, but also included items identified by community members to be important in local diets.

The Stewart DGA market basket was designed by Stewart (2006) with the objective of meeting the 2005 DGA while appealing to Southern Louisiana tastes and preferences. The Stewart DGA market basket includes food menu items such as potato salad, Cajun spiced chicken, green bean

casserole, beef pot roast with vegetables, Mardi Gras chicken, and others. Across 59 grocery stores, as shown in Table 1, its average cost was \$270.11, versus \$259.61 for the TFP market basket, so the difference in cost between the diets for one month would be approximately \$22.50.

For the survey, a supermarket was assumed to be a store within which it should be possible to obtain a full market basket of all food types without making an unreasonable number of substitutes. The store must have had both produce and fresh meat sections. The store list was developed from the list by Stewart (2006) and verified using the local phone directory, individual chain websites, the Associated Grocers website, and individual survey via automobile. Eighty-two supermarkets were identified in the nine-parish Baton Rouge metropolitan area.

After initial training, surveyors (six individuals including faculty, staff, and students with the Louisiana State University Agricultural Center) participated in the first survey as a group to confirm consistent price-recording methods. Sizes for the packaged items were specified on the food list. The surveyor recorded the lowest-priced item, including a sale price if it was the lowest. Brand was not considered. This assumes that store brands and name brands have the same nutritional content, which would generally be the case for most foods, though some minor differences would be expected for more extensively processed items. For instance, there might be differences in the fiber content of whole wheat bread. We did not record this level of detail in our survey, so we do not analyze "quality" by store, a limitation of the study. It is noted, however, that any nutritional differences by brand would not necessarily favor the higher-priced product. If the specified size was unavailable, a similar-sized item of the same type was recorded if available, with the size noted. Surveyors priced items that were of reasonable size for a family of four to consume in a reasonable time period prior to spoilage. Therefore, bulk items were not priced.

Items may be missing due to their being out of stock, the store not selling them, or surveyor error. From the list of 208 foods on the survey form, the average number of missing items was 21, the minimum was one, and the maximum was 68, an outlier. However, for the 2005 DGA and TFP menus specifically, the average number of missing items was only 1.73 and 2.36, respec-

tively. The lowest number of missing items for the 2005 DGA was 0 and the maximum was 9. The lowest number of missing items for the TFP was 0 and the maximum was 7. To analyze this, a count data regression equation similar in structure to equation (3) uses counts of missing items of the two market baskets as the dependent variable, a function of the same variables included in equation (3). Poisson regression analysis, as discussed by Greene (2000, p. 884), is used for the count data analysis. Either Poisson or negative binomial regression may be used for count data analyses, with the limitation of Poisson regression being the assumption of equal conditional mean and variance functions. To test for the Poisson distribution, both models were run and a Wald test carried out for both market baskets, as suggested by Greene (2000, p. 887), with results suggesting use of the Poisson regression.

Kaufman et al. (1997) listed ways researchers have dealt with missing items: entering prices for missing items based on prices of related items, leaving missing items out of the analysis, etc. We replaced missing items with "nutritionally equivalent" substitutes, determined by a registered dietitian at Louisiana State University.¹ The assumption is that conscientious consumers attempting to meet dietary guidelines would substitute missing items with nutritionally similar items rather than stop at multiple supermarkets. Lists of substitutes for each item are found in Hatzenbuehler (2010). In cases where chosen substitute items were not equivalent to the missing item in terms of refuse produced (i.e., boneless turkey breast substituted with bone-in chicken fryer), percent refuse was considered when determining the amount of the substitute item to include, the conversion based on USDA National Nutrient Database information (USDA 2009b).

Along with pricing data for each store, additional data were collected on store size and services offered. Demographic data by census tract in which the store was located are from the 2000 Census, downloaded from Atlas: the Louisiana Statewide GIS.²

¹ Carol E. O'Neil, Ph.D., R.D.

² [Http://atlas.lsu.edu/](http://atlas.lsu.edu/).

Table 1. Descriptive Statistics for Dependent and Independent Variables (59 observations)

Variable	Units	Mean	Minimum	Maximum
<i>TFP Market Basket Cost</i>	\$	259.61	204.93	318.09
<i>Stewart Market Basket Cost</i>	\$	270.11	212.11	346.97
<i>Population Density</i>	No./mi ² /1,000	1.773	0.036	5.358
<i>Income</i>	\$/1,000	40.704	17.170	77.668
<i>Household Size</i>	No.	2.61	1.87	3.08
<i>Chain</i>	0–1	0.38	0	1.00
<i>Supercenter</i>	0–1	0.18	0	1.00
<i>Services</i>	No.	3.08	0	6.00
<i>Store Size</i>	ft ² /1,000	12.291	1.620	50.964
<i>Black</i>	%	32.53	0.50	97.00
<i>Other Minority</i>	%	4.55	1.06	11.96
<i>Competition Index</i>	From equation (4)	6.014	0	15.034

Dependent Variables

Equations (2) and (3), with dependent variable *Cost*, were first evaluated as the cost of purchasing the TFP market basket for a family of four for two weeks. Then they were evaluated as the cost of purchasing the Stewart DGA market basket, also for a family of four for two weeks. Finally, they were evaluated as the total cost of four components of the 2005 Dietary Guidelines of Americans within both market baskets: lowfat dairy products, whole grains, dark green vegetables, and fruit. These individual components were chosen because they were among the “Food Groups to Encourage” in the Dietary Guidelines (DGA 2005). The $Cost_i$ calculation is in ounces consumed rather than “as purchased,” so it does not account for non-consumption due to disposal or spoilage. The ounces consumed are those specified in the TFP and Stewart market baskets.

The dependent variable for equation (1), $Comp_i$, is a spatial competition gravity index variable, created to measure degree of competition within a ten-mile radius of the supermarket. Areas outside a ten-mile radius of a supermarket were described by Blanchard and Lyson (2003) as having low access. Our gravity index is an adaptation of a retail gravity model developed by Bucklin (1971), assuming consumers are more likely to patronize geographically closer stores. We created a continuous retail gravity weight:

$$(4) \quad Comp_{ij} = \sum_{j=1}^n \frac{Distance_{ij}}{(Distance_{ij})^2},$$

where i refers to store i , and n is the number of competing stores, j , within a ten-mile radius of store i . Stores beyond ten miles of supermarket i were not considered in the gravity model calculation, as they were not considered to be competitors. Distances from store i to its competitors j were measured using MapQuest, which calculates travel distance between stores rather than distance of a straight line segment between them. The gravity index is not limited to the 60 surveyed stores, but also includes all other supermarket competitors. The gravity index is weighted so that a higher $Comp$ results from (i) closer competitors and (ii) more competitors.

Independent Variables

Independent variables included in the econometric models borrow heavily from Binkley and Connor (1998) and Stewart and Davis (2005). *Population Density*, *Income*, *Household Size*, and two minority variables indicate population characteristics of the census tract in which the supermarket was located, serving as proxies for demand D_i in equations (1) and (3). Population per square mile within each store's census tract, *Population Density* (divided by 1,000); median household in-

come, *Income* (divided by 1,000); and *Household Size* (persons per household) are included, with increased values of each expected to increase demand and, thus, *Comp*. Minority variables, *Black* and *Other Minority*, respectively represent percentages of residents self-identified as black or as part of another ethnic group other than white. Broda, Leibtag, and Weinstein (2009) and Hoch et al. (1995) found areas with higher percentages of minority populations to be more price-sensitive. Minority variables account for varying tastes and preferences by ethnic group. Since store owners choose to locate based on demand and consumers may locate based on amenities, there is the potential for endogeneity for each of the independent variables. It is recognized, however, that given the use of cross-sectional data at one point in time, it would be difficult to identify better instruments. Hausman (1978) tests for endogeneity were run individually for each of the independent variables in the *Comp* equation, with each instrumental variable run, including all variables in the *Comp* equation plus the average number of children in the household. None of the variables were found to be endogenous at $P \leq 0.05$.

We include four variables as proxies for cost structure, *MC* in equations (2) and (3). Bell and Burlin (1993) and Chung and Myers (1999) found “chain stores” to have lower prices. *Chain* is a binary variable distinguishing between chain and independent stores, expected to be negatively related to *Cost_i*. Basing our analysis on Marion et al. (1979), we consider any store owned by a firm owning and operating eleven or more stores to be a chain. *Supercenter* is a binary variable representing supercenter-style stores, defined as being “a very large discount department store that also sells a complete line of grocery merchandise” (Merriam-Webster 2011). Based on Leibtag (2005), *Supercenter* would be expected to have a negative relationship with *Cost*. In this analysis, all supermarkets are categorized into only one of three groups: supercenters, chains, or independents.

Services is a count of the following available supermarket services: salad bar, olive bar, prepared hot meals, prepared salads, full-service deli, and full-service bakery. Stores with more services generally have higher costs (Anderson 1993). MacDonald and Nelson (1991), Anderson (1993), and King, Leibtag, and Behl (2004) found positive relationships between the number of services provided and food prices due to increased labor and other variable costs.

Store Size ($\text{ft}^2/1,000$) is retail space as measured by the surveyors. MacDonald and Nelson (1991), Binkley and Connor (1998), and Hayes (2000) identified store size as an important economy of scale variable. Alternatively, Anderson (1993) suggested that larger stores tend to have longer hours and higher utility costs, serving to increase costs.

Results

Table 1 lists dependent and independent variables and descriptive statistics. Mean TFP and Stewart DGA market basket costs were \$259.61 and \$270.11, respectively, including 59 of the surveyed observations. One of the 60 surveyed stores was not included because, as a full-service upscale grocery store that specialized in foods from non-conventional agricultural production systems, such as organic, natural, etc., it was a distinct outlier in terms of food cost, thus skewing the data. With its inclusion, the assumption of a normal distribution was rejected. Note the disparities in variables such as income, ethnicity, and population density across census tracts. Figure 1 further illustrates the income disparities. Results of estimates for equations (1) and (2) are shown in Tables 2 and 3. For the first-stage *Comp* equation, all but one of the explanatory variables (*Other Minority*) were significant. *Population Density* was significant ($P \leq 0.01$) and estimated to increase competition. *Income* also had a positive relationship with competition ($P \leq 0.01$). Figure 1 illustrates this: in the 16 lowest income census tracts with median household incomes of $\leq \$20,000$, there were only two supermarkets; however, in the six highest income census tracts with median household incomes of $\geq \$65,000$, there were four. *Household Size* was significant ($P \leq 0.01$) and estimated to negatively impact competition. The significant *Black* variable ($P \leq 0.05$) suggested greater competition in areas with greater proportions of African Americans. Based on the White test, Shapiro-Wilk test, Condition Indices, and Moran’s I test, heteroskedasticity, collinearity, and spatial autocorrelation did not appear to be influencing the data.

Coefficient estimates for second-stage *Cost* regressions are shown in Table 3. In their two-equation system, Stewart and Davis (2005) found the number of fast-food stores to be significant in

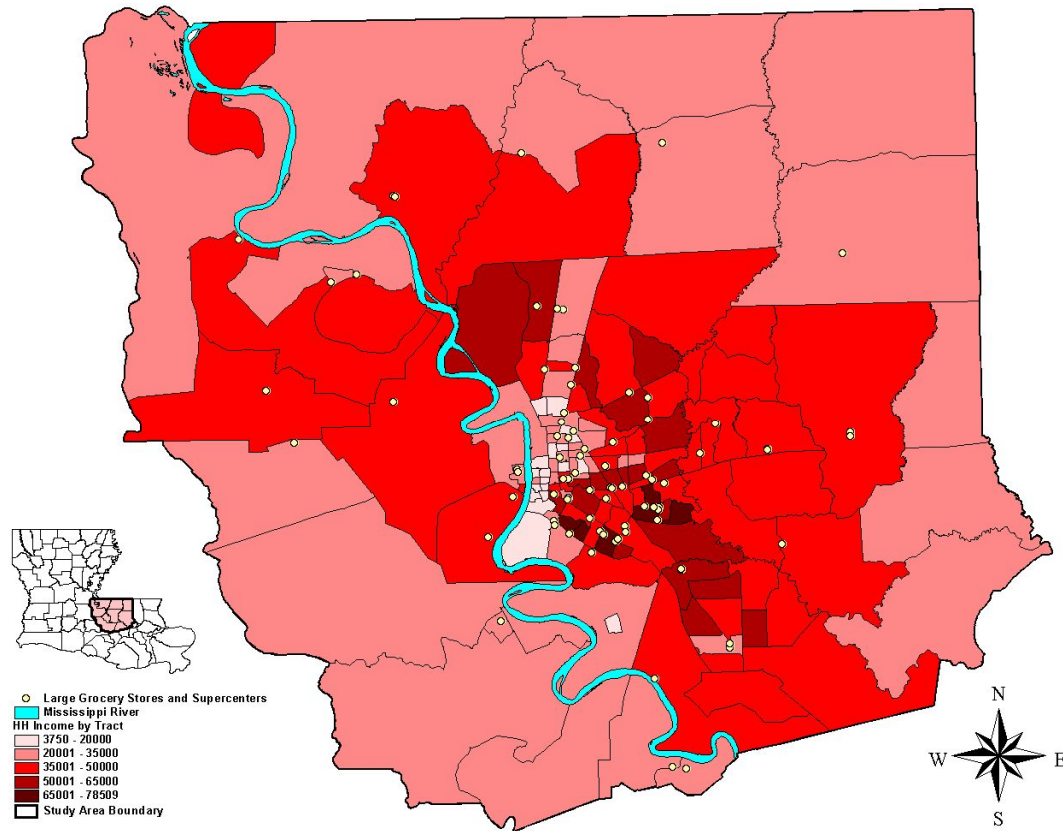


Figure 1. Location of Supermarkets, by Census Tract Median Household Income, Baton Rouge Metropolitan Area

the second-stage equation. Since number of fast-food stores was the dependent variable in their first-stage equation, they could discuss the impact of first-stage independent variables on fast-food meal price. The instrumental variable for *Comp*, which was the predicted value estimated in equation (1), was non-significant in the second stage, deeming it inappropriate to discuss the impacts of first-stage significant variables on market basket cost. We tried replacing *Comp* with the number of supermarkets (by zip code) in both stages, similar to Stewart and Davis (2005), but this variable was also non-significant in the second-stage equation.³

³ Inclusion of the actual value for *Comp* in equation (2), though inappropriate assuming endogeneity, also showed no significance.

Variables influencing the cost of the TFP and Stewart DGA market baskets were *Chain* and *Supercenter*. Relative to non-chain, non-supercenter stores, chain stores had TFP and Stewart DGA market basket costs that were \$21.81 and \$22.50 lower, respectively. Relative to non-chain, non-supercenter stores, supercenters had TFP and Stewart DGA market basket costs that were \$51.78 and \$49.52 lower, respectively. No other variable was significant in this analysis.

Further analysis was conducted to determine which factors influenced the cost components of lowfat dairy products, whole grains, dark green vegetables, and fruit, as shown in Table 4. As with the total market baskets for the TFP and Stewart DGA, *Supercenter* and *Chain* were the variables that were the most significant in determining cost. *Supercenter* was negative and significant for all components for both the Stewart DGA and TFP market baskets, while *Chain* was

Table 2. First-Stage Equation of Two-Stage Model (dependent variable *Comp*)

Variable	Competition, 59 Stores	
	β	t-value
Intercept	9.90***	2.05
<i>Population Density</i>	1.16***	2.93
<i>Income</i>	0.15***	3.30
<i>Household Size</i>	-5.37***	-2.89
<i>Black</i>	0.06**	2.25
<i>Other Minority</i>	0.03	0.22
\bar{R}^2	0.4912	
Model F-value	12.20***	
White test p-value	0.5945	
Shapiro-Wilk p-value	0.0180	
Condition index (highest value)	4.0365	
Moran's I p-value	0.9723	

Note: ** and *** indicate significance at the 5 percent and 1 percent levels, respectively.

Table 3. Second-Stage Equation, Costs of TFP and Stewart DGA Market Baskets

Variable	TFP Market Basket Cost 59 Stores		Stewart Market Basket Cost 59 Stores	
	β	t-value	β	t-value
Intercept	279.61***	31.04	288.98***	38.24
<i>Chain</i>	-21.81**	-2.02	-22.50**	-2.24
<i>Supercenter</i>	-51.78***	-8.49	-49.52***	-8.71
<i>Services</i>	-1.05	-0.47	-2.33	-1.02
<i>Store Size</i>	0.57	1.11	0.47	1.20
Pr-competition	-1.01	-0.83	0.02	0.01
\bar{R}^2	0.3430		0.3655	
Model F-value	7.06***		7.68***	
White test p-value	0.1505		0.1076	
Shapiro-Wilk p-value	0.2674		0.3848	
Condition index (highest value)	2.5342		2.5342	
Moran's I p-value	0.7323		0.4564	

Note: ** and *** indicate significance at the 5 percent and 1 percent levels, respectively.

Table 4. Stewart DGA and TFP Market Basket Second-Stage Equations for Individual Food Categories

Stewart 2005 Dietary Guidelines for Americans Market Basket								
	Lowfat Dairy Products		Whole Grains		Dark Green Vegetables		Fruit	
Variable	β	t-value	β	t-value	β	t-value	β	t-value
Intercept	53.05***	28.15	25.79***	13.39	9.22***	17.68	27.72***	24.29
<i>Chain</i>	0.53	0.27	-1.31	-0.69	-0.85	-1.33	-5.49***	-3.71
<i>Supercenter</i>	-5.74***	-4.32	-5.67***	-4.74	-2.10***	-4.81	-5.67***	-7.00
<i>Services</i>	-0.76	-1.43	-1.23**	-2.35	-0.15	-0.90	-0.11	-0.31
<i>Store Size</i>	-0.12	-1.35	-0.04	-0.45	0.04	1.05	0.18***	3.23
Pr-competition	0.33	1.49	-0.18	-0.85	0.01	0.07	0.01	0.04
\bar{R}^2	0.2370		0.2217		0.1372		0.3065	
Model F-value	4.60***		4.30***		2.85**		68.78***	
Thrifty Food Plan Market Basket								
Intercept	31.98***	33.04	2.93***	12.21	1.43***	14.19	63.48***	14.99
<i>Chain</i>	1.42	1.20	-0.48**	-2.28	-0.23**	-2.11	-11.11***	-3.25
<i>Supercenter</i>	-2.12***	-3.83	-0.76***	-4.64	-0.41***	-4.11	-17.30***	-6.36
<i>Services</i>	-0.24	-0.88	-0.10	-1.96	0.00	0.08	-1.06	-1.23
<i>Store Size</i>	-0.05	-1.05	0.00	0.04	0.00	0.51	0.35	1.97
Pr-competition	-0.02	-0.15	-0.00	-0.00	0.00	-0.48	-0.25	-0.60
\bar{R}^2	0.1469		0.2030		0.1376		0.2801	
Model F-value	3.00**		3.95***		2.85**		5.51***	

Note: ** and *** indicate significance at the 5 percent and 1 percent levels, respectively.

negative and significant for the Stewart DGA fruit equation and the TFP whole grains, dark green vegetables, and fruit equations. In only two cases were additional variables significant in the food component analyses: *Services* decreased the cost of whole grains and *Store Size* increased the cost of fruit in the Stewart DGA market basket.

Analyses led us to question whether significant relationships existed between income and locations of chain stores and supercenters. Though maps of census tracts where the stores were located did not indicate obvious relationships, several regressions were run with binary dependent variables, *Chain* and *Supercenter*, and explanatory variables including *Income* and other demographic variables. In none of these models was *Income* ever statistically significant, so we cannot conclude that household income levels influence chain or supercenter location.

With the predicted value of *Comp* being non-significant in equation (2), we estimated equation (3) to determine whether direct estimation of the reduced-form model would show demographic variables influencing market basket cost. The reduced-form model (3) was analyzed using ordinary least squares (OLS). Table 5 shows results for the two market baskets. Results of analyses of the variation in the TFP and Stewart DGA market basket costs are notably similar. Similar to the two-equation model, both *Supercenter* estimates were significant ($P \leq 0.01$), with the TFP and Stewart DGA supercenter market baskets estimated to cost about \$50 less than at non-supercenter, non-chain supermarkets. Both *Chain* estimates were also significant ($P \leq 0.05$), with TFP and Stewart DGA chain store market baskets estimated to cost about \$20 less than at non-supercenter, non-chain supermarkets. However, similar

Table 5. Thrifty Food Plan and Stewart DGA Market Basket Ordinary Least Squares Reduced-Form Cost Results

Variable	TFP Market Basket Cost 59 Stores		Stewart DGA Market Basket Cost 59 Stores	
	β	t-value	β	t-value
Intercept	268.06***	5.58	270.71***	6.26
<i>Population Density</i>	-2.88	-0.79	-1.48	-0.45
<i>Income</i>	0.29	0.76	0.52	1.50
<i>Household Size</i>	1.01	0.06	-0.33	-0.02
<i>Chain</i>	-19.34**	-2.10	-20.48**	-2.47
<i>Supercenter</i>	-52.17***	-5.68	-50.49***	-6.11
<i>Services</i>	-2.34	-0.80	-3.33	-1.27
<i>Store Size</i>	0.61	0.47	0.53	1.27
<i>Black</i>	-0.00	-0.01	0.09	0.46
<i>Other Minority</i>	-0.27	-0.23	-0.16	-0.15
\bar{R}^2	0.3250		0.3655	
Model F-value	4.10***		4.71***	
White test p-value	0.2075		0.1404	
Shapiro-Wilk p-value	0.3682		0.6414	
Condition index (highest value)	3.1991		3.1991	
Moran's I p-value	0.7182		0.5819	

Note: ** and *** indicate significance at the 5 percent and 1 percent levels, respectively.

to the two-equation model, the reduced-form model did not provide evidence of demographic variables influencing market basket cost when the entire market baskets were evaluated. The insignificant White Test and low condition index values suggest no evidence of heteroskedasticity or multicollinearity. Insignificant Shapiro-Wilk W statistics suggest that the null hypothesis of normality of the residuals could not be rejected.

When the components of the market baskets were analyzed using the reduced-form model, several demographic variables became significant in a few cases (Table 6). In addition to the importance of *Supercenter* in each of the component equations and *Chain* in three of the eight, (i) higher *Income* of the area where the store was located increased the costs of the Stewart DGA lowfat dairy and fruit components, (ii) larger *Store Size* increased the costs of the Stewart DGA and TFP fruit components, and (iii) *Black* increased the costs of the Stewart DGA lowfat dairy

products component. These results suggest that, as found by Jetter and Cassady (2006), cost components may differ by demographics.

Due to the spatial nature of the data, spatial autocorrelation was tested. Fotheringham, Brundson, and Charlton (2000) suggested spatial autocorrelation to be present when trends in the distribution of a variable exist over space. Positive spatial autocorrelation can prevent OLS estimates from being unbiased and efficient (Anselin 1980). Zenk et al. (2005) found empirical evidence of positive spatial autocorrelation in a supermarket study. In our study, using GeoDa, Moran's I statistic was insignificant in all regressions, providing no evidence of spatial autocorrelation.

Analysis of Missing Items

Table 7 shows results of the Poisson regressions of counts of missing items in the two market baskets. For both market baskets, larger stores that

Table 6. Stewart DGA and TFP Market Basket Reduced-Form Equations for Individual Food Categories

Stewart 2005 Dietary Guidelines for Americans Market Basket								
	Lowfat Dairy Products		Whole Grains		Dark Green Vegetables		Fruit	
Variable	β	t-value	β	t-value	β	t-value	β	t-value
Intercept	56.21***	5.80	15.30	1.58	6.37**	2.10	30.63***	4.83
Population Density	-0.46	-0.62	0.15	0.20	-0.07	-0.29	-0.74	-1.54
Income	0.17**	2.19	-0.01	-0.17	0.02	1.00	0.13**	2.55
Household Size	-3.85	-1.07	3.60	1.00	0.52	0.46	-2.59	-1.10
Chain	0.94	0.50	-1.71	-0.92	-0.81	-1.39	-4.67***	-3.84
Supercenter	-5.62***	-3.03	-5.93***	-3.20	-2.27***	-3.92	-5.63***	-4.64
Services	-0.85	-1.45	-1.01	-1.71	-0.18	-0.97	-0.51	-1.32
Store Size	-0.11	-1.18	-0.02	-0.23	0.04	1.46	0.18***	2.94
Black	0.10**	2.15	-0.01	-0.20	0.01	0.65	0.03	1.16
Other Minority	-0.11	-0.46	-0.02	-0.10	0.11	1.42	-0.08	-0.53
\bar{R}^2	0.2407		0.1784		0.1433		0.3778	
Model F-value	3.04***		2.40**		2.08**		4.91***	
Thrifty Food Plan Market Basket								
Intercept	35.87***	7.01	2.11	1.82	0.97	0.63	64.03***	3.46
Population Density	-0.67	-1.72	0.02	0.25	-0.04	-0.73	-1.94	-1.38
Income	0.06	1.43	0.00	0.35	0.00	0.87	0.23	1.52
Household Size	-2.23	-1.17	0.23	0.54	0.07	0.30	-3.77	-0.55
Chain	1.94	1.98	-0.49**	-2.22	-0.21	-1.77	-10.09***	-2.84
Supercenter	-2.01**	-2.06	-0.80***	-3.61	-0.42***	-3.54	-16.91***	-4.78
Services	-0.48	-1.56	-0.09	-1.30	-0.00	-0.08	-1.36	-1.21
Store Size	-0.06	-1.21	0.00	0.14	0.00	0.42	0.38**	2.08
Black	0.03	1.36	-0.00	-0.04	0.00	0.74	0.13	1.45
Other Minority	0.04	0.29	0.01	0.22	0.01	0.66	-0.43	-0.93
\bar{R}^2	0.1491		0.1524		0.1135		0.2893	
Model F-value	2.13**		2.16**		1.83		3.62***	

Note: ** and *** indicate significance at the 5 percent and 1 percent levels, respectively.

provided more services had fewer missing items, a result that was expected. *Income* was significant at the $P \leq 0.01$ level for the Stewart DGA market basket, suggesting that stores in higher-income areas had fewer missing items than those in lower-income areas. Though *Income* was not significant in the TFP analysis at $P \leq 0.05$, it was significant

at $P \leq 0.10$, suggesting a potential negative relationship between income and availability of foods for that market basket, as well. Furthermore, stores in areas with higher percentages of African American residents had fewer missing items for the Stewart DGA market basket.

Table 7. Maximum-Likelihood Estimates of Poisson Regressions with Robust Standard Errors

Variable	Stewart DGA Market Basket		TFP Market Basket	
	β	Standard Error	β	Standard Error
Intercept	2.19	1.85	1.15	1.51
<i>Population Density</i>	0.21	0.12	0.03	0.10
<i>Income</i>	-0.04***	0.01	-0.02	0.01
<i>Household Size</i>	1.02	0.62	0.57	0.53
<i>Chain</i>	0.53	0.37	0.11	0.28
<i>Supercenter</i>	0.01	0.40	0.01	0.27
<i>Services</i>	-0.25***	0.09	-0.15**	0.08
<i>Store Size</i>	-0.12***	0.03	-0.04**	0.02
<i>Black</i>	-0.03***	0.01	-0.01	0.01
<i>Other Minority</i>	-0.08	0.05	-0.02	0.04
Log likelihood	22.24		5.84	

Note: ** and *** indicate significance at the 5 percent and 1 percent levels, respectively.

Conclusions

Our results do not suggest that supermarkets located in lower-income areas charge more for healthy market baskets that meet the TFP and 2005 DGA than stores in higher-income areas. In fact, for two components of the Stewart DGA market basket (lowfat dairy products and fruit), stores in the higher-income areas of Baton Rouge, Louisiana, charged more. As previous studies have suggested, however, the major drivers for market basket cost were whether the store was a supercenter or part of a chain, regardless of whether the reduced-form or two-stage models were used. Further investigation did not suggest that supercenter and chain locations depended upon income level. Some of the chains tended to be located in lower-income neighborhoods, while others were in higher-income areas.

Degree of supermarket competition, however, was highly dependent upon income—the higher the census tract income level, the more competition, as shown in Figure 1. This suggests that, although healthy market baskets that meet the DGA may be just as affordable in lower-income as in higher-income areas, there are not as many stores in the lower-income areas. Thus, lower-income shoppers must travel further and/or have fewer shopping options than do higher-income shop-

pers. The bigger concern, then, for the low-income household may be the availability of close supermarkets rather than the prices charged for food in the markets that are available. Distance of a store from the shopper's home would be of particular concern for low-income individuals who may not have access to an automobile and/or must depend upon public transit, walking, or friends and family to access supermarkets. Wal-Mart's recent campaign to locate more stores in underserved areas is consistent with the need for greater access. Of additional concern is that the grocery stores in lower-income areas had more missing items than did those in higher-income areas. Thus, not only might access to a grocery store be of concern for low-income residents, but also access to specific food items in the available grocery stores.

From a policy perspective, issues that may need to be addressed with regard to low-income nutrition would include supermarket access—affordable transportation would be one primary concern. Furthermore, grants and loans that provide funding for new construction of supermarkets in low-income areas, as well as store renovations through Louisiana's Healthy Food Retail Act, should increase access to affordable, healthy food.

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