Location Choice and Local Foods: A Micro-Level Analysis of Household Health Tradeoffs

Abstract

A significant amount of attention has been focused on both the prevalence of obesity in the United States and the corresponding interest in maintaining a healthy lifestyle; one aspect of this trend is food access. This study uses real estate prices in the Cleveland area to assess consumer preferences for healthy and local food options. Specifically, a sorting model is employed to account for feedback effects whereby consumers settling in certain areas can actually affect the provision of amenities in that neighborhood. I find that in addition to traditional location drivers such as school quality, consumers take food access into account when deciding where to live. Additionally, households value both traditional healthy retailers as well as local food establishments. Using the ordered probit from the local food competition model I allow for endogeneity in the sorting process as households that move can impact the subsequent provision of local public goods.

1. Introduction

More than one-third of U.S. children are obese and in 2008 obesity-related medical costs totaled $147 billon. As concerns about the obesity epidemic increase so does an emphasis on living a healthier lifestyle by consuming fewer or healthier calories and exercising more. Each of these decisions can be thought of as an input to a health production function. Namely, health outcomes are a function of food intake, exercise, demographics and preferences. Many healthy inputs are directly tied to an individual's location decision as food access and recreation opportunities are likely to vary widely across space. Food access can encompass a variety of businesses including supermarkets, farmer's markets and restaurants, while recreation options can range from nearby gyms to local parks. Successful policy interventions targeting public health through changes in zoning and land use need to consider the tradeoffs households are willing to make in regards to their health as revealed through residential location decisions.

In addition to preferences for public goods, a fundamental aspect of the locational decision-making model is household income. This is especially imperative empirically as income segregation is prevalent in American neighborhoods, and has increased in 27 of the 30 major metropolitan areas since 1980 (Fry and Taylor, 2012). Studies have shown that this income segregation can result in disparate neighborhood amenity provision and health outcomes. For instance, low income residents tend to have reduced access to healthy food retail stores such as supermarkets[1] and live in neighborhoods with a greater number of unhealthy food establishments (Zenk and Powell, 2008), which has material consequences for residents as there is a potential relationship between access to healthy food and diet[2]. Specifically, studies have shown that access to supermarkets is associated with a reduced obesity risk (Liu et al., 2007; Powell et al., 2007) while the opposite effect was true for convenience stores (Powell et al., 2007; Beydoun, Powell and Wang, 2008).

Increasingly, policies striving to improve healthy food access have emphasized utilizing local food resources. The prevalence of local foods has grown quickly in the past decade: the number of farmer's markets in the U.S. has quadrupled between 1994 and 2012 (Tropp, 2014), the incidence of CSAs increased by 50% from 2001 to 2005 (Martinez, 2010) and local food sales have grown from $1 billion in 2005 to $7 billion in 2012 (USDA, 2013). Additionally, in a survey of grocery store consumers 87% stated that the availability of locally grown produce was "very important" (Tropp, 2014) and research has shown that local food sales can have positive economic benefits for local communities (Brown et al., 2014). The Centers for Disease Control and Prevention (CDC)

---

[1] For further review see Alwitt and Donley (1997); Chung and Myers (1999); Morland et al. (2002b); Shaffer (2002); Zenk et al. (2005); Baker et al. (2006); Powell et al. (2007); Moore et al. (2008)

[2] E.g. Cheadle et al. (1991); Morland et al. (2002a); Laraia et al. (2004); Rose and Richards (2004); Bodor et al. (2008)

recommendations to reduce obesity include incentivizing healthy food establishments, facilitating consumer procurement of food directly from farmers and encouraging local food production (Khan et al., 2009). Though there has been only limited research pertaining to the effect of local food on health outcomes, initial results allude to a role for local foods in a healthy built environment. In an analysis of the impact of a randomized intervention that gave farmer's market vouchers to recipients of the Women, Infants and Children (WIC) supplemental nutrition program, Herman et al. (2008) found a significant increase in consumption of fruits and vegetables. Quandt et al. (2013) showed similar results for Community Supported Agriculture as low-income families that were offered a membership had a significantly higher availability of produce and tended to consume more fruits and vegetables. These findings held for community gardens, as Bellows et al. (2003) showed that neighborhood residents who participated in urban agriculture consumed more fresh produce and suggested that using local food to reduce food expenditures led to overall diet improvement. Taken together, this research suggests an evidentiary basis for public policies that use the local foods trend to improve impoverished neighborhoods, but there has been no corresponding analysis on whether enhancing a neighborhood's built environment could lead to increasingly high neighborhood prices.

The identification in this study is derived from the assumption that when households are deciding where to live they take into account the bundle of amenities provided by their neighborhood, which will be reflected in house prices, and that household preferences for these amenities are likely to vary across demographics such as income. A variety of hedonic valuation studies have shown a positive relationship between house price and amenities such as school quality (Black, 1999; Downes and Zabel, 2002; Figlio and Lucas, 2004; Bayer et al., 2007) and open space (Bolitzer and Netusil, 2000; Epsey and Edusei, 2001; Roe and Irwin, 2004; Anderson and West, 2006). However, the same emphasis has not been placed on researching whether healthy food options are capitalized into housing prices. In addition to traditional drivers of location such as education quality it is also likely that households will consider resources such as access to food of different types in choosing a neighborhood; local food accessibility, such as nearby farmers' markets, have been cited as an important factor people take into account when choosing what neighborhoods to move into (Bibbo, 2009).

This paper uses revealed preference data on household location decisions to model homeowner preferences for healthy amenities as well as the tradeoffs made with respect to school quality using a structural model of location choice. Additionally, this method accounts for potential endogeneity in food provision that can result from linkages between household location choice, neighborhood demographics and local food offerings. A partial equilibrium approach is presented below, while additional work is ongoing to extend this analysis to fully capture the general equilibrium feedback effects and endogenous amenity provision that arises from the collective location choices made by the population of households.

Given the increasing public awareness and policy concern surrounding food provision in communities (see, e.g. recent efforts to limit fast food in some municipalities), this paper provides policy relevant and timely information for local policymakers. In addition to consumer valuation of food and recreation inputs to health, the general equilibrium framework undertaken in this paper has the potential to address issues of economic justice; specifically, households may respond to changes in amenity provision driven by policy in such a way as to exclude minority and low income groups.

2. Household Preferences

The food access literature differentiates between the concept of a food desert, where there is limited healthy food availability, and a food swamp, which is characterized by a multitude of unhealthy and healthy food establishments, and research on this topic has been inconclusive. For instance, Lee (2012) found that while low-income neighborhoods had twice as many fast-food restaurants and convenience stores per square mile, which is in line with previous studies, the same relationship was also true of supermarkets and warehouse clubs. While both convenience stores and small groceries are more prevalent in lower-income neighborhoods (Lee, 2012) it has not been assessed whether this results from disparate access or preferences. For instance, though prices paid at convenience stores tend to be higher than those charged at supermarkets for the same items (Ver Ploeg et al., 2009) and small, independent grocery stores have fewer healthy offerings and variety (Jetter et al., 2005), the foods offered at these establishments are often more convenient. Furthermore, while conventional theory assumed a relationship between lack of healthy food access and obesity, leading policymakers to concentrate on the 23.5 million people living more than 1 mile from a supermarket, a USDA report suggests that all food access could have a causal obesity link as consumers may not substitute healthy food for unhealthy items but instead increase overall consumption (Ver Ploeg et al., 2009). Thus it is possible that preferences for store types could differ across income levels, and adding less expensive healthy food options would not improve overall health. Additionally, prior research has not accounted for the impact of local food sources.

Though hedonic analyses have traditionally been used to measure how different public goods are capitalized into housing prices this is an incomplete picture of the housing location decisions made by households. While a hedonic price function is essential when developing a sorting framework, any interpretation requires a thorough understanding of the sorting process underlying the locational equilibrium. Namely, sorting models can capture the endogeneity of amenities represented by households re-sorting and thus changing the subsequent provision of public goods that are not properly described by a hedonic function.

Several recent studies have updated the traditional hedonic analysis to account for endogeneity. In the area of school quality, Bayer et al. (2007) used a sorting model to explain the racial segregation observed in San Francisco attendance districts and demonstrated that previous hedonic results showing preferences for sociodemographic characteristics, such as a neighbor's average income or race, could be explained by unobserved and correlated neighborhood characteristics. Furthermore, while their study agreed with previous research that households have a preference for school quality they found that this effect was attenuated after accounting for endogeneity.

In regards to preferences for open space, Walsh (2007) combined a model of household location decisions with a model of resulting land conversion policies to develop a general equilibrium framework that accounted for the endogeneity of open space decisions. He distinguished between an exogenous measure of open space, the distance from each house to the nearest parcel, and the percentage of land area that is undeveloped in a neighborhood, which was endogenously determined by household development decisions. He showed that under a partial equilibrium approach, akin to a hedonic analysis, a policy that protected open space led to more open space in a neighborhood, and thus increased demand and subsequently house prices in that area, which were logically then occupied by higher income households. However, by allowing for endogeneity he found that an increase in protected open space was met by a decrease in demand for lot size and thus little change in overall open space in an area. Similarly, Klaiber and Phaneuf (2010) used a horizontal sorting model to simulate the effect of potential open space policies in Minnesota and found that the general equilibrium results from their model were significantly different than a partial equilibrium approach that did not take re-sorting into account. Thus all three studies demonstrate the importance of taking a general equilibrium approach when analyzing consumer preferences for location amenities, and I expand upon this research by combining the two public goods and including the local food environment.

3. Model of household location choice

This study adapts the Epple and Sieg (1999) pure characteristics model (PCM) of household location choice using a CES specification for utility. This framework employs mixed discrete-continuous depictions of the choice set where households can choose continuous quantities of physical housing characteristics in each of a discrete number of residential communities. In effect, households choose a neighborhood, thereby choosing public goods, g_j, which are a composite of local public goods including health inputs and school quality. Conditional on that location decision, a consumer also selects a house with the optimal level of housing services given housing prices.

The population of heterogeneous households differ in preferences (α) and income (y). These households are characterized by $F(\alpha,y)$, the joint distribution of income and tastes. Household preferences are defined over neighborhood quality/amenities *g*, quantity of housing consumed *q* and a composite private good *b*. In order to characterize a sorting equilibrium it must be the case that prices, physical housing characteristics, amenities and location choices are all defined such that no household could improve its utility by moving and each household exactly occupies one house.

Households are assumed to choose the neighborhood that maximizes utility and a CES specification for preferences defines the utility that household *i* obtains from living in community j as:

$$V_{i,j} = \left\{ \alpha_i \left(G_j\right)^\rho + \left[\exp\left(\frac{\left(y_i\right)^{1-\nu} - 1}{1-\nu} \right) \exp\left(-\frac{\beta P_j^{\eta+1} - 1}{1+\eta} \right) \right]^\rho \right\}^{\frac{1}{\rho}}, \quad (1)$$

where $F(\alpha, y)$ ~ *lognormal*. The first term in this CES specification represents the utility households receive from neighborhood amenities while the second term encompasses utility from the private good component of housing. This specification is convenient as the CES parameters are readily interpretable and can be easily compared to estimates from the existing literature.

The index of public goods, G, is defined as a linear index of amenities provided by each community $G_j = \gamma_1 g_{1,j} + \cdots + \gamma_{R-1} g_{R-1,j} + \xi_j$. Households agree on a common set of weights for the amenities in the index $(\gamma_1, \ldots, \gamma_{R-1})$ but differ in their overall preferences for amenities relative to the private good components of housing and the numeraire (α_i). Of the R amenities in the index, R-1 are observable. Then $g_{R,j} = \xi_j$ represents the composite of public goods unobserved by the analyst but observed by the households. Note that the "error term" of the model enters into the indirect utility function in a non-additively separable manner. This gives rise to the "pure characteristics" nomenclature as utility is defined solely over the characteristics of communities and there is no idiosyncratic location-household-specific shock.

For the private good component, households are assumed to share the same elasticity of substitution between amenities and private goods (ρ), and the same demand parameters for the private good components of housing: price elasticity of housing (η), income elasticity of housing (ν), and demand intercept (β). Nu (ν) is expected to be positive as an increase in income will lead to an increase in demand for housing, while eta (η) is negative as a higher price should result in reduced demand. Beta (β) is expected to be positive because as price increases demand will decrease, and the formulation above incorporates a negative sign.

Using this indirect utility function, Epple and Sieg (1999) derive the necessary conditions for equilibrium that include boundary indifference, increasing bundles and stratification. The *increasing bundles* property implies that locations with higher prices have better amenities, and conditional on taste one should see a positive sorting by income. *Boundary indifference* defines the income and preference combination (α,y) that makes households exactly indifferent between neighborhoods j and *j+1*. *Stratification* implies that households in locations with higher rankings of the public good have higher income and stronger preferences for amenities.

Given that a household with income and preference combination (α,y) makes their location decision based on amenity provision, *g*, and house price, *p*, Ellickson's (1971) *single crossing* condition ensures the sorting restrictions described above hold. Specifically, the model is "vertical" as households agree on the ranking of locations by overall quality and differ only in their preferences for said housing "quality" relative to the numeraire. Given this assumption, if the slope of an indirect indifference curve in (g,p) space is monotonically increasing in income (y|α) and preferences (α|y) then indifference curves in the (g,p) plane will satisfy single crossing in y and α. This ensures that households will sort into neighborhoods by income and taste preferences and implies a negative value for rho (ρ), the elasticity of substitution between amenities and private goods.

Additionally, given certain constraints[3] on the utility function a sorting equilibrium can be described by a hedonic price function. Namely, equilibrium prices are functionally related to housing characteristics and amenities $P_{n_j} = P(g_j, h_{n_j})$. Unlike the traditional hedonic model, there is no requirement that households be free to choose continuous quantities of each amenity nor is the market assumed to be perfectly competitive. Thus, we can no longer translate the price function gradient into measures of the marginal willingness to pay for amenities. However, Sieg et al. (2002) show that housing expenditures can be expressed as the product of a price index and a quantity index[4]

(2) $$P_{n_j} = q\left(h_{n_j}\right) \cdot p\left(g_j\right).$$

By taking the log of this function it is possible to generate a hedonic model

(3) $$\ln P_{n_j} = \ln q\left(h_n\right) + \ln p\left(g_j\right),$$

allowing the neighborhood level prices $P_1,\dots,P_j$ to be estimated as fixed effects in a hedonic regression using transactions data.

Estimation proceeds using the simulated two-stage generalized method of moments estimator developed by Sieg et al. (2004). In the first stage housing price estimates are treated as known constants in order to recover all of the structural parameters

(4) $$\theta = \left[\beta, \eta, \nu, \rho, \mu_\alpha, \mu_y, \sigma_\alpha, \sigma_y, \lambda, G_1, \gamma_1, \dots, \gamma_{R-1}\right].$$

Following Sieg et al (2004), all the parameters can be recovered using moment conditions defined over income quartiles, expenditure quartiles and public goods. These moment

---

[3] If $U_i(g_i, h_{n_j}, b, \alpha_i)$ is continuously differentiable, monotonically increasing in the numeraire, and Lipschitz continuous.

[4] As long as a h_{n_j} enters utility through a separable sub-function that is homogeneous of degree 1.

conditions are given as

$$(5)\qquad m_j(\theta)=\begin{Bmatrix} \widetilde{G}_j-\gamma_1 g_{1,1}-\ldots-\gamma_{R-1}\cdot g_{R-1,j} \\ y_j^{25}-\widetilde{y}_j^{25} \\ y_j^{50}-\widetilde{y}_j^{50} \\ y_j^{75}-\widetilde{y}_j^{75} \\ \ln P_{n\in j}^{25}-\ln\beta-(\eta+1)\ln p_j-\nu\ln\widetilde{y}_j^{25} \\ \ln P_{n\in j}^{50}-\ln\beta-(\eta+1)\ln p_j-\nu\ln\widetilde{y}_j^{50} \\ \ln P_{n\in j}^{75}-\ln\beta-(\eta+1)\ln p_j-\nu\ln\widetilde{y}_j^{75} \end{Bmatrix}.$$

The first moment condition is based on the level of amenity provision, where the public good is defined using a linear relationship between school quality and food access. Given a value for the cheapest community, G_1, the sorting behavior implied by vertical differentiation allows $G_2,\ldots,G_J$ to be defined recursively. The predictions for $G_1,\ldots,G_J$ are then used to identify the (constant) weights in the amenity index. The residual to the moment condition defines the composite unobserved amenity in each community $(\xi_1,\ldots,\xi_J)$ as the researcher does not perfectly observe g_j but instead $g_j + \xi_j$.

The next three moment conditions are based on the model's prediction for the distribution of income. Under the maintained assumptions on preferences, the information in θ can be used to simulate community-specific income distributions. Three of the moment conditions match the 25th, 50th, and 75th quantiles from the simulated distributions of income in each community $(\tilde{y}_j^{25},\tilde{y}_j^{50},\tilde{y}_j^{75})$ to their empirical counterparts $(y_j^{25},y_j^{50},y_j^{75})$. Income data from the 2000 census was used to create income quartiles for each neighborhood. Given that the data included the number of households in a series of income brackets, coefficients from a censored interval regression were used to estimate the 10th, 25th, 50th, 75th and 90th quantiles.

The last three moment conditions use the simulated income distributions to match predicted and observed quantiles from the distribution of housing expenditures in each community. The expenditure moments are obtained by multiplying the demand function by price and taking logs.

The mechanics of the simulated GMM estimator are straightforward. It can be implemented using a Nelder-Mead algorithm that iterates over the following steps.

Step 1. Select a starting value for $\theta=[\beta,\eta,\nu,\rho,\mu_\alpha,\mu_y,\sigma_\alpha,\sigma_y,\lambda,G_1,\gamma_1,\ldots,\gamma_{R-1}]$

Step 2. Draw *I "*households" from $F(\alpha,y)$ ~ *lognormal*, where I is the population of the Cleveland metro area in the year 2000.

Step 3. Use *boundary indifference* to sort households in ascending order.

Step 4. Sort households across communities. Let $S_1,\dots,S_J$ represent the observed population counts of each community such that $\sum_j S_j = I$. Assign the first S_1 households to community 1. Then assign the next S_2 households to community 2, and so on.

Step 5. Given G_1, solve for G_2 to make the boundary person between communities 1 and 2 indifferent between them. Then given G_2, solve for G_3, and so on....

Step 6. Calculate $\hat{y}_j^{25}, \hat{y}_j^{50}, \hat{y}_j^{75}$ for each community.

Step 7. Use $\hat{y}_j^{25}, \hat{y}_j^{50}, \hat{y}_j^{75}$, and $G_2(\hat{\theta}),\dots,G_J(\hat{\theta})$ and $\hat{\theta}$ to evaluate the GMM objective function. If the minimization criteria of the numerical algorithm are satisfied, stop. If not, update θ and return to step 2.

After solving for these parameters it is possible to estimate elements such as the relationship between taste for public goods and income preferences for public goods or elasticities of substitution. Additionally, this framework allows for estimation of the effect of an exogenous change, such as a public policy, by solving for a new PCM equilibrium when amenities are exogenous. As preferences in this model are "vertical", communities will always be ordered by their equilibrium housing prices and provisions of public goods: $p_1 < p_2 < \dots < p_J$. Thus the problem can be reduced to a one-dimensional root finding problem as after a policy change the new equilibrium price ranking must be identical to the new ranking by *G*. Using this fact, the solution algorithm proceeds as follows:

Step 1. Make a guess for the new price of housing in the cheapest community, p_1^*

Step 2. Use *boundary indifference* to sort households into community 1 until total housing demand equals supply.

Step 3. Use the last household sorted into community 1 to solve for the value of p_2^*.

Step 4. Repeat steps 2-3 for communities 2 through *J*, or until all households are assigned to communities.

Step 5. If there is excess housing supply in community *J*, increase p_1^* and return to step 2. If there is excess demand, decrease p_1^* and return to step 2.

This recursive structure effectively reduces the simulation to a one-dimensional problem where the new equilibrium price of housing in community 1 is adjusted until the market clears in community *J*.

4. Data

This paper uses data covering a five-county region comprising the Cleveland, OH metropolitan area and is shown in figure 3. This region contains a population of 1.7 million and is the 29th largest metropolitan region in the United States, as well as one of the most impoverished; in 2013 over 50% of children lived below the poverty line and Cleveland has the second-highest poverty rate of all large cities in the United States. Contained within the metropolitan area are 599 census tracts, which are defined to represent one of the j=1...599 neighborhoods over which households choose to locate. The analysis combines data on residential household transactions, firm locations, and local public goods including school quality. Each of these three distinct sources of data is described in the subsections that follow. The results presented here consider years 2011-2014, a period which captures the local food movement while avoiding the identification issues inherent in transactions data from the housing boom and subsequent bust.

a. Housing transactions

Housing transactions data for the years 2011-2014 was obtained from each county auditor and supplemented with parcel-level GIS data collected for each county in the study area. These transactions contain information on the sale price as well as physical characteristics of homes such as number of bedrooms, number of bathrooms and lot size. Summary statistics for this set of housing transactions data are shown in table 1 and reveal an average sales price of $129,999 with mean square footage of 1,765 and approximately 1.5 baths.

A fundamental step required for estimation of the structural location choice model described in section 2.3 is conversion of the individual housing transactions data into price indices, which represent the price of a homogenous unit of housing services in a given community. For this analysis, we defined communities as consisting of one of 599 Census tracts, with each tract containing approximately 1,316 households. By creating a price index for each neighborhood, which we represent by census tracts, it becomes possible to rank each community by price. We estimate a hedonic regression that controls for housing attributes and captures location-specific indices of housing prices for each community. The hedonic equation can be written as:

$$(6)\ \ln P_n = \sum_{k=1}^{K} \beta_k X_{nk} + \sum_{j=1}^{J} \delta_j + \epsilon_n$$

where $k = 1 \dots K$ are housing attributes, $\delta_j = 1 \dots J$ are the tract fixed effects that serve as price indices, and ϵ_n is an idiosyncratic unobservable. We estimate this regression using sales prices for 70,067 transactions. By including tract fixed effects it is possible to isolate the impact of each tract on sales price. Not only were all 599 tracts significant but along with house attributes the neighborhood helped explain over 90% of the variation in housing price. The resulting estimates for the key housing attributes that contributed to the price index are shown in table 2. Taking the exponential of the estimated tract-level fixed effects provides the price index used in the structural model.

b. Local Public Goods

In order to properly characterize a neighborhood's food environment we develop two separate food access measures that encompass both local and traditional retailers. To assess the healthiness of conventional food businesses we use the modified retail food environment index (mRFEI). Developed by the CDC's Division of Nutrition, Physical Activity and Obesity, it defines a neighborhood's health index as the percentage of food establishments that are considered healthy. Data was collected from the Dunn and Broadstreet Million Dollar Database, a national database of both publically and privately held companies. Establishments were identified using North American Industry Classification System (NAICS) codes. In this index, an unhealthy food retailer includes fast food restaurants (722211), small grocery stores (NAICS 445110 with 3 or fewer employees) and convenience stores (445120), while healthy establishments include supermarkets, large grocery stores, warehouse clubs (452910) and produce markets (445230). The mRFEI is calculated as $\frac{\#\ of\ healthy\ food\ establishments}{Total\ \#\ of\ food\ establishments}$, where we included all neighborhood establishments as well as those within ½ mile of the census tract boundary.

As consumers may value local and traditional healthy establishments differently we additionally included information on the local food environment. Data on local food establishments was purchased from Local Harvest, an independent database that maintains an exhaustive list of farms and direct marketing locations in the United States. For each farm the available information includes whether they run a CSA, the locations of all CSA drop-off centers, as well as whether there is a U-Pick enterprise or farm stand. In order to ensure we are accurately counting current farms we only incorporated establishments whose entry had been updated or created in 2011 or later. Local Harvest additionally provided a list of farmer's market locations, which was supplemented with data from the USDA National Farmer's Market directory. Our local food measure is the total number of farmer's markets, CSA pick-ups, U-Pick and farm stands within a ½ mile buffer of the census tract.

As a body of previous research has demonstrated a significant relationship between school quality and housing price, our analysis also includes student test scores. Each census tract was assigned to a school district based on the spatial location of the centroid of the census tract and testing data was collected from the Ohio Department of Education website. As raw test scores were not available the school quality performance statistic is calculated as the percentage of 3rd grade students who passed the reading test for the 2006-2007 school year at a state-designated proficiency level, which is a necessary prerequisite for advancement to the 4th grade.

5. Results

Before presenting the preliminary GMM estimation results it is important to consider whether our model appears appropriate given the study area. To gauge this suitability, we consider the summary statistics provided in table 3. These results reveal significant heterogeneity between neighborhoods, lending credence to the high R^2 in table 1. For example, the median income in a given tract ranges from \$6,131 to \$293,431 while the price index goes from a low of 7.44 to a high of 9.92. This trend is also present in the public good distribution. While an average neighborhood is situated in a school district where 76% of students meet the pass standard, in certain areas only 58% of students are deemed proficient readers, compared to 97% in the top district. Similarly, in the average neighborhood only 12% of food establishments could be considered healthy, though this ranged from 0 to 100%. Meanwhile, some neighborhoods had as many as 7 local food establishments, while others had none.

Turning now to the initial GMM estimation results in table 4, all signs are as expected. The parameter for ν, the income elasticity, is positive; η, the price elasticity, is negative and β, the demand intercept, is positive. The point estimate for ν of .84 is consistent with that seen in previous literature, as is the value for η of -.68. Finally, the estimate for ρ, the elasticity of substitution between amenities and private goods, is negative, which indicates the single crossing property holds. However, our neighborhoods do not demonstrate perfect income stratification, which is reflected by our lambda value of .11, implying very little correlation between income and preferences. Focusing on the parameters associated with the public goods index, we find that the effect of mRFEI, represented by γ_1, is positive, which demonstrates a consumer preference for neighborhoods with healthy retail establishments. The positive value for γ_2 also implies that access to local foods is an important and positive determinant of households' decisions about community location. Figure 4 shows the relationship between the public good index and house prices, confirming the positive parameter values.

An asset of the sorting model is the ability to calculate general (versus partial) equilibrium welfare measures that result from a proposed policy by comparing the ex-ante and ex-post equilibria. In a partial equilibrium framework households cannot move so house prices remain constant and willingness to pay (WTP) estimates reflect only the amount of money needed to compensate a resident for a change in amenities. This value can be calculated by solving the equation

(7) $V_1(\alpha, y\text{-}WTP_{PE}, g_j^*, p_j) = V_0(\alpha, y, g_j, p_j)$

A general equilibrium approach additionally recognizes not only that households can react to a change in the provision of amenities by moving to a new neighborhood but also allows for a characterization of how this resorting process results in individuals further inducing a change in neighborhood amenities. A general equilibrium WTP resulting from an *exogenous* amenity change can be described as the value that solves

(8) $V_1(\alpha, y\text{-}WTP_{GE}, g_k, p_k^*) = V_0(\alpha, y, g_j, p_j)$

where the change in subscript from g_j to g_k recognizes that households can move to a new location, thus affecting house prices p_k^*. In order to model an *endogenous* change it is necessary to define the process by which neighborhood residents can potentially influence the provision of amenities in the new community, which would be defined as g_k^*.

We simulate a public policy of adding one local food establishment to the 20% most impoverished communities, which translates to the 120 census tracts with the lowest price indices. This resembles policies such as Cleveland's Gardening for Greenbacks, which provides grants to new urban farmers. Turning to the willingness to pay (WTP) results in table 5, the marginal willingness to pay (MWTP) calculations describe the value consumers place on a public good change, holding all other amenities and prices constant. For a 1% increase in the percentage of 3rd graders passing the reading exam households were willing to pay an additional $73.68 in monthly rent, which is higher than previous estimates, potentially reflecting our use of a proficiency measure. A 1% increase in the healthy food environment was valued at $85.61, and the addition of one local food establishment was associated with a MWTP of $231.06. Though the local food values are high they most likely reflect the large policy implication of adding an entirely new establishment to neighborhoods with few healthy options. In order to assess the welfare effects of a change in public good provision we additionally calculate both partial and general equilibrium measures. We find that adding an additional local food establishment has a small and positive effect on overall consumer welfare. However, the results are strikingly different when we look at the consumers who lived in the neighborhoods that received the new local food options. Specifically, in a partial equilibrium framework, where households are not allowed to re-sort, we find a significantly positive impact on inhabitants. However, in a general equilibrium framework these households are negatively impacted by the policy, suggesting they are either priced out of the market by wealthier citizens or are not properly compensated for the large increase in housing prices. Turning to table 6 we compare neighborhood prices before and after the included policy. As expected there were significant price increases in the neighborhoods that received new local food establishments, resulting in reduced welfare for those residents.

Work is ongoing to endogenize the provision of local food establishments. In our sorting model, as households re-sort neighborhood prices and household incomes change. We use a regression model to link the number of local food establishments in a neighborhood to changing characteristics. We run a regression on the number of local food establishments in a neighborhood, the results of which can be found in table 7. These coefficients are then used to re-estimate the number of local food operations after a policy shock by accounting for the effect of the household re-sorting process. Specifically, the welfare results in table 5 represent an exogenous effect as we merely observe how household location decisions change after a policy of adding local food to the lowest-ranked neighborhoods. The welfare results in table 8 are considered endogenous as the amount of local food available post-policy was additionally updated using the regression coefficients from table 7 to account for the impact of changing neighborhood demographics. This extension allows us to evaluate the welfare implications of non-marginal changes in land use driven by public policies, which are an issue of current debate. We find no significant differences between our welfare results, and in both scenarios households in the neighborhoods that received additional food establishments were slightly worse off as a result of increased house prices.

6. Discussion

Our initial results suggest that households do sort across healthy neighborhood attributes. First, there is a positive relationship between relative prices and food access. Second, the positive γ parameter estimates show that both the percentage of healthy food establishments and the number of local food retailers affect the perceived public good provision of a neighborhood, which households then use to rank communities. This ranking is used by households to sort themselves across communities as consumers with a high value for α, representing the preference for amenities relative to the housing good/numeraire, will choose communities with a higher value for g. Our results also suggest that households take school quality into account when making location decisions, but that this is not the only public good that influences location choice.

Interpreting these results, we should note that the sorting of households with different values for α is conditional on income. Thus there is an economic justice question as low-income households may be in low-ranked communities not because of a lack of preference for healthy built environments but instead because of a lack of income. Thus the endogeneity of healthy establishments is potentially significant as households that move into a location with a high level of public goods, g, may lobby for even more healthy establishments, improving the amenities of that community and leading to higher prices that result in the relocation of lower-income households.

This study has several potential policy implications. First, as these results show that households value local healthy food establishments it is also likely that policies incentivizing local food would appeal to potential consumers; this very conclusion is bolstered by CDC recommendations that communities incentivize local food production (Khan et al., 2009). However, this could have unintended consequences as households re-sort with their income constraints and affect the subsequent public good provision. Without a structural model that endogenizes retail establishments, this linkage would remain unexplored. Using a regression model our study was able to determine how a neighborhood's changing demographics influence the decision of a local food establishment to open in a neighborhood. The structural sorting model then translated these changes into new housing prices, which were then used to estimate general equilibrium welfare measures resulting from different public policies. We found that the addition of a local food establishment had a negative impact on the nearby residents, though increased house prices, suggesting the importance of targeted public policies.

As an additional note of caution, the efficacy of public policies that incentivize local food access is still unclear as the evidence linking healthy food access to a healthy diet remains inconclusive. For instance, Boone-Heinonen et al (2011) found that those living near fast food restaurants were more likely to consume fast food while access to supermarkets was unrelated to healthy food intake, whereas Larson et al. (2009) demonstrated that access to supermarkets and distance to convenience stores was associated with healthier diets and lower obesity rates. Meanwhile, Jeffrey et al. (2006) found no relationship between access to fast food restaurants and eating at those establishments and Lopez (2006) showed an association between the presence of a supermarket in the neighborhood and obesity risk, with no strong relationship to fast food establishment density. While this evidence does suggest that a public policy to increase the availability of healthy establishments may not be effective if the goal is to improve health, none of these studies considered consumer preferences or included local food establishments. Future work is needed to assess the relationship between consumer preferences for local food access and health outcomes

There are a variety of ways public policies can influence neighborhood amenities, including zoning regulations which dictate the nature and provision of food establishments. Diet is a significant input into a healthy lifestyle and households will take into account food access when choosing a neighborhood. This study demonstrates the importance of several measures of healthy food and can establish general equilibrium welfare measures to assess the effects of a change in neighborhood amenity provision.

7. Tables

Table 1: Housing Summary		
	Mean	**Std. Dev**
Sale Price	$129,999	$115,86
Square Feet	1,764.93	808.8
Lot Size	0.51	9.68
Age	54.76	31.08
# Bathrooms	1.53	0.81

Table 2: Hedonic Analysis of Housing Price Tract Fixed Effects		
Variable	**Coefficient**	**P-Value**
Lot Size	0.0039	<.0001
Square Feet	0.0513	<.0001
# of Full Baths	0.0149	<.0001
Age	-0.0093	<.0001
Lot Size^2	0.0000	<.0001
Square Feet^2	-0.0003	<.0001
Age^2	0.0000	<.0001
2012	0.0027	0.589
2013	0.0629	<.0001
2014	0.1356	<.0001
R^2	0.9973	
Observations	70,067	

Table 3: Summary Statistics				
	Obs	**Mean**	**Std. Dev.**	**Min**
Household Size	2.37	0.30	1.37	3.72
Total # of Households	1,316	602	102	3,747
Total # of Transactions	117	103	1	999
Local Food Establishments	0.69	1.22	0.00	7.00
mRFEI	0.12	0.11	0.00	1.00
School Quality	0.76	0.14	0.58	0.97
Price Index	8.62	0.54	7.44	9.92
25th Income Quantile	$24,962	$12,425	$2,998	$98,920
50th Income Quantile	$43,627	$23,554	$6,131	$293,431
75th Income Quantile	$77,052	$50,888	$12,536	$870,421

Table 4: Parameter Estimates	
Mean of Income	10.56271
Standard Deviation of Income	1.0085
Mean Alpha	1.0518
Standard Deviation of Alpha	0.47072
Lambda	0.11283
Income Elasticity (ν)	0.83586
Price Elasticity (η)	-0.68205
Beta (β)	0.68765
Rho (ρ)	-0.049428
G_0	2.0839
γ_1	0.95796
γ_2	0.35059
Note: Gamma 1 refers to mRFEI	
Gamma 2 refers to local food establishments	

Table 5: Monthly Willingness to Pay Estimates					
		Whole Population		Treated Population	
	MWTP	WTP PE	WTP GE	WTP PE	WTP GE
School Quality	$73.68				
mRFEI	$85.50				
Local Food	$230.76	$6.68	$14.32	$31.37	-$0.72

Note: School Quality refers to MWTP for a 1% increase in the % of students with a passing score

mRFEI refers to MWTP for a 1% increase in the percentage of retail options that are healthy

Local Food refers to MWTP for one additional local food establishment

Table 6: Effect of Policy on Price		
	Mean	Std.
Average Change	0.024979	0.10672
Change for Non-treated	-0.02215	0.05033
Change for Treated	0.213099	0.04934

Table 7: Local Food Regression Results	
Variable	**Coefficient**
Population (1,000's)	0.001
Price Index	-0.163
Mean HH Income	-0.006*
Avg. HH Size	-0.867*
% Male	0.085*
% Residents less than than 18	2.996**
% Residents with at least a Bachelor's	2.515*
% Residents White	-0.365
Ashtabula County	0.650
Cuyahoga County	-0.721
Geauga County	0.564
Lake County	-0.538
Lorain County	-0.743
Medina County	-0.835

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

Standard errors are clustered at the county level

Table 8: Monthly Willingness to Pay Estimates (Endogenous)					
		Whole Population		**Treated Population**	
	MWTP	**WTP PE**	**WTP GE**	**WTP PE**	**WTP GE**
School Quality	$73.73				
mRFEI	$85.57				
Local Food	$230.93	$6.69	$14.09	$31.32	-$0.84

Note: School Quality refers to MWTP for a 1% increase in the % of students with a passing score

mRFEI refers to MWTP for a 1% increase in the percentage of retail options that are healthy

Local Food refers to MWTP for one additional local food establishment

8. Figures

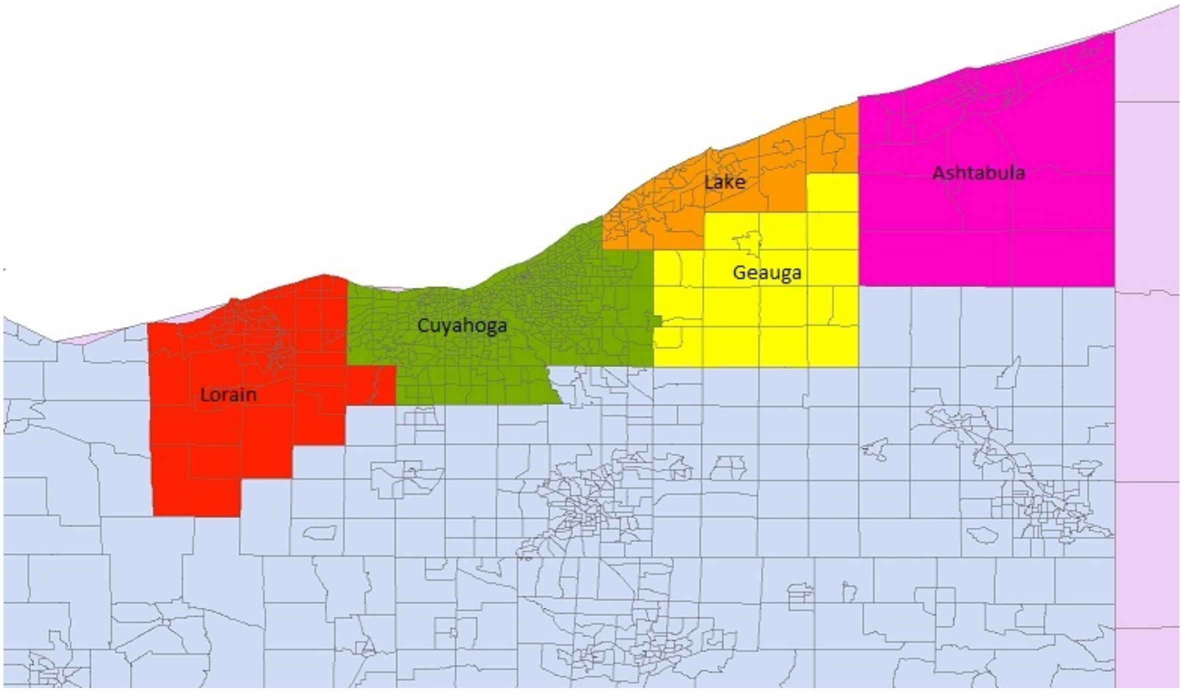

Figure 1: Cleveland, OH Counties

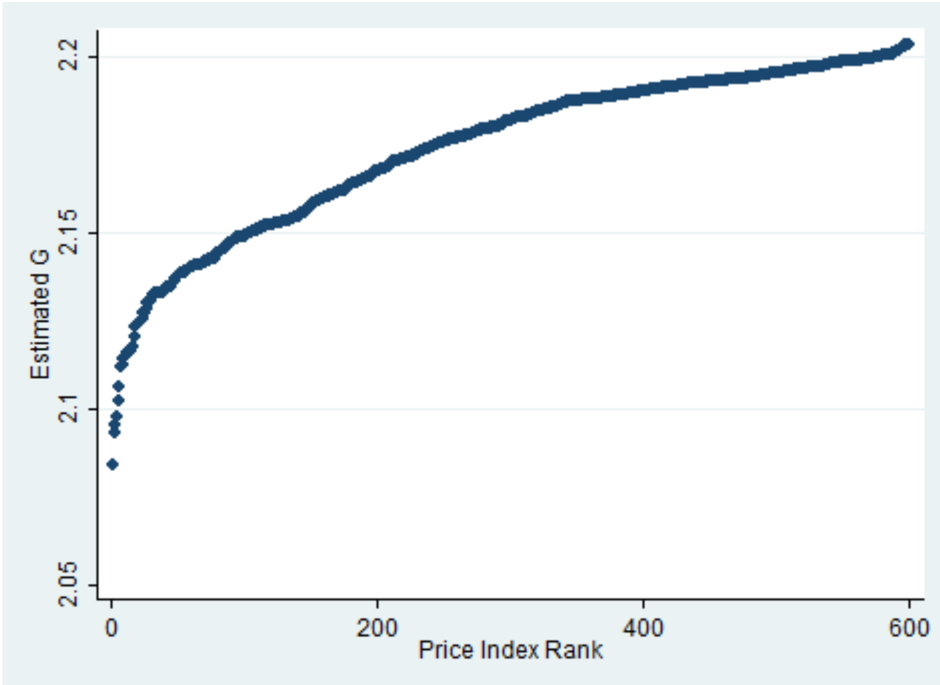

Figure 2: Relationship between Public Good Index and House Prices

References

Alwitt, L.F., and T.D. Donley. 1997. "Retail Stores in Poor Urban Neighborhoods." *Journal of Consumer Affairs* 31(1):139–164.

Anderson, S.T., and S.E. West. 2002. "The Value of Open Space Proximity and Size: City versus Suburbs." *Working Paper: Macalester College, St. Paul, MN*. Available at: http://www.macalester.edu/wests/index.htm [Accessed October 14, 2014].

Baker, E.A., M. Schootman, E. Barnidge, and C. Kelly. 2006. "The Role of Race and Poverty in Access to Foods That Enable Individuals to Adhere to Dietary Guidelines." *Preventing Chronic Disease* 3(3).

Bayer, P., F.V. Ferreira, and R. McMillan. 2007. "A Unified Framework for Measuring Preferences for Schools and Neighborhoods." *NBER Working Papers* No. 13236. Available at: http://econpapers.repec.org/paper/nbrnberwo/13236.htm.

Bayer, P., and C. Timmins. 2005. "On the equilibrium properties of locational sorting models." *Journal of Urban Economics* 57(3):462–477.

Bellows, A.C., K. Brown, and J. Smit. 2003. "Health Benefits of Urban Agriculture." Community Food Security Coalition's North American Initiative on Urban Agriculture

Beydoun, M.A., L.M. Powell, and Y. Wang. 2008. "The association of fast food, fruit and vegetable prices with dietary intakes among US adults: Is there modification by family income?" *Social Science & Medicine* 66(11):2218–2229.

Bibbo, C., S. Burbank, E. Hall, J. Johnson, B. Kahler, K. Nunn, and K. Tsuchiya. 2009. "A Study of Successful Farmers Markets in Urban, Low-Income Communities." Empowered Growing Spaces Case Western Reserve University: Weatherhead School of Management.

Black, S.E. 1999. "Do Better Schools Matter? Parental Valuation of Elementary Education." *Quarterly Journal of Economics* 114(2):577–599.

Bodor, J.N., D. Rose, T.A. Farley, C. Swalm, and S.K. Scott. 2008. "Neighbourhood fruit and vegetable availability and consumption: the role of small food stores in an urban environment." *Public Health Nutrition* 11(04):413–420.

Bolitzer, B., and N.R. Netusil. 2000. "The impact of open spaces on property values in Portland, Oregon." *Journal of Environmental Management* 59(3):185–193.

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.

Bresnahan, T., and P.C. Reiss. 1991. "Entry and Competition in Concentrated Markets." *Journal of Political Economy* 99(5):977–1009.

Bresnahan, T.F., and P.C. Reiss. 1990. "Entry in Monopoly Markets." *Review of Economic Studies* 57(4):531–53.

Brown, J.P., S.J. Goetz, M.C. Ahearn, and C. (Kathleen) Liang. 2014. "Linkages Between Community-Focused Agriculture, Farm Sales, and Regional Growth." *Economic Development Quarterly* 28(1):5–16.

Cheadle, A., B.M. Psaty, S. Curry, E. Wagner, P. Diehr, T. Koepsell, and A. Kristal. 1991. "Community-level comparisons between the grocery store environment and individual dietary practices." *Preventive Medicine* 20(2):250–261.

Chung, C., and S.L. Myers. 1999. "Do the Poor Pay More for Food? An Analysis of Grocery Store Availability and Food Price Disparities." *Journal of Consumer Affairs* 33(2):276–296.

Connolly, C., and H.A. Klaiber. 2014. "Does Organic Command a Premium When the Food is Already Local?" *American Journal of Agricultural Economics* 96(4):1102–1116.

Downes, T.A., and J.E. Zabel. 2002. "The impact of school characteristics on house prices: Chicago 1987–1991." 52(1):1–25.

Ellickson, B. 1971. "Jurisdictional Fragmentation and Residential Choice." *American Economic Review* 61(2):334–39.

Epple, D., M. Peress, and H. Sieg. 2010. "Identification and Semiparametric Estimation of Equilibrium Models of Local Jurisdictions." *American Economic Journal: Microeconomics* 2(4):195–220.

Epple, D., and H. Sieg. January 8. "Estimating Equilibrium Models of Local Jurisdictions." *Journal of Political Economy* 107(4):645–681.

Espey, M., and K. Owusu-Edusei. 2001. "Neighborhood Parks and Residential Property Values In Greenville, South Carolina." *Journal of Agricultural and Applied Economics* 33(03). Available at: http://econpapers.repec.org/article/agsjoaaec/15446.htm [Accessed October 30, 2014].

Figlio, D.N., and M.E. Lucas. 2004. "What's in a Grade? School Report Cards and the Housing Market." *The American Economic Review* 94(3):591–604.

Fisher, B.D., and D.S. Strogatz. 1999. "Community measures of low-fat milk consumption: comparing store shelves with households." *American Journal of Public Health* 89(2):235–237.

Fry, R., and P. Taylor. 2012. "The Rise of Residential Segregation by Income." Pew Social Trends. Available at: http://www.pewsocialtrends.org/2012/08/01/the-rise-of-residential-segregation-by-income/ [Accessed October 30, 2014].

Jeffery, R.W., J. Baxter, M. McGuire, and J. Linde. 2006. "Are fast food restaurants an environmental risk factor for obesity?" *International Journal of Behavioral Nutrition and Physical Activity* 3(1):2.

Jetter, K.M., and D.L. Cassady. 2006. "The Availability and Cost of Healthier Food Alternatives." *American Journal of Preventive Medicine* 30(1):38–44.

Khan, L.K., K. Sobush, D. Keener, K. Goodman, A. Lowry, J. Kakietek, and S. Zaro. 2009. "Recommended community strategies and measurements to prevent obesity in the United States." *CDC. Recommendations and reports: Morbidity and mortality weekly report.* 58(RR-7):1–26.

Klaiber, H., and N. Kuminoff. 2014. "Equilibrium Sorting Models of Land Use and Residential Choice." In J. M. Duke and J. J. Wu, eds. *The Oxford Handbook of Land Economics*. Oxford Handbook of Land Economics . Forthcoming.: OUP USA.

Klaiber, H.A., and D.J. Phaneuf. 2010. "Valuing open space in a residential sorting model of the Twin Cities." *Journal of Environmental Economics and Management* 60(2):57–77.

Laraia, B.A., A.M. Siega-Riz, J.S. Kaufman, and S.J. Jones. 2004. "Proximity of supermarkets is positively associated with diet quality index for pregnancy." *Preventive Medicine* 39(5):869–875.

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

Lee, H. 2012. "The role of local food availability in explaining obesity risk among young school-aged children." *Social Science & Medicine* 74(8):1193–1203.

Liu, G.C., J.S. Wilson, R. Qi, and J. Ying. 2007. "Green Neighborhoods, Food Retail and Childhood Overweight: Differences by Population Density." *American Journal of Health Promotion* 21(4s):317–325.

Lopez, R.P. 2007. "Neighborhood Risk Factors for Obesity." *Obesity* 15(8):2111–2119.

Martinez, S.W., M. Hand, M. Da Pra, S. Pollack, K.L. Ralston, T.A. Smith, S. Vogel, S. Clarke, L. Lohr, S.A. Low, and C. Newman. 2010. "Local food systems: Concepts, Impacts, and Issues." No. 97, USDA:ERS.

Moore, L.V., A.V.D. Roux, J.A. Nettleton, and D.R. Jacobs. 2008. "Associations of the Local Food Environment with Diet Quality—A Comparison of Assessments based on Surveys and Geographic Information Systems The Multi-Ethnic Study of Atherosclerosis." *American Journal of Epidemiology* 167(8):917–924.

Morland, K., S. Wing, and A. Diez Roux. 2002. "The Contextual Effect of the Local Food Environment on Residents' Diets: The Atherosclerosis Risk in Communities Study." *American Journal of Public Health* 92(11):1761–1768.

Morland, K., S. Wing, A. Diez Roux, and C. Poole. 2002. "Neighborhood characteristics associated with the location of food stores and food service places." *American Journal of Preventive Medicine* 22(1):23–29.

Powell, L.M., M.C. Auld, F.J. Chaloupka, P.M. O'Malley, and L.D. Johnston. 2007. "Associations Between Access to Food Stores and Adolescent Body Mass Index." *American Journal of Preventive Medicine* 33(4, Supplement):S301–S307.

Powell, L.M., S. Slater, D. Mirtcheva, Y. Bao, and F.J. Chaloupka. 2007. "Food store availability and neighborhood characteristics in the United States." *Preventive Medicine* 44(3):189–195.

Price, Rita. 2012. "Report: Neighborhoods segregated by income." *The Columbus Dispatch*. Available at: http://www.dispatch.com/content/stories/local/2012/08/01/economically-segregated-neighborhoods.html [Accessed October 1, 2014].

Roe, B., E.G. Irwin, and H.A. Morrow-Jones. 2004. "The Effects of Farmland, Farmland Preservation, and Other Neighborhood Amenities on Housing Values and Residential Growth." *Land Economics* 80(1):55–75.

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(08):1081–1088.

Shaffer, A. 2002. "The Persistence of L.A.'s Grocery Gap: The Need for a New Food Policy and Approach to Market Development." Center for Food and Justice, Urban and Environmental Policy Institute (UEPI), Occidental College. Available at: http://scholar.oxy.edu/uep_faculty/16.

Sieg, H., V.K. Smith, H.S. Banzhaf, and R. Walsh. January 11. "Estimating the General Equilibrium Benefits of Large Changes in Spatially Delineated Public Goods." *International Economic Review* 45(4):1047–1077.

Sieg, H., V.K. Smith, H.S. Banzhaf, and R. Walsh. 2002. "Interjurisdictional housing prices in locational equilibrium." *Journal of Urban Economics* 52(1):131–153.

Tropp, D. 2014. *Why Local Food Matters: The rising importance of locally-grown food in the U.S. food system*. National Association of Counties Legislative Conference: USDA.

USDA Office of Communications. 2013. "USDA Celebrates National Farmers Market Week, August 4-10." No. 0155.13,

Ver Ploeg, M., V. Breneman, T. Farrigan, K. Hamrick, D. Hopkins, P. Kaufman, B.-H. Lin, M. Nord, T.A. Smith, R. Williams, K. Kinnison, C. Olander, A. Singh, and E. Tuckermanty. 2009. "Access to affordable and nutritious food: measuring and understanding food deserts and their consequences." Administrative Publication No. (AP-036), USDA: ERS.

Walsh, R. 2007. "Endogenous open space amenities in a locational equilibrium." *Journal of Urban Economics* 61(2):319–344.

Zenk, S.N., and L.M. Powell. 2008. "US secondary schools and food outlets." *Health & Place* 14(2):336–346.

Zenk, S.N., A.J. Schulz, B.A. Israel, S.A. James, S. Bao, and M.L. Wilson. 2005a. "Fruit and vegetable access differs by community racial composition and socioeconomic position in Detroit, Michigan." *Ethnicity & disease* 16(1):275–280.

Zenk, S.N., A.J. Schulz, B.A. Israel, S.A. James, S. Bao, and M.L. Wilson. 2005b. "Neighborhood Racial Composition, Neighborhood Poverty, and the Spatial Accessibility of Supermarkets in Metropolitan Detroit." *American Journal of Public Health* 95(4):660–667.