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# A Spatial Analysis of the Effect of Entry by Supercenter and Warehouse Club Retailers on Grocery Sales

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### Abstract

This research evaluates the effects of entry by supercenters and warehouse club retailers on the location of retail grocery sales. Drawing on location theory and empirical works, spatial econometric convergence models are specifi ed and estimated. Because grocery shopping is generally a local phenomenon, the spatial models are used to capture spillover effects between geographical areas. The results show that supercenter and warehouse club retailers have a signifi cant and large effect on growth of grocery sales, especially in low population areas. The results suggest that the large stores are new grocery distribution channels, which are changing where consumers shop for groceries.

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Since the late 1980s the U.S. retail grocery industry has seen a steady exodus of small grocers, large retailers emerging via mergers and acquisitions, and the entry of large new retailers (e.g., Wal-Mart, Target, K-Mart). The CR4 (a measure of market concentration) for grocery store sales has increased from 16 percent in 1982 to 36 percent in 2005 (GAO 2009). Thus the grocery industry has shifted from an industry dominated by small grocers serving local markets to one characterized by large retailers present in international markets.

Large retailers are changing where and how often consumers shop for groceries and the logistics of selling groceries. ACNielsen's "Channel Blurring" study (2005) found that consumers made 25 percent fewer trips to the grocery store in 2004, down to 69 from 92 in 1995. Reasons for this decline include improved grocery packaging with longer shelf lives, increased food-away-from-home purchases, and the consumer's willingness to patronize one-stop-shop food store formats. Shoppers patronize traditional supermarkets less often as they shift some of their purchases to supercenters (Duff 2002). At the same time, *Convenience Store News* reported that the average number of fill-in trips to purchase single or small-basket quantities averaged 12.8 trips per month in 2001, pushing the total all-outlet fill-in market to over $200 billion (Enis 2002).

As consumers shift from shopping at traditional supermarkets to supercenter and warehouse stores, retail grocery sales as measured in dollars grow in some markets and decline in others. The shift from traditional supermarkets to warehouse club and supercenter stores appears to be shifting grocery sales from low population density markets without supercenter or warehouse stores to markets with supercenter and warehouse stores. However, less is known about the effects of entry by supercenters and warehouse club grocery retailers on sales for areas larger than local markets or metropolitan areas. Furthermore, the literature reviewed only considered the isolated effects of particular markets. To date, Artz and Stone (2006) developed the most comprehensive model to analyze changes in food store sales, but their study evaluated only the impact of Wal-Mart Supercenters on grocery store sales in Mississippi and they did not incorporate a spatial dimension to their model.

## Objective of Study

This study evaluates the effects of entry by supercenter and warehouse stores on growth of total retail grocery sales (traditional and supercenter sales) across individual markets for large areas including both metropolitan and rural markets. This analysis is unique because it evaluates both metropolitan and rural markets and because it incorporates spatial relationships among supercenters, among traditional grocery stores, and among supercenters and traditional grocery stores. This analysis recognizes that the effect of entry by a supercenter store

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will differ depending on the distance to other local supercenter stores and to traditional grocery stores in neighboring markets.

Entry by warehouse and supercenter stores in counties with lower population densities is expected to have a stronger effect on growth in grocery sales than in counties with higher population densities for two reasons. First, supercenters in counties with low population densities face less competition from other warehouses and supercenters. Second, residents in counties with low population densities are more willing to drive farther distances for grocery purchases. Therefore low population density counties are expected to experience additional sales growth when a supercenter or warehouse store enters. This is consistent with the Mississippi findings where Wal-Mart's entry reduces growth of traditional grocery store sales by nearly 17 percent in nonmetropolitan markets but by only four percent in metropolitan markets (Artz and Stone 2006).

In the next section, location literature and empirical works serves as a basis to specify a model, and we discuss the data used in our econometric models. The third section serves two purposes. First, a spatial analysis of growth in retail grocery sales is presented, including modeling techniques and spatial effects. Second, the use of spatial econometric modeling is introduced to supply chain management research. Finally, in the fourth section we discuss our models and present and discuss the empirical results, showing that supercenter and warehouse stores affect the logistics of grocery shopping.

## Methodology

A developed framework to evaluate growth in retail grocery sales for large areas does not exist because the topic has not been widely explored. Therefore the econometric specification for this analysis is based on several related literatures dealing with issues of location. Location theory; trade area analysis; and empirical studies on the effects of large retailers on communities, existing businesses, and the grocery industry are all used to develop this growth in retail grocery sales specification.

Location literature finds that beginning location density and initial market size have a negative relationship with changes in concentration and entry (Hannan and Freeman 1977; Krugman 1980; Curry and George 1983; Rogers 2001). Therefore models evaluating changes in the retail grocery industry should include variables such as the initial numbers of warehouse stores and traditional supermarkets (used as a measure of beginning location density), the log of population density and initial sales (used as a measure of initial market size), and income. Furthermore, the variables describing market changes are important in related models. Changes in population density and income are proxies for market growth variables, while changes in number of warehouse stores and supermarkets describe the industry.

Trade area analysis estimates the number of people buying locally and gives information about retail sales capture or leakage (Harris and Shonkwiler 1997; Gruidl and Kline 1992; Stone 1997; Artz and McConnon 2001; Stone, Artz, and Myles 2002; Irwin and Clark 2006). Retail sales capture is when a defined area experiences increased sales, and retail sales leakage is when a defined area experiences decrease sales. The trade area studies show that entry of a Wal-Mart store harms direct competitors but benefits or has no impact on those businesses that do not directly compete with Wal-Mart. Transportation, employment growth, business mix, income, and location all affect changes in retail sales (Ma 1997).

Several works have evaluated the impacts of large retailers locally or through case study examples. Arnold and Luthra (2000) reviewed 35 such works and found that following the entry of a Wal-Mart store, sales of competing retail stores decline in the home and in nearby markets and that changes to market efficiency and market structure occur. In this literature, prices were found to decrease after Wal-Mart entry (Woo et al. 2001; Marion 1998; Basker 2005; Hausmann and Leibtag 2005; Basker and Noel 2007; Volpe and Lavoie 2008), while sales for incumbent supermarkets fell between 17 and 21 percent (Singh, Hansen, and Blattberg 2004; Capps and Griffin 1998). The indirect price effect of sales decline due to price drops in response to entry by supercenters was estimated to be three to five percent (Hausmann and Leibtag 2005).

## Model Specification

Using the location-based literature as a guide to model the effect of entry by supercenters and warehouse stores, two general sets of variables are used to describe the initial market and to capture market changes. The following model was specified:

$$\ln\frac{S_{i,02}}{S_{i,99}} = \beta_0 + \beta_1 \ln S_{i,99} + \beta_2 \ln PDN_{i,99} + \beta_3 WS_{i,99} + \beta_4 SSM_{i,99} + \beta_5 LSM_{i,99} + \beta_6 \ln I_i + \beta_7 \Delta PDN_i + \beta_8 \Delta SSM_i + \beta_9 \Delta LSM_i + \beta_{10} \Delta WS_i + \beta_{11} \Delta I_i + \varepsilon_i \,. \tag{1}$$

where $\ln\frac{S_{i,02}}{S_{i,99}}$ is the log of the growth in total grocery sales in county $i$ from 1999 to 2002; $\ln S_{i,99}$ is the initial (1999) grocery sales in county $I$; $\ln PDN_{i,99}$ is the initial (1999) population density in county $i$; $WS_{i,99}$ is the initial (1999) number of warehouse and supercenter stores that employed more than 50 people in county $i$; $SSM_{i,99}$ is the initial (1999) number of small supermarkets that employed less than 50 people in county $I$; $LSM_{i,99}$ is the initial (1999) number of large supermarkets that employed more than 100 people in county $i$; $\ln I_{i,99}$ is the initial (1999) income in county $i$; $\Delta PDN_i$ is the change (1999–2002) in population density in county $i$ $(P_{i,t} - P_{i,t-1})$; $\Delta SSM_i$ is change in number of small supermarkets in county $i (SM_{i,t} - SM_{i,t-1})$; $\Delta LSM_i$ is change in number of large supermarkets in county $i$ $(SM_{i,t} - SM_{i,t-1})$; $\Delta WS_i$ is the change in the number of warehouse and supercenter stores that employed more than 50 people in county i $(W_{i,t} - W_{i,t-1})$; and $\Delta I_i$ is the change in per capita income in county $i$ $(I_{i,t} - I_{i,t-1})$.

The dependent variable is the log of growth in grocery sales ($\ln\frac{S_{i,02}}{S_{i,99}}$). This convergence/divergence model is consistent with other growth literature. Advantages of using a convergence/divergence model include ease of interpretation and the ability to determine whether the market is converging to a new level of sales. The closer the dependent variable is to zero, the closer the market is to converging to a new steady state. This is also a double log model, which further simplifies interpretation. The coefficients on the independent variables show the percentage change in sales resulting from a change in the right-hand-side variable.

The log of sales and population density and the number of warehouse stores, large and small supermarkets, and income were all used to describe the initial market. Changes in population density, the number of large and small supermarkets, large warehouse stores, and income were included to describe market changes that occurred from 1999 to 2002. Only warehouse and supercenter stores that employed more than 50 people were used in this specification because only the largest stores are expected to have a significant effect on sales.

We gave careful consideration to possible endogeneity of supercenter entry with sales. Recent work by Holmes (2008) suggests that store density is a strong driver of one supercenter chain's expansion behavior. Holmes notes that "the benefits to Wal-Mart of high store density are substantial and likely extend significantly beyond savings in trucking costs." Wal-Mart almost certainly makes expansion decisions strategically, but at the county level, store density could play a larger role in their location decisions than other competitive factors such as areas with already growing sales.

Furthermore, Hicks (2008) investigated the question of endogeneity in Wal-Mart retail employment studies by testing 15 factors that potentially influence Wal-Mart's entry decisions. Of the factors tested, Hicks found only personal income growth rates to be significant. Hicks concluded "that there is weak evidence of endogeneity in Wal-Mart's entrance decision." (2008). Unfortunately, Hicks' sample of 23 Maryland counties was relatively small and did not address all possible causes of endogeneity with supercenter and warehouse store entry.

Although most estimation improvements using instrumental variables to control for possible endogeneity caused by Wal-Mart entry are questionable, Neumark, Zhang, and Ciccarella developed a unique instrument "using a natural instrumental variables approach that arises from the geographic and time pattern of the opening of Wal-Mart stores" (2008). Work by Holmes seems to support their geographic time pattern instrument (2008). However, this instrument is not applicable for all supercenter and warehouse store data. Rather, it is specific to Wal-Mart.

Ultimately, we chose not to employ an instrumental variables approach, recognizing that our parameter estimates could be overstated if endogeneity at the county level does exist. This paper adds to the growing Wal-Mart literature by accounting for the spatial dimensions of supercenter and warehouse store entry on retail grocery sales.

*Data*

The geographical areas used as a sample were all 1,160 counties in the southeast and north central U.S., as defined by Trade Dimensions. These regions were chosen because they include the region where Wal-Mart first expanded, the home area of Kroger Foods, the home area of Meijer, and many metropolitan and non-metropolitan counties. In addition, the county sizes in these regions are relatively smaller than in the Western U.S., so the county size is closer to a grocery store market area. The 1,160 counties were located throughout Alabama, Arkansas, Florida, Georgia, Indiana, Kentucky, Louisiana, Maryland, Michigan, Mississippi, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia (Figure 1).

The sample size was sufficiently large, but additional years of data would make the results stronger. For example, the data allow for a single change from 1999 to 2002 but are insufficient to conduct an analysis of possible time lags or other temporal market changes. In addition, the change calculation is based on a three-year time span. This was necessary because only a few supercenters enter during any single year, which could in turn reduce the significance level of the models. In this study, the only years available were from 1999 to 2002.

The sources of data for the model were Trade Dimensions' *Marketing Guidebook*, the U.S. Census Bureau of County Business Patterns, and the U.S. Department of Commerce Bureau of Economic Analysis. The grocery sales per county were obtained from Trade Dimensions' *Marketing Guidebook* (2000, 2003) for the years 1999 and 2002. Trade Dimensions Marketing Guidebook reports sales for a range of food and limited consumer goods products typically sold by traditional retail grocery stores. The sales include food sales and limited consumer goods sales from supercenter and warehouse stores, but not all supercenter and warehouse store sales. Therefore Trade Dimensions' data allows comparisons between traditional retail grocery store sales and supercenter and warehouse store sales.

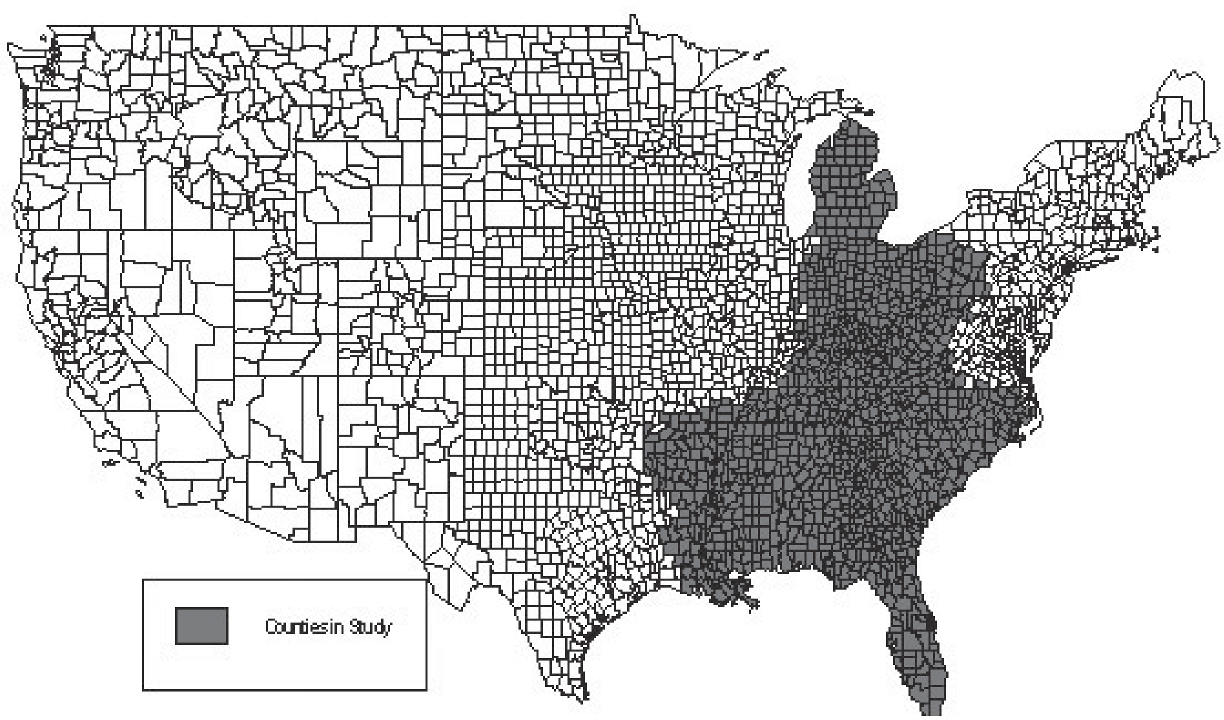


**Figure 1. Counties Used in the Study.**

The U.S. Census Bureau of Business Patterns was used for groupings of supermarkets by employment size, using North American Industry Classification System (NAICS) code 445110 (food stores not including convenience stores), and NAICS code 452910 for warehouse clubs and supercenters, by employment size. Income and population data were gathered from the U.S. Department of Commerce Bureau of Economic Analysis (2005).

*Descriptive Statistics*

Descriptive statistics for selected variables are shown in Table 1. Of the decrease of 3,155 supermarkets from 1999 to 2002 in the study region, 81 percent (2,557) were considered small supermarkets (employing less than 50 people). At the same time, the total number of warehouse and supercenter stores increased by 192 stores, of which 103 (54 percent) employ more than 50 people. The total number of large warehouse and supercenter stores in 2002 was 723 stores.

*Modeling Spatial Effects*

The spatial scale or size of the physical geographical area is important in this study because entry by supercenter and warehouse stores not only affects the county entered, but the effects spill over into neighboring counties. Spatial spillovers occur because the county lines are not physical barriers to where people shop for groceries. For example, if a large warehouse store opens in one county, it may have a positive influence on the county where it opened, while spillover effects may decrease sales in the next county. If the spatial scale is appropri-

**Table 1. Descriptive Statistics for Selected Variables.**

| Variable | Notation | Mean | Median | Mode | St. dev. | Total |
|---|---|---|---|---|---|---|
| Change in sales | $\Delta S$ ($000,000) | 5.1 | 0.5 | 0.6 | 33.4 | |
| Population density, 1999 | PDN | 154.4 | 68 | 48 | 314.7 | |
| Number of large warehouse/ supercenters, 1999 | WS | 0.5 | 0 | 0 | 1.3 | 620 |
| Number of large supermarkets, 1999 | LSM | 2.6 | 0 | 0 | 7.8 | 3,002 |
| Number of small supermarkets, 1999 | SSM | 14.2 | 8 | 3 | 30.8 | 16,526 |
| Change in per capita income | $\Delta I$ | 1.7 | 1.8 | 2.2 | 1.7 | |
| Change in population per sq mile | $\Delta PDN$ | 6.8 | 2 | 1 | 23.6 | |
| Change in number of large warehouse/supercenters | $\Delta WS$ | 0.1 | 0 | 0 | 0.4 | 103 |
| Change in number of large supermarkets | $\Delta LSM$ | -0.5 | 0 | 0 | 2.0 | -622 |
| Change in number of small supermarkets | $\Delta SSM$ | -2.4 | -1 | -1 | 5.2 | -2,557 |

ate, spatial econometric models capture spillover effects. In this study, the spatial scale is defined by county size, which is sufficiently small to measure spillover effects.

Diagnostics tests were performed to determine whether the data are related spatially. Based on a univariate Moran's I statistic, which is often used to show the degree of spatial autocorrelation, the data are spatially related (Anselin 1996). Therefore a spatial weights matrix relating neighboring counties to one another was defined as

$$(3)\quad \begin{cases} w_{ij} = d_{ij}^{-1} \text{ if } d_{ij} < 40 \text{ miles} \\ w_{ij} = 0 \text{ otherwise and if } i = j \end{cases},$$

where $d_{ij}$ is the distance in miles between the centroids of counties $i$ and $j$. This is an inverse distance weights matrix with a cut-off point of 40 miles, based on Moran's I results for varying distance bands. For a distance band from 37 to 40 miles, the Moran's I result was 0.1345, suggesting that the data are related spatially. For a distance band of 40 to 45 miles, the Moran's I was 0.0378, but the result was not significantly different from zero. The degree of spatial autocorrelation is greatest for observations within 40 miles, and the spatial autocorrelation, as measured by the Moran's I, decreases rapidly for distances greater than 40 miles.

Spatial regimes or groupings of similar counties were used for comparison purposes and to control for heteroskedasticity resulting from spatial heterogeneity. The spatial regimes allow for different slopes, intercepts, and error variances, so regimes can be used to control for heteroskedasticity. Heteroskedasticity likely exists due to market and demographic differences between lower and higher population density counties. Therefore population density was used to group counties with varying population levels into regimes. Metropolitan as defined by the Office of Management and Budget (OMB) can include outlying counties economically tied to the core counties, as measured by work commuting. The OMB definition is too broad for retail grocery markets which are relatively small in geographic scope. When defining regimes based on population density, our intuition is that grocery shopping is different between densely populated counties, moderately populated "suburban" counties in which cars are used by most shoppers and where parking and store space is more readily available, and the more sparsely populated rural counties in which grocery shopping often requires a relatively long commute by car.

Several methods for defining regimes based on population density were considered: standard deviations, quartiles, high population areas with neighboring counties (metropolitan statistical areas), and natural break points. The method chosen was to use percentiles of population density smoothed by area in square miles. Figure 2 maps the counties based on the defined regimes. The high counties were those counties with a smoothed population density greater than the 90th percentile (116 counties), the moderate counties were those counties with a population density between the 50th and 90th percentiles (464 counties), and the low counties were those counties with population densities less than the 50th percentile (580 counties).

## Results

Three regression models are estimated, and diagnostic tools are used to determine which model and results are most valid. Model 1 is an OLS regression using the inverse distance weights matrix with a cut-off distance of 40 miles to test for spatial relationships (Table 2). The KB and White tests show that heteroskedasticity exists. The Lagrange Multiplier (LM) and Robust LM tests point to the spatial error model as the correct specification.

Model 2 is a maximum likelihood spatial error (MLERR) model that tests for groupwise heteroskedasticity (GHET) between the population-based regimes (Table 2). The maximum likelihood (ML) estimator is used because the OLS estimators for the spatial error model are inconsistent due to the spatial lag in the errors. The Breusch-Pagan (BP) test confirms that differences in the regimes are a source of heteroskedasticity. Model 3 is a MLERR model that uses spatial regimes, allowing for different slopes, intercepts, and error variances (i.e., GHET between regimes) (Table 2).

Model 3 gives the most valid results based on the likelihood test. In addition, eight of the 11 variables are significant in at least one of the spatial regimes (Table 2). Model 3 results are also the most useful because the spatial regimes allowed for different coefficients by regime. The overall Chow test and Chow tests on seven of the variables indicate that the estimated regression parameters are not identical

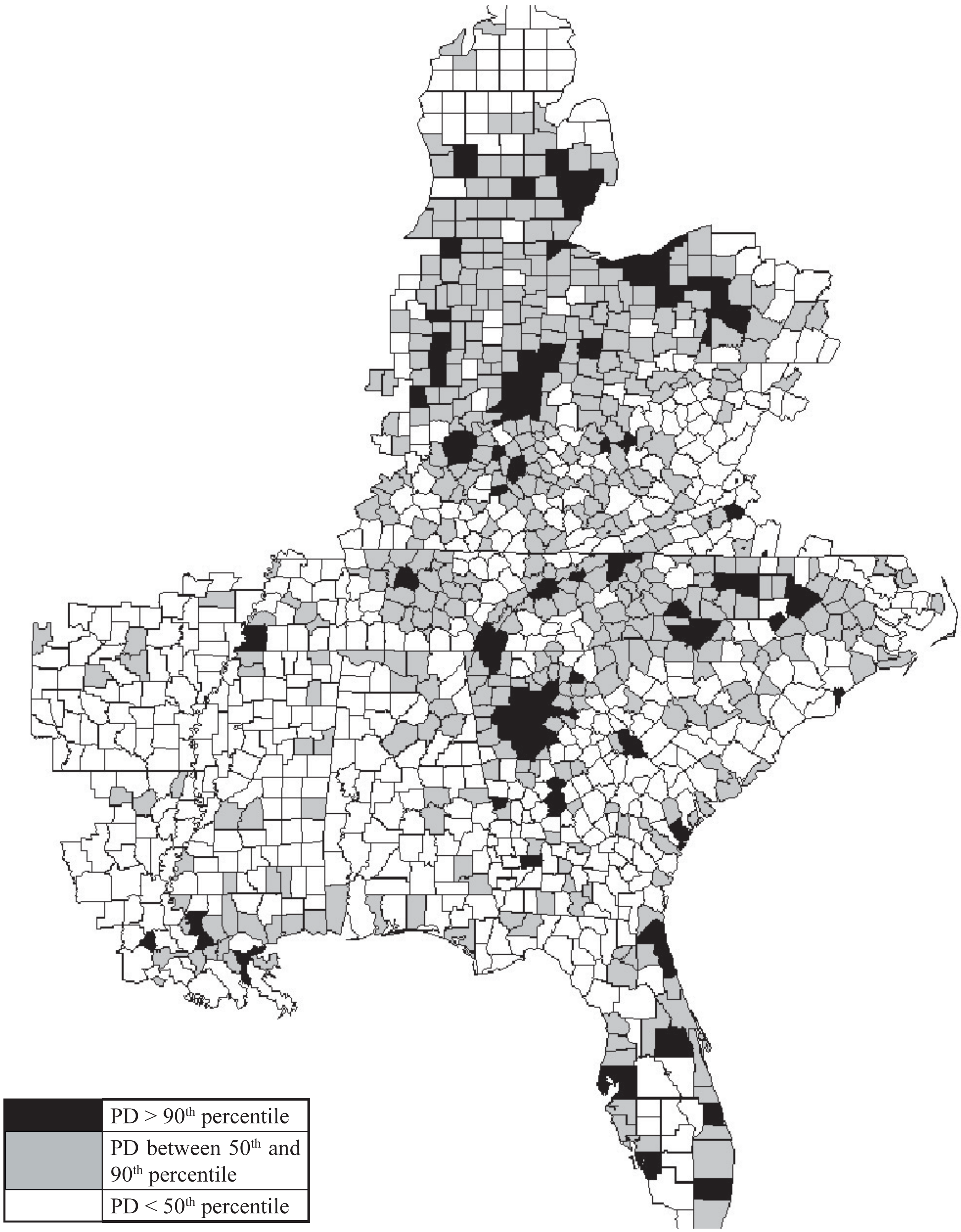


**Figure 2. Map of Regimes Based on Smoothed Population Densities.**

**Table 2. Estimation Results for Growth in Sales Specification.**

| | Model 1 | Model 2 | Model 3 MLERR+GHET REG | | | |
|---|---|---|---|---|---|---|
| | OLS | MLERR + GHET | High pop | Med pop | Low pop | Chow |
| Constant | -0.498*** | -0.387*** | -0.022 | 0.270 | -0.730*** | 7.31** |
| | (-4.043) | (-3.771) | (-0.080) | (1.051) | (-2.650) | |
| Ln$S_{i,99}$ | -0.210*** | -0.191*** | -0.063* | -0.211*** | -0.285*** | 24.25*** |
| | (-12.239) | (-11.938) | (-1.736) | (-7.069) | (-10.431) | |
| $Ln\ PDN_{i,99}$ | 0.007 | 0.008 | -0.026 | 0.007 | 0.011 | 1.52 |
| | (0.551) | (0.839) | (-1.470) | (0.230) | (0.340) | |
| $WS_{i,99}$ | -0.014* | -0.008* | 0.000 | -0.013 | 0.000 | 0.925 |
| | (-1.828) | (-1.760) | (0.216) | (-0.948) | (0.010) | |
| $SSM_{i,99}$ | 0.000 | 0.000 | 0.000 | 0.004*** | 0.010*** | 12.97*** |
| | (0.838) | (0.576) | (0.751) | (2.604) | (2.718) | |
| $LSM_{i,99}$ | -0.002 | 0.000 | 0.000 | 0.000 | 0.064** | 4.65* |
| | (-0.865) | (0.114) | (0.455) | (0.042) | (2.173) | |
| $Ln\ I_{i,99}$ | 0.211*** | 0.186*** | 0.064** | 0.152*** | 0.283*** | 20.62*** |
| | (10.469) | (11.334) | (2.193) | (4.956) | (7.330) | |
| $\Delta PDN_i$ | 0.000 | 0.000 | 0.000** | 0.003** | 0.002 | 4.55* |
| | (0.873) | (0.510) | (2.354) | (2.458) | (0.382) | |
| $\Delta SSM_i$ | 0.002 | 0.002 | 0.001 | 0.002 | 0.011* | 2.82 |
| | (1.067) | (1.500) | (1.156) | (0.668) | (1.929) | |
| $\Delta LSM_i$ | 0.000 | 0.002 | 0.002 | -0.009 | 0.014 | 1.96 |
| | (0.910) | (1.004) | (1.267) | (-1.071) | (0.0451) | |
| $\Delta WS_i$ | 0.045** | 0.013 | -0.006 | 0.064** | 0.492*** | 34.04*** |
| | (2.446) | (1.186) | (-0.517) | (2.454) | (5.394) | |
| $\Delta I_i$ | -0.019*** | -0.019*** | 0.009 | -0.018** | -0.013** | 7.12** |
| | (-5.077) | (-5.341) | (1.113) | (-2.407) | (-2.019) | |
| Lambda | | 0.182*** | 0.185*** | | | |
| | | (3.873) | (3.974) | | | |
| F / Chow | 20.811*** | | 109.37*** | | | |
| Likelihood | 194.010 | 234.264 | 300.428 | | | |
| N | 1160 | 1160 | 1160 | | | |
| CN | 138.560 | | | | | |
| JB | 1138.47*** | | | | | |
| BP/KB/LR | 17.031*** | 105.735*** | 125.73*** | | | |
| Moran's I | 0.058*** | | | | | |
| LMERR | 13.121*** | | | | | |
| R LMERR | 6.147** | | | | | |
| LMLAG | 8.759*** | | | | | |
| R LMLAG | 1.785 | | | | | |

Significance levels are indicated by *** (1% level), ** (5% level) and * (10% level). CN is the condition number indicating the degree of multicollinearity and the JB test tests for the normality of the errors. BP/KB/LR are the Breusch-Pagan or Koenker-Bassett tests for heteroskedacity and the Likelihood Ratio test for groupwise heteroskedasticity.

between regimes and that several of the estimated coefficients are not identical between regimes. Coefficients for each regime show differences that exist between higher, medium, and low population density counties.

The most interesting variable in this study, change in the number of supercenter and warehouse stores ($\Delta WS_i$), is significant and positive in the medium and low population density regimes. In low population density counties, the direct effect of entry by a supercenter or warehouse store increases the natural log of growth in sales by 0.492 units (Table 2), which is equivalent to increasing average growth in sales from 106 to 174 percent (64 percent increase in growth in sales). In dollars, the direct effect of entry by a supercenter or warehouse store increases average low population density county grocery sales from \$36.2 million to \$57.9 million.

In medium population density counties, entry of a supercenter or warehouse store ($\Delta WS_i$) increases the natural log of growth in sales by 0.064 units (Table 2). On average this results in a 6.6 percent increase in growth in sales, or \$5.8 million of additional grocery sales (from \$142.2 million to \$148.25 million). The Chow test on the change in supercenter and warehouse store variable ($\Delta WS_i$) was significant at the one percent level, further evidence that the effects of entry by supercenter and warehouse stores are not identical between population density regimes. Together, the results support our hypothesis that entry by supercenter and warehouse stores is affecting low population density counties more than higher population density counties. Supercenter and warehouse store entry ($\Delta WS_i$) was not significant in the high population density regime, and the initial number of supercenter and warehouse stores ($WS_{i,99}$) variable was not significant in any regime.

Small and large supermarkets affect the growth in retail grocery sales in medium and low population density counties. First, the small supermarket results are significant at the one percent level in both the low and medium population density county regimes, and the Chow tests are both significant. Each initial small supermarket ($SSM_i$) increases the natural log of growth in sales by 0.004 and 0.010 units for medium and low population density counties, respectively. Therefore average sales are expected to increase by approximately \$60,000 and \$450,000, respectively, for each additional existing small supermarket ($SSM$) in medium and low population density counties. Entry by a small supermarket ($\Delta SSM_i$) increases the growth in sales in low population density counties by approximately \$450,000. This result was significant at the ten percent level, and the Chow test on the variables was not significant. In the low population density counties, existing large supermarkets ($LSM_i$) increase the natural log of sales growth by 0.064 units, meaning each existing large supermarket increases sales by \$2.45 million. Entry by large supermarkets ($\Delta LSM_i$) was not significant in any regime.

The income ($\ln I_{i,99}$) result, which can be interpreted as an elasticity, was highly significant in all three population density counties. A one percent increase in initial income results in a 0.064, 0.152, and 0.283 percent increase in growth in grocery sales for the high, medium, and low population density counties, respectively. The Chow test was also significant at the one percent level, providing more evidence of differences between population regimes. Change in income was significant and negative in the medium and low population density regimes. The negative coefficients could be the result of more food eaten away from home when income increases.

Sales converge to a steady state with the elasticity of initial sales ($\ln S_{i,99}$) with respect to growth in sales of −0.063, −0.211, and −0.285 for the high, medium, and low population density counties, respectively. Thus a higher level of initial sales means that future growth in sales is less. The magnitude of the coefficient on sales is largest in the lowest population density counties, meaning that the lowest population density counties are converging to a new level of sales at a faster rate than are the medium population density counties. Once again, the Chow test was significant at the one percent level.

## Discussion

The effects of warehouse and supercenter stores, small supermarkets, income level, and the initial level of grocery sales on growth in retail grocery sales are significantly different between high, medium, and low population density regimes. As expected, the effects of changes in the number of supercenter and warehouse stores ($\Delta WS_i$) on growth in retail grocery sales are larger in low population density counties. Assuming entry by supercenter and warehouse stores lowers the cost of groceries due to increased competition, increased growth resulting from supercenter and warehouse store entry can be attributed to additional sales (i.e., more consumers purchasing groceries) (Basker 2005; Hausmann and Leibtag 2005).

Therefore the results from this spatial model shows that grocery sales in neighboring counties are decreasing when a supercenter enters the host county (e.g., spatial spillovers from neighboring counties exist when a supercenter enters a host county). Supercenter and warehouse store entry, especially in low population density counties, changes where (and perhaps how often) consumers shop for groceries, fundamentally changing traditional retail grocery distribution channels. The result supports previous research on the effects of Wal-Mart entry on retail sales capture and leakage (Stone 1997; Gruidl and Kline 1992; Artz and McConnon 2001; Stone, Artz, and Myles 2002).

Each existing small supermarket ($SSM_i$) in low and medium population density counties increases growth in sales, due to increased prices, increased sales, or both. As consumers shift where and when they shop for groceries, they likely pay small supermarkets increased prices for convenient fill-in shopping trips. Sales growth (decline) resulting from entry (exit) by small supermarkets ($\Delta SSM_i$) probably reflects both exit by small supermarkets and the consumer's willingness to patronize one-stop-shop food store formats.

The income ($\ln I_{i,99}$) result continues to show the differences that exist among high, medium, and low population density regimes in retail grocery. In the high population regime, a one percent increase in initial income only increases growth in retail grocery sales by 0.06 percent, but the same percentage increase in income increases growth in retail grocery sales by 0.28 percent in low population density regimes. This higher elasticity of income with respect to growth in retail grocery sales likely reflects consumers choosing to pay higher prices for groceries instead of driving to a supercenter or warehouse store. Therefore the low population density consumers are willing to pay for convenience derived from location.

## Implications and Future Research

Large grocers and supercenter and warehouse stores should consider population-density differences when making location decisions, knowing sales will be captured from neighboring counties in suburban and rural areas. Small rural grocers should carefully consider the effect of entry by large supercenter and warehouse stores both locally and in neighboring counties. Small rural grocers must be ready to take advantage of their rural location (convenience).

When deciding whether to grant supercenter and warehouse store entry, policy makers often trade-off advantages and disadvantages associated with the large stores. These results show that in rural counties grocery purchasers are willing to travel across county borders to purchase groceries from supercenter and warehouse stores, expanding retail grocery trade areas. As retail trade areas for groceries are expanded, trade areas for other products may be expanding as well. Work by Stone and Artz (2002) suggests that trade areas are in fact expanding. Therefore entry by supercenter and warehouse stores may create commerce centers, increasing local tax revenues.

In contrast to the benefit of increased tax revenues and commerce, supercenter and warehouse retail grocery distribution channels are competing for and attracting sales from neighboring low population density counties. This research clearly shows that consumers travel across county lines to purchase groceries when a supercenter or warehouse store opens in a neighboring county. As sales decrease in non-host counties, some retail grocery stores would be expected to exit the market or reduce inventories and even raise prices to capture a premium for their close proximity (location). In turn, access to reasonably priced groceries might be decreased.

A series of hearing jointly conducted in 2010 by the Antitrust Division of the U.S. Department of Justice and the U.S. Department of Agriculture highlight a renewed policy concern related to concentration and competition in food and agribusiness, including retailing (U.S. Departments of Agriculture and Justice 2009). Policy concerns are confounded by conflicting evidence as to whether concentration leads to increased market power (and hence higher prices) or efficiency gains (with lower prices) (GAO 2009). The GAO report also found that most studies of concentration have serious theoretical, data aggregation, or modeling limitations. Unfortunately, this work shares similar limitations. These concerns lead to recommendations for future research.

Future research evaluating the retail grocery industry and the effects of supercenter and warehouse stores should include an evaluation of the market-level spatial effects. If data become available, extending this research by reducing the spatial scale to a lower spatial aggregation (i.e., zip code) would give additional insights into market differences between metropolitan and rural areas and the effects of supercenter and warehouse stores. Additional research should evaluate the spatial effects of supercenter and warehouse store entry on the retail grocery prices. Finally, logistics is by definition spatial. This study uses spatial methods to investigate where groceries are sold and finds that changes in the logistics of shopping for groceries is closely tied to differences in population density regimes. Future work should continue exploring how various aspects of metropolitan, suburban, and rural transportation infrastructure affects retail grocery shopping.

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