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The Effect of Entry by Supercenter and Warehouse Club Retailers on Grocery Sales and Small Supermarkets: A Spatial Analysis

Bobby Martens[a,*], Raymond J.G.M. Florax[b], Frank Dooley[c]

[a] Bobby Martens is a Ph.D. candidate, department of Agricultural Economics- Purdue University.
[b] Raymond J.G.M. Florax is a professor, department of Agricultural Economics- Purdue University.
[c] Frank Dooley is a professor, department of Agricultural Economics- Purdue University.
[*] Telephone: 765-412-2602; Email: bjmarten@purdue.edu, Address: 403 West State Street, West Lafayette, IN 47901.

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Abstract

This research evaluates the effects of entry by supercenters and warehouse clubs on retail grocery sales and the exit of small supermarkets. Drawing on literature from trade area analysis, agglomeration, and location theory, spatial econometric models are estimated. Results suggest that warehouse and supercenter stores have a significant and large effect on the change in grocery sales and the exit of small supermarkets operating at the county level.

Introduction

Since the late 1980s, the U.S. retail grocery industry has seen a steady contraction of small "Mom and Pop" retailers,[1] mergers and acquisitions among large retailers, and the emergence of a new national retailer (Wal-Mart). In addition, wholesale and retail grocery concentration as measured by CR4 increased 6 percent from 1999 to 2002 (Trade Dimensions, 1999-2000 and 2002-2003).[2] The grocery industry shifted from an industry dominated by small grocers serving local markets to one characterized by large retailers present in international markets. The growth of the large grocers is explained by economies of size and scope, the adoption of advanced information technology, supply chain management strategies which drastically lower their costs compared with traditional grocers, fewer weekly trips to supermarkets by consumers, and evolving store

[1] The number of small supermarkets decreased by 15.5 percent from 1999 to 2002 (U.S. Bureau of Census, 2005).
[2] CR4 is the market share of the top 4 retail grocery firms.

formats[3]. These larger retailers enjoy a lower cost structure, combined with leading positions in marketing, store design, and shelf space allocations.

Concerns have emerged that large international grocers are using their lower cost structure and advantages in marketing, store design, and shelf space allocations to reduce consumer access to local groceries (Blanchard and Lyson, 2002), increase retailer market power (Foer, 1999), and discourage competition (FTC Report, 2001). Wal-Mart is often at the heart of the media's reporting of the grocery industry's changes, due in part to its rapid growth and size.[4]

Even though Wal-Mart is only one of several warehouse club and supercenter firms, its tremendous growth shows how quickly the grocery industry has changed and reinforces the importance of evaluating this transformation. In 1987 Wal-Mart did not sell groceries. By 2002, the company surpassed Kroger Foods to become the largest retail grocer in the United States. This rapid growth is expected to continue, with one prediction that Wal-Mart will control 35 percent of the U.S. retail grocery sales for many consumer products by 2010 (Clarke).

Much time and energy has been devoted to understanding how Wal-Mart has achieved its success and the effects of Wal-Mart on labor, towns, and communities. Published research on Wal-Mart's influence in grocery retailing includes pricing models (Jones, 2004; Lal and Roa, 1997), rural poverty models (Stone, 1997; Goetz and Swaminathan, 2004), labor market effect models (Basker, 2003; Ketchum and Hughes,

[3] The number of warehouse and supercenter stores increased by 29 percent from 1999 to 2002 (U.S. Bureau of Census, 2005).
[4] A few of the hundreds of newspaper articles, radio commentaries, television documentaries, and news stories include National Public Radio's series "Is Wal-Mart Good for America?" (2004), *The Los Angeles Times'* Pulitzer Prize winning series of articles on Wal-Mart, *The Economist's* "How Big Can It Grow" (2004) article, and *Business Week's* "There Goes the Rainbow Nut Crunch" article on reduced consumer variety (2004). These reports, although often based on inferential analysis and anecdotes, identify important changes occurring in the grocery industry.

2004), and studies that evaluate Wal-Mart's impacts on traditional food retailers (Woo et al., 2001; Capps and Griffen, 1998; Hicks and Wilburn, 2001). No work was discovered in a literature review that addresses the effects that large supercenters and warehouse club grocery retailers have on the spatial structure of the retail grocery industry.

Research Objective

The objective of this research is to evaluate the effects of entry by supercenters and warehouse club stores on county level retail grocery sales and changes in the numbers of small supermarkets. ACNielsen's "Channel Blurring" study (2005) motivates the objective. They found that consumers made 69 trips to the grocery store in 2004, down from 72 in 2003, and down every year since 1995 when ACNielsen began tracking consumer shopping patterns. In total, the average annual number of trips to a grocery store in the US decreased by 25 percent since 1995 (ACNielsen, 2005). This decline could be due to improved grocery packaging increasing the shelf live of groceries, decreased food-away-from-home purchases, or the consumer's willingness to patronize new food store formats such as supercenters and warehouse club stores.

Shoppers patronize traditional supermarkets less often as they shift some of their purchases to supercenters (Duff, 2002). This shift from traditional supermarkets to warehouse club and supercenter stores is shifting sales from small markets to larger ones and forcing small grocers to close. However, the impacts of warehouse club and supercenter stores on grocery sales or on the number and size of local grocery retailers has not been well thoroughly studied or understood. Therefore, this research tests the following three hypotheses.

- Hypothesis 1: The entry of a supercenter or warehouse club increases grocery sales within a non-metropolitan county.
- Hypothesis 2: The entry of a supercenter or warehouse club decreases grocery sales in neighboring counties.
- Hypothesis 3: The entry of a supercenter or warehouse club decreases the number of small grocery retailers in immediate non-metropolitan and in adjacent counties.

The hypotheses are based on the concepts of spatial spillovers and crowding out, both of which will be analyzed using spatial econometric models. The data for these models are taken from the U.S. Census Bureau County Business Patterns and Trade Dimension's Marketing Guidebook and Market Scope publications (Trade Dimensions, 1999 - 2003).

The geographical areas used were all counties in the southeast and north central U.S., as defined by Trade Dimensions.[5] These regions were chosen because they include the area where Wal-Mart first expanded, the home area of Kroger Foods, the home area of Meijer, and many metropolitan and non-metropolitan counties. The 1160 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 (see figure 1).

We expect that entry by warehouse and supercenter stores have a greater effect in non-metropolitan counties as compared to metropolitan counties for two reasons. First, supercenters in non-metropolitan face less competition from other warehouse and supercenters. Second, non-metropolitan residents are more willing to drive further

[5] Because of minor changes in the areas defined by Trade Dimensions, only counties that were included in the SE and NC regions for both the 2000 and 2003 editions of Marketing Guidebook were included in the dataset.

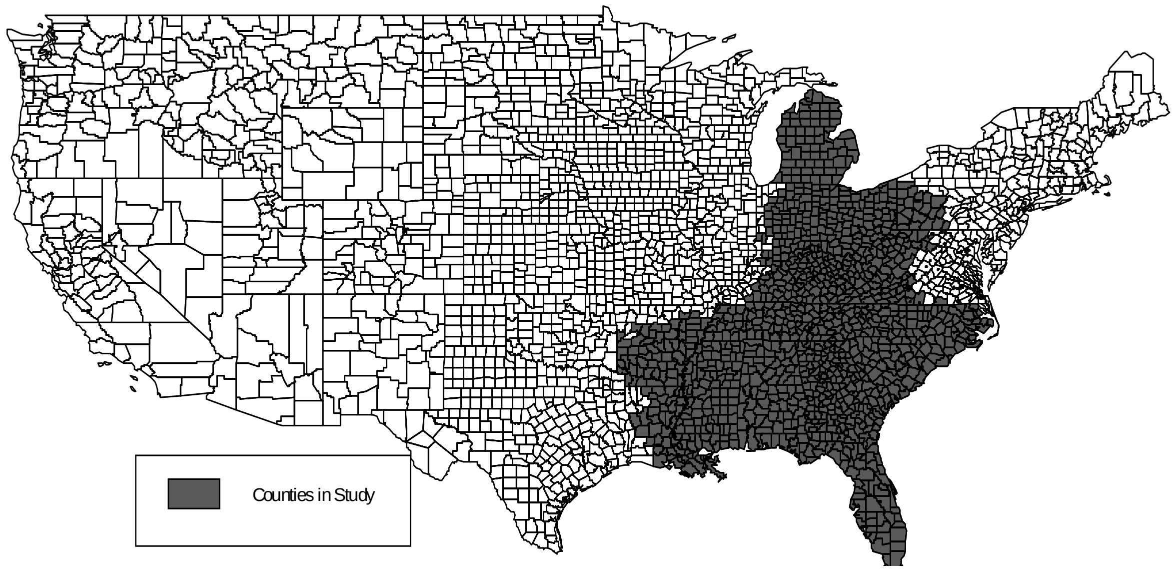

Figure 1: Counties Used in the Study

distances for grocery purchases. For purposes of this research, population density was used to group metropolitan and non-metropolitan counties in two ways. First, counties were simply grouped as metropolitan and non-metropolitan counties based on population. Next, they were divided into three groups; metropolitan, less metropolitan, and rural.

Relevant Literature

Related literature includes trade area analysis, studies on the impacts of large retailers, agglomeration and location theory, and concentration studies. First, trade area analysis estimates the number of people buying locally and gives information about retail sales capture or leakage, utilizing trade area capture and pull factor indexes (Harris and Shonkwiler, 1997; Gruidl and Kline, 1992; Stone, 1997; Artz and McConnon, 2001; Stone et al., 2002). Within this literature, income is an important factor influencing retail trade in several studies, albeit at decreasing rates inferring that a quadratic specification may be appropriate (see e.g., Ring, 1984; Ingene and Yu, 1981). Lower retail sales leakages are found in counties that are farther from trade centers, have higher incomes and larger populations, and have smaller population losses (Yanagida et al., 1991). Shields and Deller (1996) found that counties with major tourism activities have higher pull factors, while Ma (1997) showed that transportation, employment growth, business mix, income, and the location of a county all affect changes in retail sales.

Several trade area studies evaluated how pull factors change with entry by a Wal-Mart or a large discount store. In general, businesses that compete with Wal-Mart are harmed, while those that do not directly compete with Wal-Mart benefit (Stone, 1989; Stone, 1997). Retail sales or pull factors increase following the entry by Wal-Mart, but food store sales remain constant or increase at a slower rate than general merchandise sales (Gruidl and Kline, 1992; Artz and McConnon, 2001; Stone et al., 2002).

Other 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, sales of competing retail stores decline in the home and in nearby markets and that changes to market efficiency and market structure occur. Prices were found to decrease after Wal-Mart entry (Woo et al., 2001; Marion, 1998), while sales for incumbents fell between 17 and 21 percent (Singh et al., 2004; Capps and Griffin, 1998).

Location and agglomeration theory and market concentration studies are also directly related to changes in store numbers and regional sales (table 1). Several variables from this list will be used to specify models in this study. Beginning location density (i.e., number of warehouse stores), initial market size (i.e., population density), market growth (i.e., change in population density), and change in number of stores (i.e., change in warehouse stores and change in supermarkets) are of particular interest. The review of location and agglomeration theories confirms the importance of many of the trade area and pull factor variables. Together, the pull factor variables, the trade area variables, and the agglomeration, location, and concentration study variables will be used to specify our models.

TABLE 1: Agglomeration, Location, and Concentration Study Variables

Variable	**Agglomeration and Location Theory**	**Manufacturing Concentration**
Initial Concentration / Beginning location density	Hannan and Freeman, 1977	Curry and George, 1983; Rogers, 2000; Connor et al., 1996
Increasing Returns (MES)	Krugman, 1980, 1981	Curry and George, 1983; Levy, 1985; Connor et al., 1996
Substitutability of differentiated goods	Krugman, 1980, 1981	Curry and George, 1983
Initial market size	Krugman, 1980, 1981	Curry and George, 1983; Rogers, 2000; Connor et al., 1996
Market growth	Hannan and Freeman, 1977	Curry and George, 1983; Levy, 1985; Connor et al., 1996
Trade costs	Fujita, Krugman, and Venables, 1998	
Proximity to Resources	Brulhart, 1998; Harris, 1954	
Advertising or fixed assets (entry barrier)		Curry and George, 1983; Levy, 1985; Rogers, 2000
Change in Number of Firms		Curry and George, 1983; Rogers, 2000

Model Specification and Variable Definition

Econometric models were estimated to determine the effects of entry by large warehouse and supercenter stores on sales and on the change in the number of small supermarkets. Spatial regimes or groupings of similar counties were used. The spatial regimes allowed for different slope and intercepts for metropolitan and non-metropolitan counties and are used to control for heteroskedasticity by allowing for different error variances, which likely exists due to differences between metropolitan and non-metropolitan counties. The first model predicted the change in county level grocery sales. Using variables from the literature review, the following model was specified.

$$\Delta S_i = \beta_0 + \beta_1 \Delta Pd_i + \beta_2 \ln Pd_{i,99} + \beta_3 \Delta Smkt_i + \beta_4 WL_{i,99} + \beta_5 \Delta WL_i + \beta_6 \Delta I_i + \beta_7 S_{i,99} + \varepsilon_i \quad (1)$$

where:

ΔS_i is the change (2003 – 1999) in total grocery sales in county i ($S_{i,t}$ - $S_{i,t-1}$),

ΔPd_i is the change (2003 – 1999) in population density in county i ($Pd_{i,t}$ - $Pd_{i,t-1}$),

$Pd_{i,99}$ is the initial (1999) population density in county i,

$\Delta Smkt_i$ is the change (2003 – 1999) in the total number of supermarkets in county i ($Smkt_{i,t}$ - $Smkt_{i,t-1}$),

$WL_{i,99}$ is the initial (1999) number of warehouse and supercenter stores that employed more than 50 people in county i,

ΔWL_i is the change (2003 – 1999) in the number of warehouse and supercenter stores that employed more than 50 people in county i ($WL_{i,t}$ - $WL_{i,t-1}$),

ΔI_i is the change (2003 – 1999) in per capita income in county i ($I_{i,t}$ - $I_{i,t-1}$),

$S_{i,99}$ is the initial (1999) grocery sales in county i.

Specifications using percentage change in sales, change in sales per capita, or even pull-factors were considered as alternatives to ΔS_i. However, including both the initial level of sales and the initial level of population on the right-hand side was considered useful. Instead of simply using initial population density, the log of population density was used, based on previous studies (Connor et al., 1996) and on intuition that population will influence sales at a decreasing rate. $WL_{i,99}$ was added to the model to describe the initial market, while ΔWL_i and $\Delta Smkt_i$ were added to describe the changes in the local market. 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 affect on sales. In addition, only the largest supercenter and warehouse stores are expected to have an effect different than that of regular supermarkets.

The second model forecasts the changes in the number of small "mom and pop" supermarkets by predicting the change in the number of supermarket stores employing fewer than 20 people.[6] Using variables similar to the first model, the following model was specified.

$$\begin{aligned}\Delta Ssmkt_i &= \beta_0 + \beta_1 (\Delta Pd_i) + \beta_2 (\ln(Pd_{i,99})) + \beta_3 (\Delta WT_i) + \beta_4 (WT_{i,99}) + \beta_5 (\Delta I_i) \\ &\quad + \beta_6 (NS_i) + \beta_7 (S_{i,99}) + \varepsilon_i \end{aligned} \tag{2}$$

where new variables are:

$\Delta Ssmkt_i$ is the change (2003 – 1999) in supermarkets employing less than 20 people in county i ($Ssmkt_{i,t}$ - $Ssmkt_{i,t-1}$),

ΔWT_i is the change (2003 – 1999) in the total number of warehouse and supercenter stores in county i ($WT_{i,t}$ - $WT_{i,t-1}$),

$WT_{i,99}$ is the initial (1999) total number of warehouse and supercenter stores in county i,

NS_i is a dummy variable signaling if county i is in a northern state or a southern state.

Because nearly all sizes of warehouse and supercenter stores are expected to affect the number of small supermarkets, the initial *total* number of warehouse stores and supercenters and the change in the *total* number of warehouse and supercenter stores were used, as opposed to using the warehouse and supercenter stores that employ more than 50 people. A dummy variable was added to identify northern and southern counties, with the expectation that the loss in the number of small supermarkets will be greater in the southern U.S. where Wal-Mart first opened supercenters before expanding north.

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[6] Supermarkets employing less than 20 people were used based on data availability from the U.S. Bureau of Census County Business Patterns data.

The spatial scale, or the size of the physical geographical areas (counties), is important in this study. Because retail grocery markets are usually relatively small, small geographic areas are needed to evaluate market effects of a supercenter entry. This is because spatial effects, including spatial spillovers, may exist. Spatial spillovers will occur because the county lines are not physical barriers to trade (i.e., 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, but the effects of the entry will spillover into the next county where sales may decrease. The arbitrary county line should not limit the model. The models in this study allow for such spillover effects. Ideally, the spatial scale would be even smaller than the county level (i.e., at a zip code level), but data were not available at that level.

Data

Data for the model were developed using Trade Dimensions Marketing Guidebook, the U.S. Census Bureau of County Business Patterns, and the U.S. Department of Commerce Bureau of Economic Analysis. First, the grocery sales per county were obtained from the Marketing Guidebook (2000, 2003) for the years 1999 and 2002. These are total grocery sales per county. The U.S. Census Bureau of Business Patterns was used for groupings of supermarkets by employment size, using code 445110 (food stores not including convenience stores), and groupings of warehouse clubs and supercenters by employment size, using code 452910. Income and population data were gathered from the U.S. Department of Commerce Bureau of Economic Analysis (2005).

Descriptive statistics for selected variables are shown in table 2. Of the decrease in 3,155 supermarkets from 1999 to 2002, 81 percent were considered to be small supermarkets (employing less than 20 people). At the same time, the number of warehouse and supercenter stores increased by 192 stores, 54 percent of which employ more than 50 people.

Table 2: Descriptive Statistics for Selected Variables (Numbers or Units)

Variable	Change in Sales	Population Density, 1999	Change in Population Density	Change in Per Capita Income	Change in number of supermarkets
Notation	ΔS (000,000)	Pd	ΔPd	ΔI	ΔSmkt
Mean	5.1	154.4	6.8	1.7	-2.7
Median	0.5	68	2.0	1.8	-2.0
Mode	0.6	48	1.0	2.2	-1.0
St. Dev.	33.4	314.7	23.6	1.7	5.5
Total					(3,155)
Variable	Change in number of small supermarkets	Number of warehouse/ supercenters, 1999	Change in number of warehouse/ supercenters	Number of large warehouse/ supercenters, 1999	Change in number of large warehouse/ supercenters
Notation	ΔSsmkt	WT	ΔWT	WL	ΔWL
Mean	-2.20	0.58	0.2	0.5	0.1
Median	-1.0				
Mode	-1.0				
St. Dev.	4.8	1.39	0.7	1.3	0.4
Total	(2,557)	670	192	620	103

Because spatial effects are expected in both models, an exploratory spatial analysis was conducted. To begin, an initial spatial structure was defined using a first order queen (FOQ) contiguity weights matrix, which weights all immediate or boarding counties as neighbors, each with an equal weight. This FOQ contiguity weights matrix was chosen because the spatial range is not likely to be greater than the distance of a county. Figure 2 shows the number of counties arranged by the number of its respective number neighbors. Note that the “distribution” is “normal” with 378 counties having 5 neighbors or bordering counties.

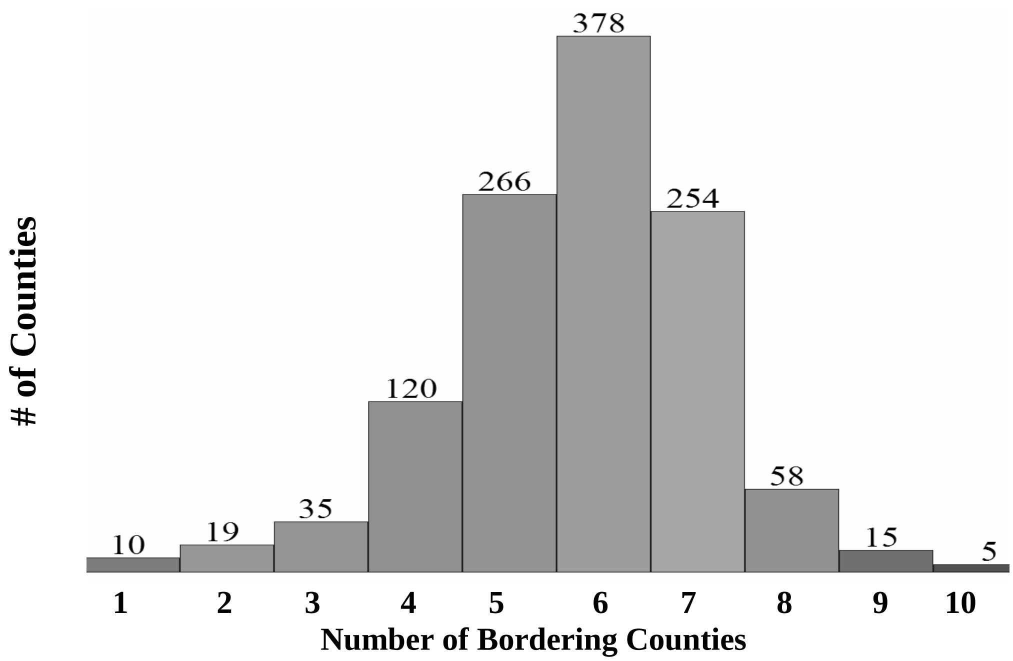

Figure 2: Counties by Number of Neighbors for FOQ Weights Matrix

Many methods have been developed and used to assess statistical properties of spatial data. The univariate Moran’s I statistic is often used to show the degree of spatial dependence. Moran’s I is given by:

$$I = \frac{n}{S_o}\frac{x'Wx}{x'x}, \qquad (3)$$

Where *x* is a vector of observations (in deviations from the mean or x), *W* is the spatial weights matrix (as defined below), and S_o is the sum of elements of the weights matrix. Anselin (1996) shows that, when *W* is standardized, equation 3 can be rewritten as:

$$I = x'(x'x)^{-1}Wx, \qquad (4)$$

allowing the results to be plotted in a scatterplot, which is a useful way to visualize spatial clusters and outliers. The Moran's I scatterplot for the change in sales variable is shown in figure 3.

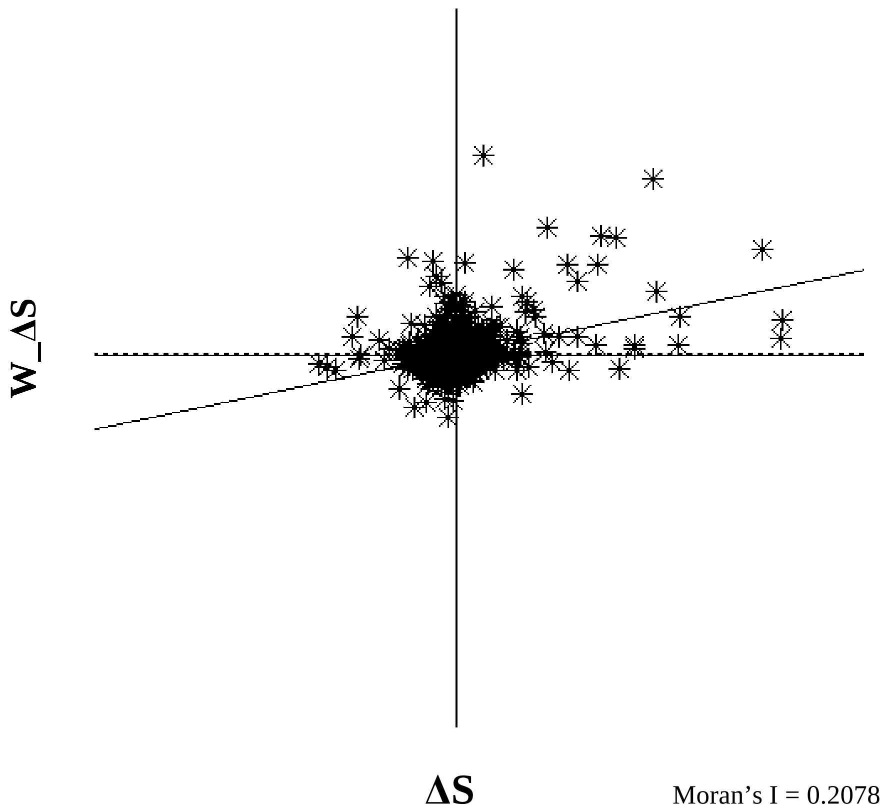

Figure 3: Moran's I Scatterplot for the Change in Sales Variable

The positive value of the Moran's I (0.2078) signals some clustering of high or low (like) values, meaning that counties with an increase in sales are near other counties with an increase in sales and that counties with a decrease in sales are near other counties with a decrease in sales. The Moran's I scatterplot for the change in small stores variable was similar, but the value of the Moran's I was smaller (0.1235).

Mapping capabilities also allow one to investigate spatial relationships. Figure 4 shows a map of all counties in this study. The counties in black are the 25 percent of counties that experienced the greatest changes in sales. The counties with crosshatched lines experienced a positive change in the number of warehouse stores employing more than 50 people. The visual map shows a clear relationship between increases in sales and increases in warehouse stores. Similarly, figure 4 shows the bottom quarter of the change in small stores (i.e., the 25 percent of the counties that lost the most small stores), and the counties that gained warehouse stores. Although not as obvious as figure 5, the visual shows that many of the counties losing small stores were those counties that gained warehouse stores. Overall, the descriptive statistics, Moran's I and scatterplots, and the visual maps all show that a relationship may exist between the change in supercenter and warehouse stores and the change in sales and in number of small stores.

VI. Estimation

Both dependent variables, changes in sales and the changes in the number of small supermarkets, are likely to be influenced by spatial spillovers, or influences that exist across counties. For example, the entry of a large warehouse store in one county may influence the sales in that county and in neighboring counties. Therefore, spatial effects are tested in both models. Two types of spatial effects are spatial heterogeneity and spatial dependence. The first refers to the uniqueness of values due to location (i.e., metropolitan areas vs. non-metropolitan areas), while the later signals that the value at one location is correlated with values at another location. If spatial dependence exists, it can either be modeled as a substantive process (spatial lag model) or as a nuisance (spatial error model) (Anselin and Florax, 1995).

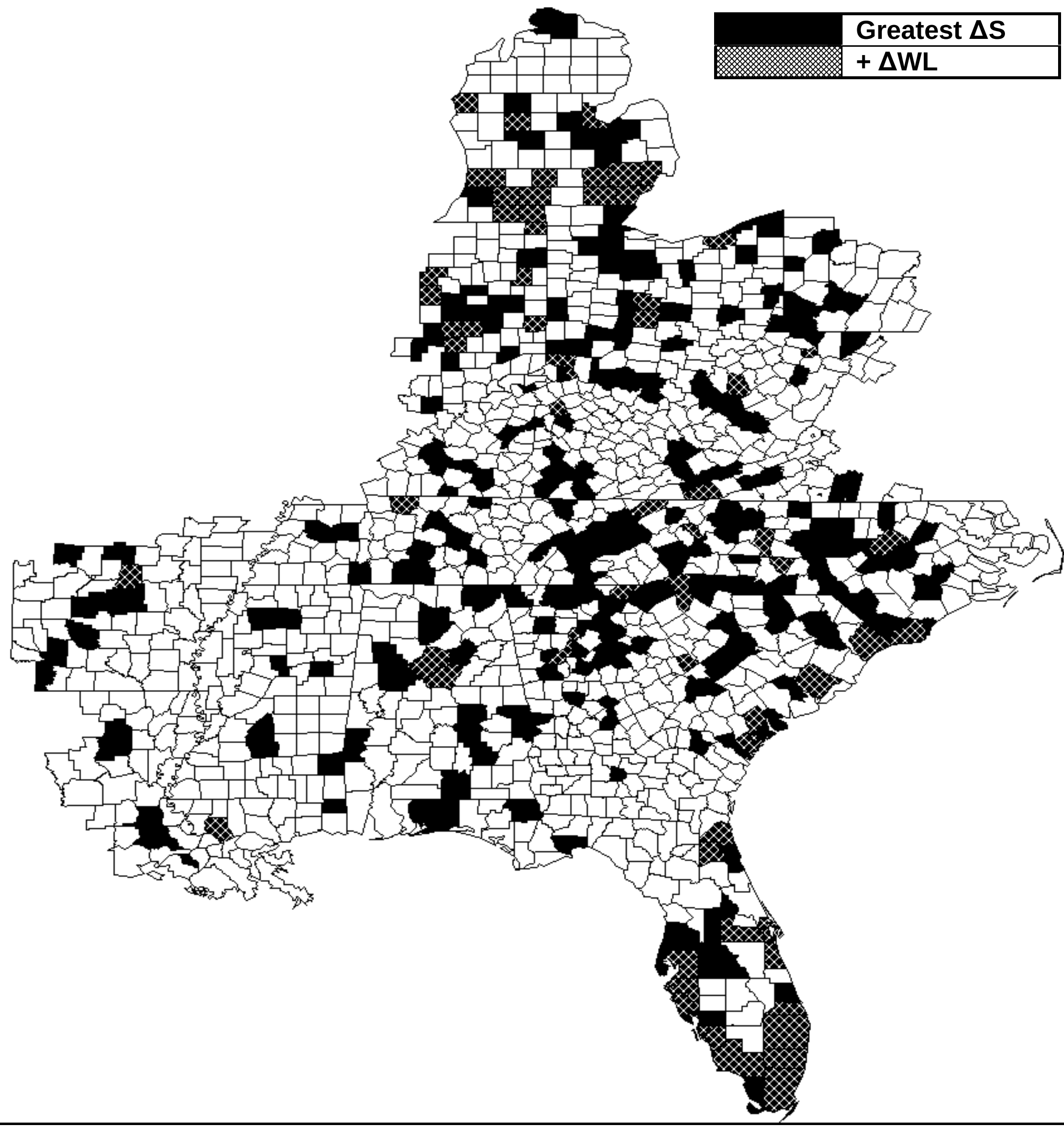

Figure 4: Changes in Sales and Changes in Warehouse Stores

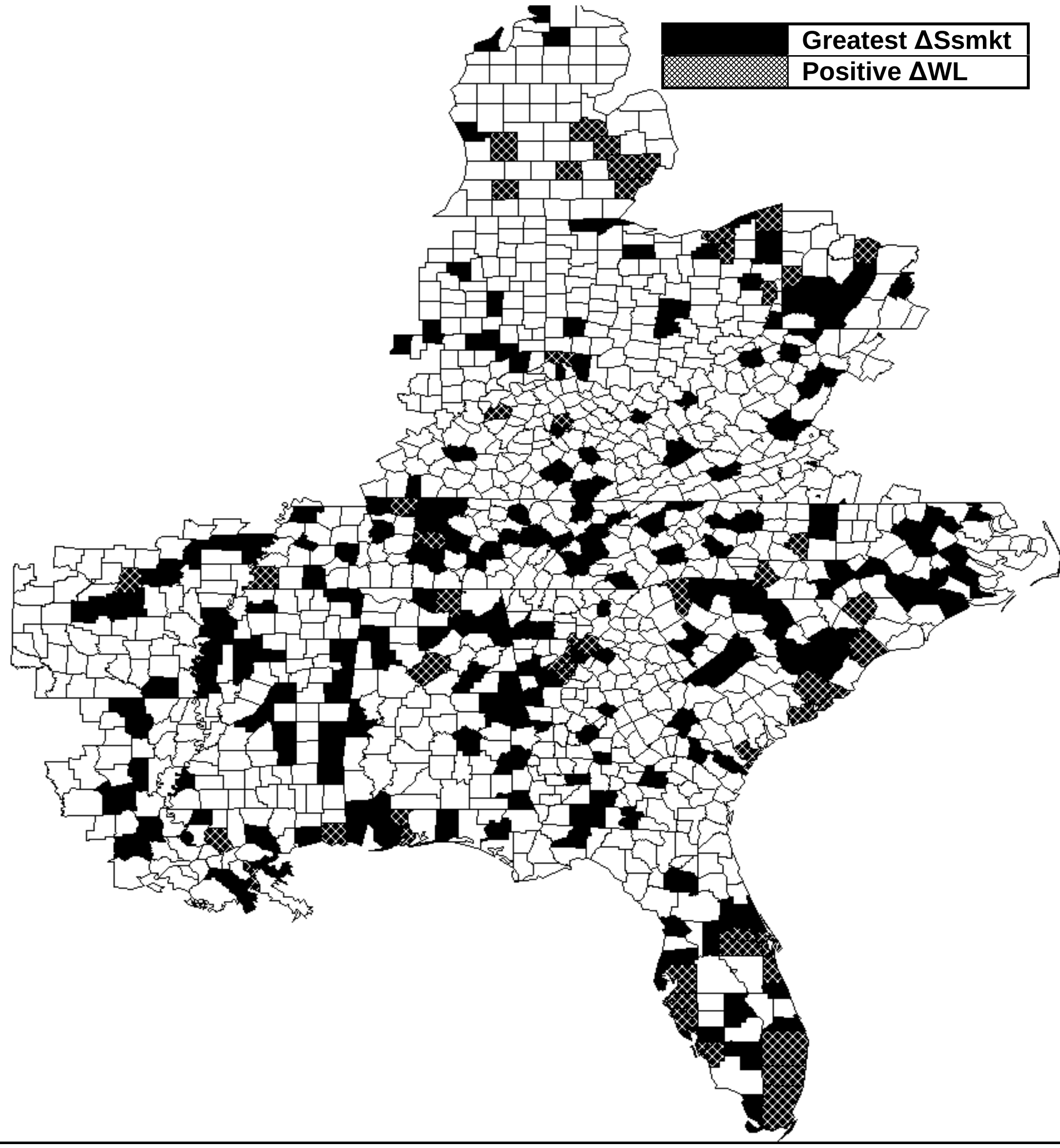

Figure 5: Changes in Small Stores and Changes in Warehouse Stores

In the spatial lag model, a spatially lagged dependent variable (*Wy*) is included in the right-hand-side of the equation:

$$y = \rho Wy + X\beta + u, \qquad (5)$$

where y is a vector of dependent variable, X is a matrix of explanatory variables, u is an error term, and ρ is an autoregressive coefficient. Wy creates endogeneity, leading to "simultaneous equation bias" (spatial lag is correlated with the error term) and a spatial multiplier effect. The simultaneous equation bias means that OLS is not consistent, and the spatial multiplier effect expresses how one location affects all other locations, written in the reduced form as:

$$y = (I - \rho W)^{-1}[X\beta + u], \qquad (6)$$

Therefore, both the values of *X* and the errors are correlated. The value of *y* depends on the *X* at the given location, and the *X* at all other locations. Distance decay adjusts the importance of more distant observations (Anselin, 2001). This means that *β* is not the marginal effect of an increase in *X*. Rather, the marginal effect of *X* is:

$$\begin{aligned} \frac{\partial y}{\partial x} &= (I - \rho W)^{-1}\beta \\ &= \mathrm{I}\beta + \rho \mathrm{W}\beta + \rho^2 \mathrm{W}^2 \beta + \ldots \end{aligned} \qquad (7)$$

so there is no direct comparison to an a-spatial model, and one can only determine location specific effects.

In the spatial error model, autocorrelation is limited to the error term:

$$y = X\beta + u \text{ with } u = \lambda W u + \varepsilon, \qquad (8)$$

where *u* is an error term with an autoregressive coefficient *λ*, and *Wu* is the spatially lagged error term (Anselin, 1990).

As noted above, these models include spatial regimes or groupings of metropolitan and non-metropolitan counties, allowing for different slopes, intercepts, and error variances, in spatially contiguous subsets. The first spatial regimes (see figure 6) are comprised of two groups labeled as metropolitan and non-metropolitan counties. Metropolitan counties are defined as counties with a population density greater than 784 people per square mile (2 standard deviations about the mean of 154 people per square mile). This classification results in 35 metropolitan counties.

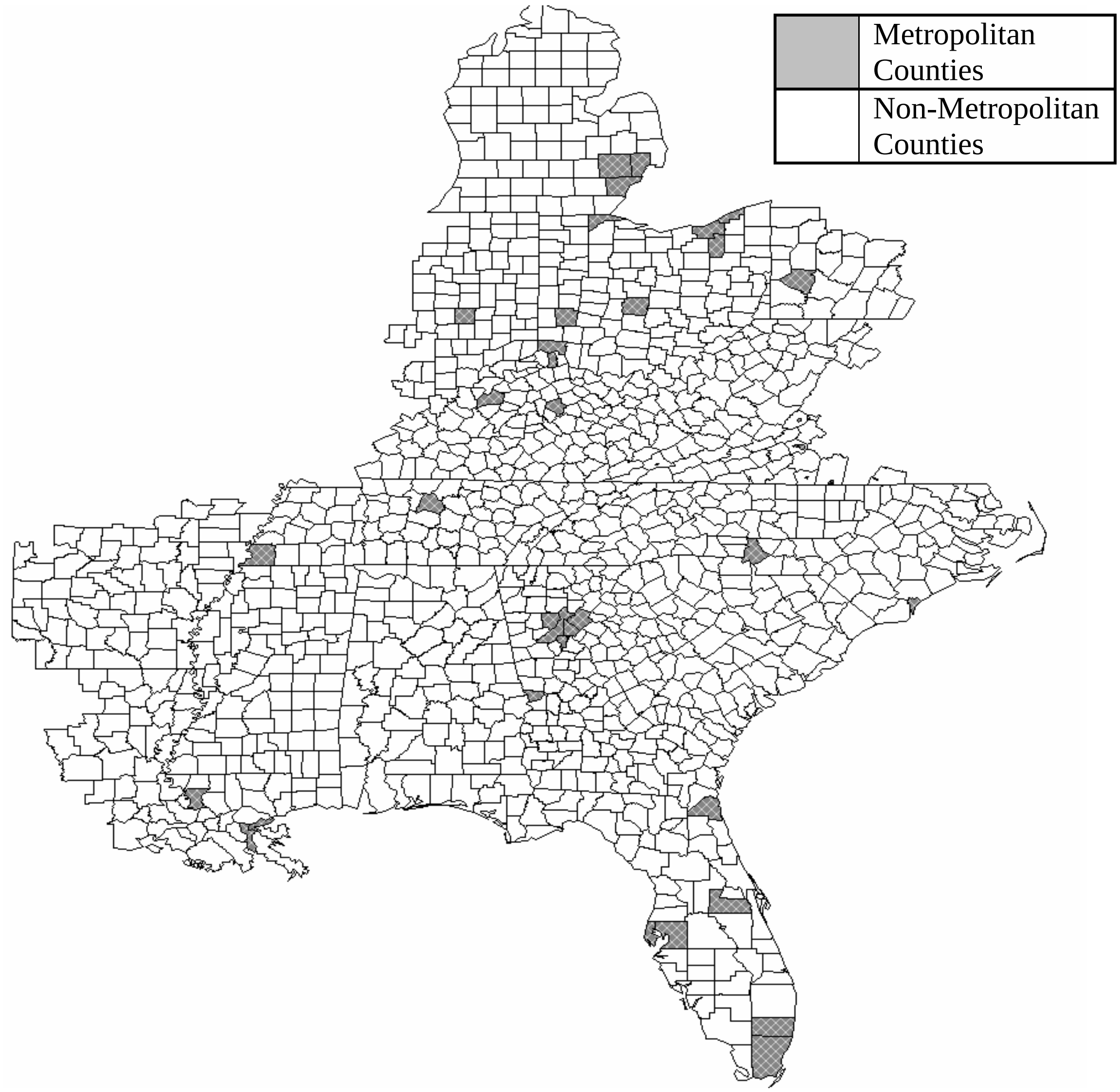

Figure 6: The First Regimes – Metropolitan and Non-Metropolitan Counties

The second spatial regimes (see figure 7) are comprised of three groups labeled as high population, medium population, and low population counties. High population counties are the 10 percent of counties with the greatest population, medium population counties are the 50 to 90 percent most populated counties, and low population counties are the 50 percent least populated counties.

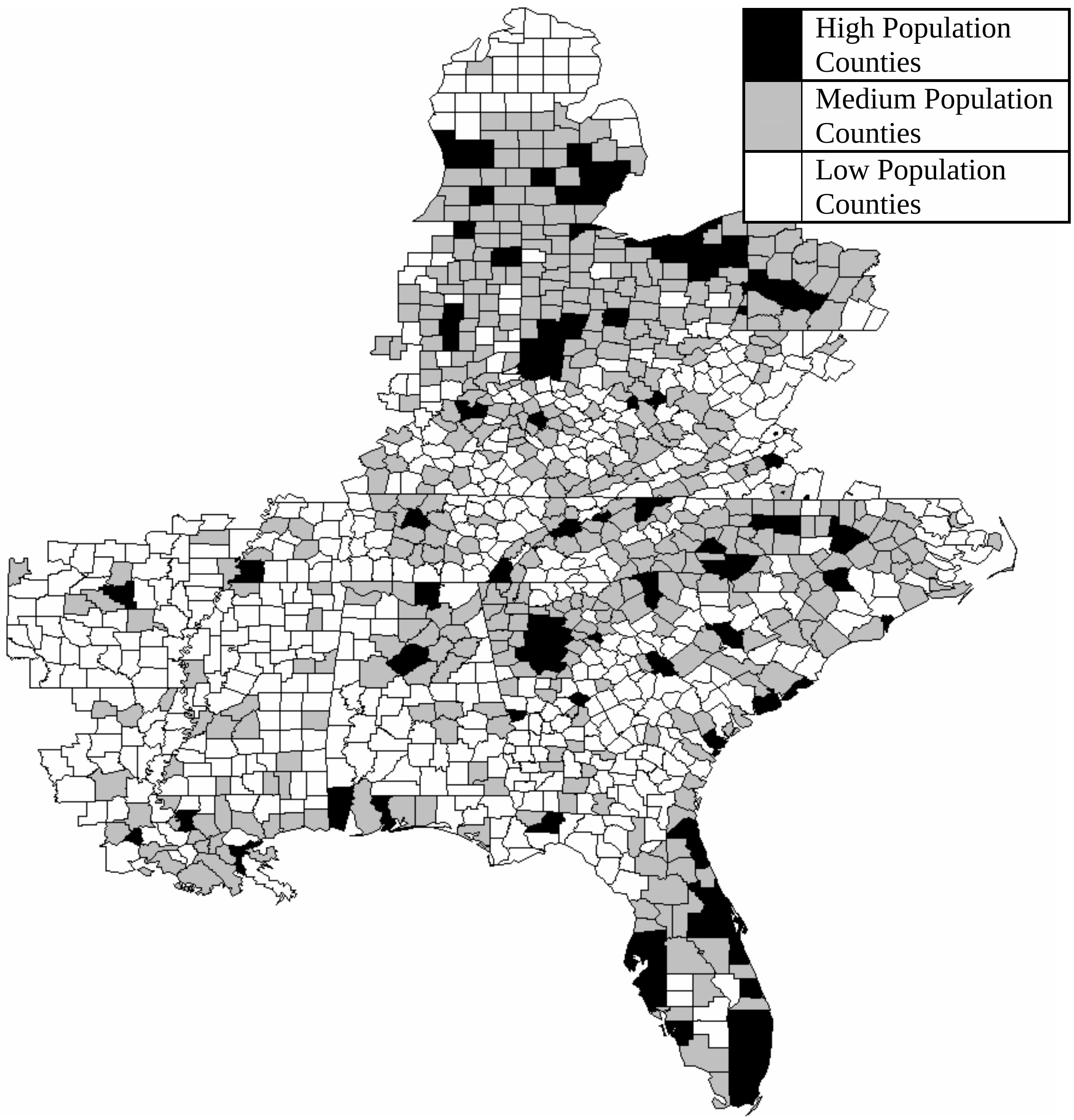

Figure7: The Second Regimes – High Population, Medium Population, and Low Population Counties

Model for Change in Sales

First, an OLS regression using the FOQ weights matrix (defined above) for the change in the sales model is estimated (see column 1 of table 3). The KB and White tests show that heteroskedasticity exists, and the LM and Robust LM tests point to the spatial lag model as the correct specification. The model is re-estimated as a spatial lag (maximum likelihood) model (column 2 of table 3). The maximum likelihood (ML) estimator is used because OLS estimators for the spatial lag model are biased and inconsistent, due to the spatial lag, irrespective of the properties of the error term (Anselin, 1988; Lee, 2003).

Dummy variables indicating metropolitan and non-metropolitan counties are used to test for heteroskedasticity between the regimes. The Breusch-Pagan (BP) test confirms that the metropolitan and non-metropolitan county difference is a source of heteroskedasticity, and the likelihood ratio test confirms the spatial lag dependence for the FOQ weights matrix. An LR test rejects spatial error dependence (significant at the 5 percent level), so there is no need to change the weights matrix. Finally, the model is estimated with the metropolitan and non-metropolitan counties used as spatial regimes, allowing for different slopes, intercepts, and variances (see column 3 of table 3). The overall Chow test rejects that the regimes are the same, and Chow tests on ΔPd, WL, and ΔWL accepts that these variables are significantly different from each other.

The second set of spatial regimes is used to re-estimate the model (see table 4). Differences among the individual coefficients will be discussed in the next section, but note that the Chow test on the model and on three of the individual variables shows that the regimes are significantly different from each other.

Because ΔWL may be endogenous to ΔS, an additional model is estimated using an instrumental variable. This 2SLS GHET spatial lag model with regimes is estimated using ΔWL as an endogenous variable, and the total number of warehouse stores in 2002 (WT_t) as an instrument (see table 5). WT_t is used as the instrument because the change in warehouse stores increases with ΔWL, as does the change in sales. Concerns that WT_t is correlated with the error term exist, but because warehouse stores of all sizes exist, the

Table 3: Estimation results for the ΔS Model – 2 regimes.

	OLS (FOQ)	MLLAG+GHET	MLLAG+GHET REG (FOQ)		
			Non-Metro	Metro	Chow
CONSTANT	14.787***	9.344***	9.735**	127.034	0.20
	(3.315)	(2.415)	(2.488)	(0.489)	
ΔPd	0.255***	0.493***	0.566**	0.225	3.13*
	(5.852)	(6.701)	(7.064)	(1.288)	
Ln(Pd)	-4.128***	-3.244***	-3.466***	-17.638	0.15
	(-3.659)	(-3.167)	(-3.319)	(-0.485)	
ΔSmkt	0.687	0.290	0.207	0.628	0.22
	(3.528)	(1.349)	(0.942)	(0.718)	
WL_{t-1}	2.269**	-5.745***	-6.383**	17.473***	17.60***
	(2.030)	(-5.234)	(-5.731)	(3.133)	
ΔWL	5.152**	10.002***	9.887***	-35.103**	7.19***
	(2.014)	(4.443)	(4.356)	(-2.112)	
ΔI	-0.401	0.050	0.190	-23.856	1.76
	(-0.798)	(0.123)	(0.463)	(-1.315)	
S_{t-1}	0.050***	0.638***	0.0643***	0.0387	0.72
	(7.643)	(8.564)	(8.339)	(1.324)	
W-ΔS		0.112***	0.110***		
		(3.425)	(3.135)		
R^2-adj	0.280	0.437	0.389		
F	65.46***				
Likelihood	-5521.64	-5270.16	-5291.74		
n	1160	1160	1160		
CN	16.56				
JB	15878.35***				
BP/KB/LR	414.710***	497.576***	345.51***		
White	712.116***				
Moran's I	0.026				
LMERR	2.108				
R LMERR	1.881				
LMLAG	5.582**				
R LMLAG	5.536**				
SARMA	7.464** (larger p-value)				
Chow			32.27***		

t-values for the OLS and z-values for the ML estimators are in parentheses below the coefficients. Significance levels are indicated by *** (1 % level), ** (5 % level) and * (10% level). CN is the condition number indicating the degree of multicollinearity and JB tests the normality of the errors. BP/KB/LR are the Bruesch-Pagan or Koenker-Bassett tests for heteroskadacity and the Likelihood Ratio test for groupwise heteroskedasticity.

correlation between the total number of warehouse stores and the errors may not be large. Operationally, the results are consistent with the ML GET model, although the values are different and Chow tests on the individual in the IV model are less significant.

Table 4: Estimation results for the ΔS Model – 3 Regimes.

	MLLAG+GHET REG (FOQ)			
	Low Pop	Med Pop	High Pop	Chow
CONSTANT	-5.885**	-13.593	8.232	0.60
	(-2.095)	(-0.947)	(0.487)	
ΔPd	0.670***	0.498***	0.315**	3.41
	(4.456)	(3.393)	(2.564)	
Ln(Pd)	1.969**	3.347	-12.344	1.42
	(2.181)	(1.033)	(-0.961)	
ΔSmkt	0.009	-0.252	0.949	2.92
	(0.053)	(-0.709)	(1.561)	
WL_{t-1}	-4.739***	-3.776**	6.966*	9.09**
	(-3.350)	(-2.381)	(1.918)	
ΔWL	20.974***	12.463***	-9.984	11.54***
	(6.491)	(3.976)	(-1.092)	
ΔI	0.254	-0.860	5.458	2.52
	(0.274)	(-0.994)	(1.021)	
S_{t-1}	-0.046***	0.001	0.061***	15.88***
	(-2.587)	(0.052)	(3.031)	
W- ΔS	0.249			
	(0.233)			
R^2-adj	0.340			
Likelihood	-4774.61			
n	1160			
CN				
LR	1395.24***			
Chow	71.91***			

z-values are in parentheses below the coefficients. Significance levels are indicated by *** (1 % level), ** (5 % level) and * (10% level). LR is the Likelihood Ratio test for groupwise heteroskedasticity.

Model for Change in Small Supermarkets

A second model is estimated for ΔSsmkt (see table 6). The OLS models without and with a dummy variable for the metropolitan and non-metropolitan dummy variable show the model only becomes spatial when the dummy variable is used (spatial error). Based on the results of the specifications with and without the dummy variable, we decided to estimate a ML heteroskedastic error model, allowing for spatial regimes between the metropolitan and non-metropolitan areas. A Chow test for the model and for five of the variables shows that the regimes are significantly different from each other. The model is re-estimated using the second set of spatial regimes (see table 7). Several differences between the individual coefficients will be discussed in the next section.

Table 5: Estimation Results for ΔS Model. GHET Spatial Lag Model using an IV (2SLS) Estimator and 2 Regimes.

SAR – IV GHET (2SLS) Spatial Lag

	Non-Metro	Metro	Chow	Low Pop	Med Pop	High Pop	Chow
CONSTANT	9.919**	84.813	0.78	-5.478*	-13.351	28.266**	0.47
	(2.502)	(0.316)		(-1.916)	(-0.928)	(0.351)	
ΔPd	0.520***	0.240	2.05	0.684***	0.487***	0.289**	4.04
	(6.374)	(1.355)		(4.502)	(3.266)	(2.283)	
Ln(Pd)	-3.441***	-12.946	0.07	1.913**	3.338	-9.816	0.97
	(-0.961)	(-0.348)		( )	(1.028)	(-0.742)	
$\Delta Smkt$	0.189	0.537	0.15	-0.001	-0.248	0.716	1.77
	(0.849)	(0.604)		(-0.007)	(-0.695)	(1.134)	
WL_{t-1}	-5.761***	16.563***	14.51**	-5.029***	-3.605**	6.764*	8.71**
	(-5.056)	(2.879)		(-3.511)	(-2.249)	(1.815)	
ΔWL	19.500***	-22.193***	2.92*	13.006**	13.928***	11.266	0.05
	(5.966)	(-0.917)		(2.067)	(3.376)	(0.838)	
ΔI	0.091	-19.163	0.99	0.206	-0.920	3.279	1.88
	(0.218)	(-0.990)		(0.877)	(-1.058)	(0.589)	
S_{t-1}	0.057***	0.031	0.65	-0.042**	0.001	0.043*	9.17**
	(7.122)	(0.976)		(-2.342)	(0.065)	(1.953)	
W-ΔS	0.115*					-0.023	
	(1.751)					(-0.703)	
Non-Met	468.55						
Met	7106.66						
High Pop				5281.26			
Med Pop				495.81			
Low Pop				62.44			
R^2-adj	0.394			0.342			
n	1160			1160			
Chow	24.03***			57.94***			

z-values are in parentheses below the coefficients. Significance levels are indicated by *** (1 % level), ** (5 % level) and * (10% level). LR is the Likelihood Ratio test for groupwise heteroskedasticity.

Discussion and Conclusions

Several results from these models show the effects that supercenters and warehouse club stores are having on the structure of the grocery industry, especially in non-metropolitan counties. Results for the change in sales model will be discussed first. Key to these results is the distinction that changes in sales can come from sales competition (capturing or losing sales by drawing customers) and price competition. These distinctions become obvious when comparing the coefficients and signs for the WL_{t-1} (initial number of

Table 6: Estimation results for ΔSsmkt – 2 regimes.

	OLS	OLS(2)	ML Heter Error Model (Groupwise)		
			Non-Metro	Metro	Chow
CONSTANT	1.440**	1.257*	0.721	80.406**	4.62**
	(2.037)	(1.763)	(1.223)	(2.169)	
ΔPd	0.029***	0.030***	0.064***	0.020	2.39
	(4.878)	(5.052)	(6.216)	(0.736)	
Ln(Pd)	-0.424***	-0.393**	-0.234*	-12.379**	5.98**
	(-2.724)	(-2.509)	(-1.698)	(-2.493)	
ΔWT	-0.357*	-0.385*	0.300*	-3.336***	8.15***
	(-1.744)	(-1.878)	(1.668)	(-2.645)	
WT_{t-1}	1.024***	1.027***	0.074	3.094***	12.39***
	(6.996)	(7.026)	(0.544)	(3.652)	
ΔI	0.055	0.053	0.093*	-0.031	0.00
	(0.799)	(0.769)	(1.764)	(-0.012)	
NS	-0.983***	-0.965***	-1.098***	3.295	0.62
	(-3.380)	(-3.321)	(-5.088)	(0.591)	
S_{t-1}	-0.013***	-0.012***	-0.011***	-0.013***	0.15
	(-15.361)	(-13.702)	(-12.129)	(-3.265)	
Meto/Non		-1.596*			
		(-1.818)			
Het Coeff			7.322***	152.821***	
			(23.675)	(4.416)	
R^2-adj	0.350	0.351	0.462		
F	90.17***	79.47***			
Wald			17.67***		
Likelihood	-3203.29	-3201.63			
n	1160	1160	1160		
CN	18.24	18.93	7.322***	152.821***	
JB	97072.25***	99997.85***	16666.64***		
BP/KB/LR	766.29***	766.09***	260.80***		
White	976.59***	987.93***			
Moran's I	-0.028	-0.029			
LMERR	2.496	2.545			
R LMERR	2.649 (.104)[a]	3.175*			
LMLAG	0.690	0.564			
R LMLAG	0.843	1.193			
SARMA	3.339	3.739			
Chow			27.09***		

t-values for the OLS and z-values for the ML estimators are in parentheses below the coefficients. Significance levels are indicated by *** (1 % level), ** (5 % level) and * (10% level). CN is the condition number indicating the degree of multicollinearity and JB tests the normality of the errors. BP/KB/LR are the Bruesch-Pagan or Koenker-Bassett tests for heteroskadacity and the Likelihood Ratio test for groupwise heteroskedasticity. a – the first OLS model's p-value was 0.104.

warehouse stores) and ΔWL (change in number of warehouse stores) variables across metropolitan and non-metropolitan counties.

Table 7: Estimation results for ΔSsmkt – 3 regimes.

	ML Heter Error Model (Groupwise)			
	Low Pop	Med Pop	High Pop	Chow
CONSTANT	1.077	-1.806	18.833*	5.25***
	(1.367)	(-0.949)	(1.884)	
ΔPd	-0.020	0.010	0.027*	1.53
	(-0.544)	(0.482)	(1.689)	
Ln(Pd)	-0.301	0.255	-3.264**	4.92*
	(-1.322)	(0.602)	(-2.016)	
ΔWT	0.375	0.335	-1.101*	4.67*
	(0.874)	(1.111)	(-1.765)	
WT_{t-1}	-0.084	-0.173	1.987***	16.99***
	(-0.282)	(-0.867)	(4.046)	
ΔI	0.061	-0.003	-0.674	1.32
	(1.048)	(-0.030)	(-0.968)	
NS	-0.873***	-0.867***	1.218	0.96
	(-3.385)	(-2.724)	(0.573)	
S_{t-1}	-0.013***	-0.008***	-0.014***	4.81*
	(-3.217)	(-4.179)	(-5.594)	
Hetro Coeff	3.714***	8.028***	85.085***	
	(17.029)	(15.215)	(7.649)	
R^2-adj	0.399			
n	1160			
Het Coeff	85.085***	8.028***	3.714***	
Wald	109.77***			
LM Error	0.066			
LM Lag	0.257			
Chow	32.52***			

z-values are in parentheses below the coefficients. Significance levels are indicated by *** (1 % level), ** (5 % level) and * (10% level).

Interpretation of the results from the spatial lag model requires care. From equation 7, we know that the value of *y* depends on marginal effects that are more complex than simply evaluating the β value. Thus, determining the exact effects on *y* would require inverting *W*, which is an 1160 by 1160 unit weights matrix. Unfortunately, Excel is not capable of inverting this size matrix. An alternative is to discuss the spatial multiplier effect in terms of the coefficient results.

The coefficient for W_ΔS is the ρ coefficient in (7). In two of the three ΔS models, W_ΔS is significant with a value of between 0.110 and 0.112. The value of ρ is between -1 and 1, so we know that 0.110 is a relatively small positive value. From equation (7), this small value of ρ means that the effects from neighbors quickly become infinitely smaller (i.e., $0.110^2 = 0.0121$). Therefore, the home or immediate county has the greatest effect on y, while the immediate neighbors have a significantly smaller effect, and further neighbors have a negligible effect. All effects are location specific, but the coefficient will be discussed knowing that the major effect is coming from the immediate county.

The coefficients on the WL_{t-1} variables for the non-metropolitan counties are negative and significant for both models and spatial regimes, suggesting that the overall presence of a large warehouse club or supercenter in a non-metropolitan county and/or in neighboring counties means the future increases in sales will be smaller or more negative in the immediate county. In contrast, the WL_{t-1} coefficient and sign for the metropolitan areas is positive, relatively large, and significant for both models and spatial regimes, suggesting that warehouse stores are attracting customers by creating agglomeration economies. Although these generalizations must be evaluated carefully due to the location specific marginal effects in the spatial lag model, the results support the ACNielsen study which claimed that consumers shop less often overall, but more often at warehouse stores (2005).

The coefficients and high significant levels on the ΔWL variable in both models and population regime structures explain that the entry of a warehouse store into a non-metropolitan county increases sales. This increase would presumably come from attracting customers, because price competition would be expected to increase with the entry of a warehouse store. In contrast, the same ΔWL variable decreases sales in the most metropolitan counties under the 2 regime structure. This explains that additional warehouse stores increase price competition in the most metropolitan counties. Note that the coefficient on this variable was not significant for the most metropolitan counties under the 3 regime model. Overall, these results confirm hypothesis 1, or the entry of a warehouse store increases sales in a non-metropolitan county.

The two variables used to describe the initial market have mixed signs. Under the 2 regime structure, coefficients on $\ln(Pd_{t-1})$ were relatively large and negative, while the S_{t-1} coefficients were small and positive. In the 3 regime models, the $\ln(Pd_{t-1})$ coefficients were relatively large and positive, while the S_{t-1} coefficients were small and negative. The variables were only significant in the most rural and non-metropolitan regimes. Finally, the change in population density coefficients were positive and significant for the non-metropolitan counties in the two regime models, and positive, but decreasing with population density, and significant for the low population counties in the 3 regime models.

Change in Small Supermarkets Model Results

In the ΔSsmkt (change in small supermarkets) model, the coefficients for WT_{t-1} and ΔWT were the most interesting. In metropolitan counties, WT_{t-1} had a significant and positive affect on ΔSsmkt, meaning that fewer small supermarkets exit if the initial number of supercenter and warehouse stores is large. This result is surprising, but it can either be explained by competition, structural change in shopping patterns, from an affect that has already occurred, or all three. If the result is from increased competition, the warehouse stores may be decreasing the size of existing supermarkets, and therefore increasing the number of small supermarkets. If the change is from a structural shift in shopping patterns, customers may be increasing their trips to the warehouse stores, but supplementing their large shopping with purchases from small supermarkets. Finally, the result may be the result that most small supermarkets have already left the market, leaving fewer to exit in the future.

The coefficient and sign on the ΔWT variable was relatively large, negative, and significant for the metropolitan counties in both regime structures. This gives evidence that additional warehouse stores force small supermarkets out of business. Interestingly, the coefficient on the ΔWT variable was positive and significant at the 10 percent level in the non-metropolitan counties in the 2 regime structure model. This may simply mean that some supermarkets lose market share and fall from employing over 20 people to employing less than 20 people. The third hypothesis that warehouse club and supercenter store entries decrease the number of small supermarkets in non-metropolitan areas has been proven incorrect.

Other variables that describe the market were also interesting. Positive changes in population density increased the number of small supermarkets (fewer small supermarkets exit the market) in the non-metropolitan counties of the 2 regime model and in the most metropolitan counties in the 3 regime model. The log of the initial population was positive, significant, and relatively large for the metropolitan counties, supporting the idea local block or neighborhood store in metropolitan counties. Finally, the initial sales variables (S_{t-1}) had negative and significant coefficients for all population levels in both models. When initial sales are higher, there is a decreased number of small supermarkets.

A dummy variable separating the northern and southern counties was added to understand if Wal-Mart's more mature market (the southern U.S.) would have a greater effect on the change in the number of small supermarkets. Contrary to expectations, the coefficient for counties in the northern part of the U.S. was negative and significant for all but the most metropolitan counties. Therefore, the northern region of this study is losing more small supermarkets than the southern region. One explanation for this difference is that the south already lost more small supermarkets when Wal-Mart first began opening their supercenter stores.

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