Spatial Dependency of the Geographically Concentrated U.S. Broiler Industry

by

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Abstract:

The study develops a county-level spatial lag model that analyzes factors affecting location and production of the U.S. broiler industry. The spatial lag coefficient was found to be positive and significant in the model indicating spatial dependency of the geographically concentrated U.S. broiler industry within the Southeast.

Spatial Dependency of the Geographically Concentrated U.S. Broiler Industry

Broiler production in the United States is geographically concentrated in the Southeastern states, where Arkansas leads in terms of the broiler establishments (50) and Georgia ranks number one in terms of the broiler production (approximately 6.24 billion pounds in 2001). Other leading states include Alabama, Mississippi, North Carolina, Texas, Delaware, Virginia, and Kentucky. Over the past few decades, the U.S. broiler industry has undergone significant changes in its geographical location. For example, between 1965 and 2001 the number of poultry establishments in the Midwest decreased by 64% as compared to 13% in the South. In general, trends show a movement in concentration of the broiler industry from the Midwest to the South, particularly in the Southeast, which accounts for eighty five percent of total U.S. production.

The objective of this study is to examine determinants that led to dominance of some southern states in the southern region of the U.S. (e.g., Georgia, Arkansas, Alabama, North Carolina, Texas and Mississippi), as compared to relatively low broiler producing states of Louisiana, Oklahoma, South Carolina, and Florida. To accomplish this we utilize an econometric model that captures the spatial organization of the broiler industry using county-level data. More specifically, we measure the degree in which selected firm-specific, location-specific, and spatial agglomeration factors affect the movement and concentration of broiler production within the southeastern region of the U.S. Spatial concentration is analyzed by employing a spatial lag model, which measures the impact of broiler production in neighboring locations on broiler production in a particular location and tests for spatial agglomeration effects on broiler location. The model uses centroid-to-centroid distance measures across counties to identify the extent of spatial lag. Estimates from the model provide strong explanatory power, as the spatial relationship between variables is explicitly accommodated (Roe, Irwin, and Sharp). The southeastern states included in the study are Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia.

Several studies have examined the determinants of the geographic concentration of broiler production within the United States (Easterling et al.; Aho; Harrison and Sambidi). These studies cite many factors that lead to concentration of broiler production in the Southeast. Easterling, Braschler, and Kuehn conducted a study on optimal location of the U.S. broiler industry. They used a transportation linear programming model to determine optimal locations for broiler industry. Their results showed that some southern regions, especially Georgia and Alabama, had substantial cost advantages with respect to labor, and that the cost of importing feed relative to the cost of locally produced feed was critical to broiler production in the South.

Aho analyzed regional trends in broiler production. High feed costs were found to be the main disadvantages for broiler production in the North, whereas high costs of production (especially transportation cost) are the main disadvantages for production in the West. Even though the Midwest has an advantage in grain costs, it is associated with high land and labor costs. Aho attributed inexpensive land and labor, a favorable business climate, and low rail rates as the main advantages for broiler location in the South. Harrison and Sambidi found that cost advantages with respect to labor, land, and utilities, as well as relatively high unemployment rates and favorable community attitudes in the Southeast offset any feed cost advantages associated with the Midwest. The present study differs from previous literature in that spatial determinants of the intra-regional distribution of broiler establishments in the southern United States are examined.

Economic Model

The site for a broiler complex is hypothesized to be a function of two sets of interrelated factors. The first is a set of firm-specific factors associated with the broiler company, and the other set of factors is related to characteristics of broiler growers in the region. Since broiler companies typically use well structured growing contracts, which specify the resources provided by the integrator and the grower, two set of determinants are expected to determine the location of a broiler complex. The factors associated with broiler growing are hypothesized to include: utility costs of the grower, availability of litter disposal, land costs, availability of local lenders, community attitude toward the broiler industry, and availability and geographic concentration of growers (Harrison and Sambidi). Factors related to the integrators decision include: the cost of feed ingredients, community attitude toward the broiler industry, utility costs associated with processing broiler meat, distances between feed mills and growers, county unemployment rates, labor costs, sewer costs, the stringency of environmental regulations, and the proximity of the processing facility to final markets (Harrison and Sambidi). Therefore, for a particular county to be a desirable place to locate a broiler complex, it should have favorable levels of the above mentioned factors.

The objective of a broiler company for selecting a particular site is assumed to be profit maximization. This objective can be represented in a functional form as follows:

$$\pi_i = p_i f(x_i, y_i, z_i) - c(x_i),$$

where π_i is the profit from a broiler complex, p_i is the vector of output prices, x_i is the vector of inputs, y_i is the vector of outputs, z_i is the vector of technology shifters, $c\,(.)$ is the total cost function.

Data

The study considered several categories of variables such as localization and agglomeration factors, community attitude, environmental regulations, cost associated with factors of production, and local economic and socioeconomic factors. County-level agricultural data for the fifteen states is obtained from the 2002 and 1997 Census of Agriculture and the Economic Research Service, USDA. The 15 states included in the model account for over 85% of U.S. broiler production in 2001. These states are grouped into three census regions, which include the West South Central (AR, LA, OK, and TX), East South Central (AL, KY, MS, and TN) and South Atlantic (FL, GA, MD, SC, NC, VA and WV) regions. The dependent variables are the natural logarithm of the county's broiler inventories in 2002, and the change in the natural logarithm of a county's broiler inventories between 1997 to 2002. A total of eight models are analyzed. They include models with two dependent variables for the following four regions: a pooled U.S. model (15 states), a West South Central model (4 states), an East South Central model (4 states), and a South Atlantic model (7 states).

Localization and Agglomeration Variables

Economies of scale associated with localization and agglomeration factors are believed to be one of the driving forces in re-organization of the broiler industry. Localization economies indicate that performance of one broiler complex is influenced by the other broiler complexes located nearby. The resulting spillovers may be due to an already existing industry specific infrastructure, which is associated with lower transaction costs, proximity to broiler establishments, litter disposal facilities, good roads, and availability of financial resources.

Isik (2002) found agglomeration economies to be important for the spatial structure of dairy production. Agglomeration economies were positively correlated with dairy cow inventories and per-farm dairy inventories, which indicates that the dairy producer's preference to locate close to the existing dairy grower in that region. Similar results were presented for the swine sector by Roe et al., who found that locating close to another county with swine and, to lesser extent, other livestock operation has a positive effect on inventory of hogs in a particular county.

The present study includes a spatial lag variable as a proxy for localization economies that accounts for the broiler inventory in neighboring counties within a given distance of each county. It accounts for absolute changes in broiler inventories for the models with changes in the broiler inventory. In addition to internal economies of scale for the broiler industry, there are also economies of scale external to the broiler industry but internal to the livestock industry. These factors are associated with an infrastructure that is favorable for livestock and broiler production in a county. As a proxy for agglomeration economies we use county's livestock inventory (*LIVESTOCK*).

Community Attitude and Environmental Regulations

Industries that produce negative externalities are assumed to face stiff opposition from local communities. For example, broiler production is associated with negative externalities such as bad odor and solid waste (litter), as well as liquid waste from broiler processing. These externalities may result in conflicts between community groups and broiler producers. It is for this reason that broiler production is currently facing strict environmental regulations. As a proxy for community attitude towards broiler production, the study includes 2002 county population

(*POP*) and change in county population from 1997-2002 (CPOP). We expect both variables to have a negative affect on a county's broiler production.

Three environmental regulation variables are also included in the models. The first is an industry-adjusted index of state environmental compliance costs for 1994 (SEC) developed by Levinson (1999) for the National Bureau of Economic Research, Inc. (NBER) and Fondazione Eni Enrico Mattei (FEEM). The second variable is the state pollution abatement cost for 1999 (PAC) estimated by the U.S. Census Bureau. The third variable is the change in state pollution abatement costs (CPAC) between 1994 and 1999. All these environmental variables are hypothesized to have a negative impact on the broiler inventory.

Factors of Production – Feed, Land, and Labor

Our models also include county-level corn (*CORN*) and soybean (*SOY*) production (measured in bushels) as proxies for local prices of raw feed ingredients (Roe, Irwin, and Sharp). Greater availability of corn and soybean is expected to be positively related to the broiler inventory.

Broiler companies generally prefer larger counties, as it is easier to find tracks of land for a large-scale facility - at affordable prices. The study includes the county's total land area (*LAND*) and hypothesizes that as the land area increases total broiler inventory increases. We also include average market value of land per acre (MKTVAL) and expect it to have a negative impact on location of a new broiler facility and expansion of existing broiler production.

The quality and availability of local labor is considered to be an important factor in the broiler complex location (Harrison and Sambidi). We include the county's unemployment rate (*UEMP*) as a proxy for labor availability and hypothesizes it to have a positive affect on the broiler inventory. To measure the quality of labor, the study includes the percent of county population with a high school degree or higher (*EDUC*). The study expects the variable *EDUC* to have a quadratic affect, indicating that areas with too many or too few educated individuals may discourage the broiler inventory. Since, county level wage rates are unavailable, we include state level wage rate (*WAGE*) to measure the labor cost. The study hypothesizes *WAGE* to have a negative affect on county's broiler inventory, holding other things constant.

Property tax is expected to have a negative impact on broiler inventory. The study includes the county's average per capita property tax bill (*PCP*) as a measure for the property tax. A county experiencing low level of economic growth is expected to recruit large operations to develop its infrastructure and improve the standard of living. We include poverty level (*POVERTY*) as a proxy for a county's economic situation, which is hypothesized to have a positive affect on broiler inventory.

As a proxy for local broiler demand, the study measures the centroid-to-centroid distance from each county to the nearest county producing broilers (*MINDIS*). All other things being equal, we hypothesize that as the distance between a county centroid and other broiler producing county centroid increases, the broiler inventory decreases. The annual personal income in each county (INC) is also included in the model to account for the impact of local economic conditions and demand for the broiler inventory. We also included a variable that accounts for average broiler production in the nearest 5 counties of a given county (NEAR5). This variable also accounts for changing demand for the broiler production within a given region. We expect this variable to have a positive impact on a county's broiler inventory.

Model Estimation

Since broiler production is determined simultaneously across counties, including endogenous variables related to agglomeration economies as regressors would lead to biased results (Roe, Irwin, and Sharp; Isik). This is formally tested by employing spatial correlation indices (Morans-I, Wald, and the Lagrange multiplier test statistic), which indicated the presence of spatially correlated residuals in the regression model. To overcome this problem, the study parameterizes the spatial lag structure by means of a spatial autocorrelation parameter and a spatial weights matrix (Anselin; Roe, Irwin, and Sharp; Isik). The model is as follows:

$$Y = \rho WY + \beta X + \varepsilon,$$

where Y is a N×1 vector of endogenous broiler production variable in each of the N counties for a given time period, ρ is the scalar for the spatial lag coefficient, W is the N×N spatial weigh matrix, β is the K×1 parameter vector*,* X is the N×K matrix of exogenous explanatory variables, ε is an N×1 vector of normally distributed error terms with zero mean and variance σ^2 (Roe, Irwin, and Sharp). The spatial weights matrix is based on an inverse distance function, $w_{ij} = 1/d_{ij}$ where d_{ij} equals the centroid-to-centroid distance in miles between counties i and j. As the county centroid to centroid distance increase the spatial dependence between two counties is assumed to decrease, and after a certain distance, the spatial weight will be zero. Based on the smallest Akaike's Information Criterion statistic, 200 miles was selected as the upper most distance above which the spatial weight is assumed to be zero. Because the spatial dependence may also arise in error terms, where residuals of counties close to one another may be correlated, the LaGrange multiplier test statistic, which is distributed as a chi-square with one degree of freedom, is used to test for spatial correlation (Anselin; Roe, Irwin, and Sharp). The model is estimated using maximum likelihood to obtain consistent estimates for the parameters. Non-linearity effects of explanatory variables on the dependent variables are captured in a manner employed by Roe, Irwin, and Sharp. The descriptive statistics of the data are presented in table 1.

Results

The study estimates eight models to emphasize the importance of spatial agglomeration economies on the geographic distribution of the U.S. broiler industry. Table 2 presents the parameter estimates for the spatial lag model of the broiler inventory for the U.S.(the pooled model) and the West South Central. Table 3 presents the separate parameters estimated for the spatial lag model of the broiler inventory for the East South Central and the South Atlantic region. Table 4 presents the separate parameters estimated for the spatial lag model of the absolute changes in the broiler inventories between 1997 and 2002 for the U.S.(the pooled model) and the West South Central. Table 5 presents the separate parameters estimated for the spatial lag model of the absolute changes in the broiler inventories between 1997 and 2002 for the East South Central and the South Atlantic region. Of the eight total models, the LaGrange multiplier test indicates the spatial dependence of residuals in two models (the pooled model for broiler inventory and the South Atlantic model for absolute change in broiler inventory).

Spatial agglomeration economies are confirmed for the spatial structure of broiler industry by all the models, except for the East South Central regional model for absolute change in the broiler inventory. This is indicated by the spatial lag coefficients for all other models, which are positive and significant at the 1 % level. This implies that broiler inventories are positively correlated across counties. Hence, broiler producing counties tend to be concentrated across regions to utilize the positive externalities associated with localization economies.

The model also includes livestock inventories to account for spatial agglomeration economies associated with a more general infrastructure for the livestock industry. The coefficient for livestock inventories was found insignificant for all the models, except for the pooled model, where it was found to be positive and significant at the 5% level. However, the elasticity of livestock inventory in the pooled model for broiler inventory was only 0.05. Thus, the results indicate that there is no significant evidence on the sectoral dependence between the broiler industry and the broader livestock industry.

A county's change in population was found to be insignificant in models with the absolute change in broiler inventory, except for the East South Central model, where it was found to have a positive impact on the absolute change in broiler inventory and was found to be significant at the 5%level. The variable was found to be insignificant in all the broiler inventory models.

The population variable was found to have a negative impact on broiler inventory in the West South Central, and was found to be significant at the 1% level. Conversely, the variable had a significant positive impact on broiler inventory in the East South Central region, with an elasticity of 2.52. These contrasting results indicate that an increase in population increases broiler inventory in the East South Central region and decreases broiler inventory in the West South Central region. The reason for this may be attributed to the fact that population in the East South Central region is low compared to other regions studied in the paper.

The industry-adjusted environmental index costs, had an expected negative sign for all models and was found to be significant at the 1% level, except for the broiler inventory model of the South Atlantic region and the absolute change in broiler inventory model for the pooled model (15 states), which had an unexpected positive sign. Among the broiler inventory models, the East South Central regional model was found to be highly sensitive to the stringent environmental regulations with elasticity of -37.56, followed by the West South Central regional model with an elasticity of -14.29. Among the absolute change in broiler inventory models, again the East South Central regional model was found to be heavily impacted by the stringency of environmental regulations, with an elasticity of -34.72, indicating that a 1% increases the index of state environmental compliance costs, the absolute change in broiler inventory decreases by 34.72 %. This result is indicated by the industry adjusted index of state environmental compliance costs for all the states included in East South Central Region are above 1.00. The change in pollution abatement costs variable was found to have an expected negative sign and was found to be significant a the 1% and 5% level for the absolute change in broiler inventory model of the East South Central and West South Central region, respectively. Variable elasticity for the East South Central region was 2.84 indicating that a 1% change in pollution abatement costs decreases the absolute change in broiler inventory by 2.84 percent. The pollution abatement costs variable for the broiler inventory model had an unexpected positive sign. In general, the environmental stringency variables indicate that environmental policy plays a key role in the location of broiler facilities and expansion of existing broiler facilities for the counties in the East South Central and West South Central Region.

A county's unemployment rate was found to have a significant positive impact on broiler inventory in all regions, except the West South Central region where it had an unexpected negative sign. Conversely, the models accounting for absolute change in the broiler inventory indicated that the unemployment rate has a negative and significant impact on changes in the broiler inventory in the pooled (15 states) and the West South Central model. However, the elasticity of unemployment variables in these two models is close to zero. The poverty variable was found to have a positively significant impact on the broiler inventory in all regions except, the South Atlantic. The West South Central region had the highest elasticity for poverty (10.36), indicating that a 1% increase in poverty increase broiler inventory in that region by 10.36 percent. Incase of the absolute change in broiler inventory, the poverty variable was found to be positively and highly significant for the West South Central region with an elasticity of 5.11.

The state level average weekly wage variable was found to be negative and significant for the broiler inventory, and the absolute change in broiler inventory model for the East South Central and West South Central regions, indicating that a slight increase in wage rate decreases broiler production considerably. The education variable was found to be significant for all models, except for the model for absolute change in broiler inventory for the East South Central region. The variable had an overall positive impact on broiler inventory and absolute change in broiler inventory in the U.S. however; regionally it had a negative impact on broiler inventory and positive impact on absolute change in broiler inventory. The per capita property tax had a negative and significant effect on broiler inventory, and the absolute change in broiler inventory in all the regions, except the East South Central region. Therefore, a county with high per capita property tax is unfavorable for either locating a new broiler facility or expanding an existing one. A county's corn and soybean production was found to be insignificant for all the models except the South Atlantic broiler inventory model. The reason for this can be attributed to the fact that much of corn and soybeans used for broiler feeds are imported from the Midwest. Therefore, local supplies of corn and soybean have little effect on broiler feed prices.

A county's land area has a positive and significant effect on all broiler inventory models, except the West South Central model. However, models with the absolute change in the broiler inventory indicated county's land area to be insignificant, except for the East South Central region. The variable for market value of land per care was found to be insignificant for all the models with absolute change in broiler inventory. It was found to be positively significant for the East South Central and West South Central broiler inventory model.

The personal income variable was found to be negative and significant for both pooled models, indicating that a county's personal income is negatively correlated with its broiler inventory. A county with high personal income indicates a high standard of living which in turn would indicate stiff opposition to facilities that are hazardous to health and environment.

The centroid-to-centroid distance from each county to the nearest broiler producing county was found to be negative and significant for both pooled models. This indicates that as the distance between counties producing broilers increases, broiler production in those counties decreases. For example, a 1% increase in the centroid-to-centroid distance from each county to the nearest broiler producing county decreases broiler production by 1.46 percent. The variable was found to be positively significant in the broiler inventory model for the West South Central and East South Central region. The variable that accounts for average broiler production in the nearest 5 counties of a given county was found to be positive and significant for all models, except the model for absolute change in broiler inventory for the East South Central and West South Central region.

Conclusion:

Over the past few decades the U.S. broiler industry has undergone significant changes in its geographic location. Geographical changes in the U.S. broiler industry have been analyzed by several studies, however, our understanding of spatial influence on intra-regional distribution of the broiler establishments within the south is anecdotal. This study develops a spatial econometrics model that analyzes factors affecting location and production of U.S. broiler industry taking the spatial affect into consideration. The study examines the impacts of localization and agglomeration economies, community attitude and environmental regulations, and local economic and socioeconomic factors on the county-level broiler inventory. A total of eight models were analyzed in the study which involve the two dependent variables with the following four regions: U.S. (15 states), West South Central (4 states), East South Central (4 states), and South Atlantic (7 states).

The hypothesis of spatial localization economies is confirmed for the spatial structure of the broiler industry, indicating that broiler inventories are positively correlated across counties. However, spatial agglomeration economies that relates to a general infrastructure suitable for livestock production was found to be insignificant for most of the models. This implies that agglomeration economies that affect broiler location are specific to the broiler industry.

Population was found to have a significant positive impact on broiler inventory in the East South Central region, which is attributed to the fact that it has low population compared to the other regions in the model. However, overall population was found to be insignificant in the location and expansion of broiler facilities. The environmental regulations factors are considered to have a significant impact on broiler inventory, especially in the East South Central and West South Central region.

A county's local supply of corn and soy was found to have no affect on the broiler inventory. However, other socio economic factors such as unemployment rate, poverty, land and per capita property tax were found to have a significant impact on the broiler inventory. The education variable had an overall positive impact on broiler inventory and absolute change in broiler inventory in the U.S. The East South Central and West South central regions are found to be very sensitive to wage rates, indicating that a slight increase in a county's wage rate results in a dramatic fall in that county's broiler inventory.

The market accessibility variables (MINDIS and NEAR5) indicated that having a well developed market infrastructure for the broiler production in a neighboring county will increase the local broiler production and as the distance between the counties increase, the local broiler production decreases. For example, proximity to a neighboring county with a broiler processing establishment would increase the local broiler production.

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Table 1. Summary Statistics of the Data Used in the Estimation

Variable	Description	Mean	Std. Dev.
BINV-2002	Broiler Inventory-2002	993343.99	2501076.00
BINV-1997	Broiler Inventory-1997	854448.52	2279453.47
UNEMP-02	% Population Unemployed-2002	6.25	2.66
UNEMP-97	% Population Unemployed-1997	6.10	3.06
POV-02	% Poverty	16.27	5.38
POP-02	Population-2002	73852.39	190120.21
POP-97	Population-1997	69735.38	171084.08
CPOP	Change in Population (2002-1997)	4117.01	83176.16
LAND	Land Area (square miles)	626.14	389.17
EDU	% Population ≥ High School Degree	62.69	9.22
PCP	Property Tax ($/household)	378.56	324.18
CORN-02	Corn Harvest in Bushels-2002	475060.62	1374804.60
CORN-97	Corn Harvest in Bushels-1997	541135.61	1452188.53
SOY-02	Soy Harvest in Bushels-2002	200577.24	608786.21
SOY-97	Soy Harvest in Bushels-1997	249401.90	678181.56
MINDIS	Distance to closest Broiler Producing County (miles)	19.70	7.00
NEAR5-02	Avg. Broiler Inventory in Nearest Five Broiler Producing Counties-2002	1033057.81	1612424.08
NEAR5-97	Avg. Broiler Inventory in Nearest Five Broiler Producing Counties-1997	875455.68	1491957.82
LIVESTOCK-02	Livestock Inventory-2002	73395.46	392282.21
LIVESTOCK-97	Livestock Inventory-1997	68199.74	330377.36
WAGE	State Level Avg. Weekly Wage ($)-2003	647.26	61.05
PAC-1999	State Level Pollution Abatement Cost in million $-1999	728.12	730.37
PAC-1994	State Level Pollution Abatement Cost in million $-1994	961.58	1043.39
SEC1994	An Industry-Adjusted Index of State Environmental Compliance Costs	1.14	0.27
MKTVAL-02	Avg. Market Value of Land per Acre in $-2002	2068.96	1664.46
MKTVAL-97	Avg. Market Value of Land per Acre in $-1997	1567.75	1066.58
INC-02	Personal Income($)-2002	2144821.77	6628195.42
INC-97	Personal Income($)-1997	1626969.49	4889511.34

Table 2. Estimated Spatial Lag Models of Change in Broiler Inventory for the U.S and the West South Central Region

Dependent Variable: ln(2002 broiler inventory+1)- ln(1997 broiler inventory+1)

	U.S. (Pooled model)[a]		**West South Central**	
Variable	**Coefficient**	**Elasticity[b]**	**Coefficient**	**Elasticity**
ρ	0.294974013* (0.000013307)[c]	0.29	0.000102307* 0.000000009	0.0001
UNEMP	-0.096000822* (0.000026894)	-0.01	-0.342433288* 0.001570821	0.032
UNEMPSQ	0.004139732 (0.008142464)		0.010284499 0.021673980	
POV	-0.006242009* (0.000026194)	-0.10	0.294599496* 0.000435649	5.11
POVSQ	-0.001318304 (0.000833173)		-0.008811507* 0.001678830	
POP	-0.000039889 (0.001671023)	-0.001	-0.000783628 0.005392801	-0.01
POPSQ	0.000000012 (0.000000354)		0.000001467 0.000003245	
LAND	0.000860535 (0.000715518)	0.54	-0.000008666 0.001196897	-0.008
LANDSQ	-0.000000109 (0.000000175)		0.000000020 0.000000233	
EDU	0.000268623* (0.000062772)	0.02	0.017481161* 0.000450253	1.13
EDUSQ	-0.000063056 (0.000150612)		0.000093557 0.000338559	
PCP	-0.003012040** (0.001112660)	-1.14	-0.002934843*** 0.001727520	-1.51
PCPSQ	0.000000760*** (0.000000449)		0.000000759 0.000000577	
CORN	-0.000000015 (0.000000270)	0.001	0.000000055 0.000000303	-0.003
SOY	-0.000000573 (0.000000850)	0.03	0.000000301 0.000001277	-0.02
MINDIS	-0.074241721* (0.000049390)	-1.46	-0.080427740* 0.000216528	-1.94
MINDISSQ	0.000690504* (0.000238669)		0.000719002* 0.000250535	
NEAR5	0.000000648** (0.000000254)	0.21	0.000000294 0.000000440	0.08
LIVESTOCK	0.000000539 (0.000001841)	0.003	-0.000000468 0.000004248	-0.0006

Table 2. Continued

Dependent Variable: ln(2002 broiler inventory+1)-ln(1997 broiler inventory+1)				
	U.S. (Pooled model)		West South Central	
Variable	Coefficient	Elasticity	Coefficient	Elasticity
CPAC	-0.000311436 (0.000536059)	0.07	-0.002246846** 0.001002508	1.14
SEC	0.025926292* (0.000001503)	0.03	-0.541724199* 0.000008905	-0.71
WAGE	0.005128154* (0.001189841)	3.32	-0.004239461 0.003716332	-2.74
MKTVAL	-0.000165481 (0.000336498)	-0.08	-0.000779728 0.002013844	-0.18
MKTVALSQ	0.000000021 (0.000000028)		0.000000673 0.000001819	
INC	-0.000317190* (0.000096378)	-0.16	0.000105851 0.000281150	0.056
INCSQ	0.000000010* (0.000000001)		-0.000000003 0.000000009	
CONST	-1.221805951* (0.000002494)		0.717793895* 0.000006689	
N	1230		405	
Log Likelihood	-3281.02		-1063.21	
Spatial Error Test[d]	3.03		0.08	

*,**,*** Statistical significance at the 1, 5, and 10% levels, respectively.
[a] U.S. (pooled model) include counties of all 15 states. West South Central Include counties of AR, LA, OK, and TX.
[b] Elasticities are evaluated at the simple mean values of the sample's independent variables.
[c] number in the parenthesis indicate the parameter's standard error.
[d] LaGrange multiplier test, distributed with one degree of freedom, that tests the null hypothesis that the model's residuals are not spatially correlated.

Table 3. Estimated Spatial Lag Models of change in Broiler Inventory for the East South Central and the South Atlantic Region

Dependent Variable: ln(2002 broiler inventory+1)-ln(1997 broiler inventory+1)				
	East South Central[a]		South Atlantic	
Variable	Coefficient	Elasticity[b]	Coefficient	Elasticity
ρ	0.069986000 (0.198483284)[c]	0.07	0.323983000* (0.106848)	0.32
UNEMP	-0.091849482 (0.104216547)	-0.01	0.048028000 (0.124022616)	0.02
UNEMPSQ	0.005727869 (0.008868387)		-0.007039000 (0.026317103)	
POV	0.012906882 (0.279061682)	0.22	-0.177112000* (0.044894965)	-2.60
POVSQ	-0.003889337 (0.006600555)		0.005097000** (0.002518646)	
POP	0.049579091** (0.021449615)	0.22	-0.002069000 (0.002164024)	-0.07
POPSQ	-0.000161034 (0.000108522)		0.000000000 (0.000000435)	
LAND	0.008074846*** (0.004738136)	4.00	0.000098000 (0.002696314)	0.05
LANDSQ	-0.000004437 (0.000003229)		0.000001000 (0.000001523)	
EDU	-0.277308578 (0.245381066)	-16.18	0.188926000** (0.084320235)	12.08
EDUSQ	0.001678176 (0.002234187)		-0.001310000*** (0.000786079)	
PCP	0.015036779** (0.006857764)	3.00	-0.007885000** (0.003687080)	-3.08
PCPSQ	-0.000010199 (0.000009385)		0.000004000 (0.000002508)	
CORN	0.000000344 (0.000000843)	-0.002	-0.000001000 (0.000000922)	0.12
SOY	-0.000001673 (0.000001355)	0.08	0.000001000 (0.000002391)	-0.04
MINDIS	0.692042907 (0.421974037)	12.23	0.244995000* (0.021602688)	4.26
MINDISSQ	-0.022625296** (0.011548456)		-0.007531000* (0.001727157)	
NEAR5	-0.000000473 (0.000000808)	-0.07	0.000001000* (0.000000351)	0.18
LIVESTOCK	-0.000003767 (0.000007850)	-0.001	0.000001000 (0.000002268)	0.01

Table 3. Continued

Dependent Variable: ln(2002 broiler inventory+1)-ln(1997 broiler inventory+1)				
	East South Central		South Atlantic	
Variable	Coefficient	Elasticity	Coefficient	Elasticity
CPAC	-0.020976090* (0.005225571)	2.84	0.002488000 (0.001743025)	-0.18
SEC	-30.579852007* (0.016912897)	-34.72	-0.709973000* (0.004968511)	-0.71
WAGE	-0.087493290* (0.008660794)	-53.58	0.010481000** (0.004082192)	7.06
MKTVAL	0.000497166 (0.001379201)	0.21	-0.000135000 (0.000476738)	-0.10
MKTVALSQ	0.000000506 (0.000000884)		0.000000023 (0.000000036)	
INC	-0.002865623*** (0.001582232)	-0.77	-0.000796000 (0.000506988)	-0.54
INCSQ	0.000000303 (0.000000271)		0.000000046 (0.000000037)	
CONST	87.241314389* (0.005439400)		-11.386975000* (0.002134356)	
N	342		483	
Log Likelihood	-881.09		-1304.40	
Spatial Error Test[d]	0.89		10.82*	

*,**,*** Statistical significance at the 1, 5, and 10% levels, respectively.
[a] East South Central Include counties of AL, KY, MS, and TN. South Atlantic Include counties of FL, GA, MD, NC, SC, VA, and WV.
[b] Elasticities are evaluated at the simple mean values of the sample's independent variables.
[c] number in the parenthesis indicate the parameter's standard error.
[d] LaGrange multiplier test, distributed with one degree of freedom, that tests the null hypothesis that the model's residuals are not spatially correlated.

Table 4. Estimated Spatial Lag Models of Broiler Inventory for the U.S. and The West South Central

	Dependent Variable: ln(2002 broiler inventory+1)			
	U.S. (Pooled model)[a]		West South Central	
Variable	Coefficient	Elasticity[b]	Coefficient	Elasticity
ρ	0.145986632* (0.000041775)[c]	0.15	0.311994966476* (0.0000071343)	0.31
UNEMP	0.133324347* (0.000010958)	0.83	-0.287055924659* (0.0000065053)	-1.65
UNEMPSQ	-0.009683731* (0.000101095)		0.015977660821* (0.0001058066)	
POV	0.121126806* (0.000014502)	1.97	0.597573252646* (0.0000219161)	10.36
POVSQ	-0.003510145* (0.000682980)		-0.014650309772* (0.0008683704)	
POP	0.000740952 (0.002003920)	0.05	-0.001244718618* (0.0001503650)	-0.09
POPSQ	-0.000001454** (0.000000621)		0.000001691764 (0.0000043146)	
CPOP	0.000883052 (0.000626665)	0.02	0.000912980510 (0.0014851321)	0.01
LAND	0.002370732* (0.000594948)	1.48	-0.000296353848 (0.0008142797)	-0.26
LANDSQ	-0.000000305** (0.000000144)		0.000000105266 (0.0000001610)	
EDU	0.227165633* (0.000041292)	14.24	-0.227785536134* (0.0000107086)	-14.78
EDUSQ	-0.001791566* (0.000129914)		0.001708352597* (0.0001644053)	
PCP	-0.002270336** (0.000949368)	-0.86	-0.000610525532 (0.0012384237)	-0.31
PCPSQ	0.000000802** (0.000000373)		0.000000464567 (0.0000004134)	
CORN	0.000000054 (0.000000091)	0.03	-0.000000064734 (0.0000000961)	-0.04
SOY	0.000000154 (0.000000203)	0.03	-0.000000578479** (0.0000002301)	-0.13
MINDIS	-0.093787600* (0.000014164)	-1.85	0.068950217675* (0.0000099649)	1.67
MINDISSQ	0.000651253* (0.000195078)		-0.000256090762 (0.0001902455)	
NEAR5	0.000001356* (0.000000074)	1.4	0.000000878523* (0.0000001186)	0.80

Table 4. Continued

	Dependent Variable: ln(2002 broiler inventory+1)			
	U.S. (Pooled model)		West South Central	
Variable	Coefficient	Elasticity	Coefficient	Elasticity
PAC	0.000415481*** (0.000231531)	0.30	0.023179897123* (0.0002814705)	31.74
SEC	-0.854954943* (0.000000774)	-0.97	-10.951191712862* (0.0000003433)	-14.29
LIVESTOCK	0.000000729** (0.000000298)	0.05	0.000000341188 (0.0000012014)	0.02
WAGE	0.003164072* (0.001108574)	2.05	-0.317541168078* (0.0001920346)	-204.95
INC	-0.000105824** (0.000045645)	-0.23	-0.000076326441 (0.0000756890)	-0.16
INCSQ	0.000000002* (0.00000000002)		-0.000000000335 (0.0000000026)	
MKTVAL	0.000150546 (0.000155787)	0.31	0.001978995140** (0.0008147366)	2.40
MKTVALSQ	-0.000000005 (0.000000006)		-0.000000330248 (0.0000002493)	
CONST	-3.887221830* (0.000001299)		192.107811160906* (0.0000003622)	
N	1230		405	
Log Likelihood	-3022.87		-933.59	
Spatial Error Test[d]	32.73*		4.879	

*,**,*** Statistical significance at the 1, 5, and 10% levels, respectively.
[a] U.S. (pooled model) include counties of all 15 states. West South Central Include counties of AR, LA, OK, and TX.
[b] Elasticities are evaluated at the simple mean values of the sample's independent variables.
[c] number in the parenthesis indicate the parameter's standard error.
[d] LaGrange multiplier test, distributed with one degree of freedom, that tests the null hypothesis that the model's residuals are not spatially correlated.

Table 5. Estimated Spatial Lag Models of Broiler Inventory for the East South Central and the South Atlantic

	Dependent Variable: ln(2002 broiler inventory+1)			
	East South Central		South Atlantic	
Variable	Coefficient	Elasticity	Coefficient	Elasticity
ρ	0.000024207* (0.000000168)	0.00002	0.161965046109* (0.000120075026)	0.16
UNEMP	0.062238448* (0.000331623)	0.44	0.474351551588* (0.000335880895)	2.89
UNEMPSQ	-0.004554674 (0.004692058)		-0.036574848010* (0.005225733032)	
POV	0.220280545* (0.001117881)	3.80	-0.085172578943* (0.000054758409)	-1.25
POVSQ	-0.006917869* (0.001350665)		0.001314943648 (0.001421691342)	
POP	0.052087719*** (0.030305229)	2.52	-0.000987669790 (0.004510051873)	-0.09
POPSQ	-0.000007113 (0.000062667)		-0.000000606432 (0.000002058278)	
CPOP	-0.011216401 (0.011683143)	-0.05	0.000643261961 (0.000744625612)	0.02
LAND	0.007161118** (0.003513597)	3.54	0.007842734809* (0.002115863227)	3.91
LANDSQ	-0.000004963** (0.000002535)		-0.000002219887*** (0.000001205631)	
EDU	-0.142586439* (0.000428384)	-8.32	-0.030086006688* (0.000112151712)	-1.92
EDUSQ	0.001176790* (0.000341161)		0.000049783425 (0.000229459003)	
PCP	-0.003559999 (0.005386013)	-0.71	-0.005463619074*** (0.003016585794)	-2.13
PCPSQ	0.000006979 (0.000007543)		0.000002396560 (0.000002003883)	
CORN	0.000000199 (0.000000270)	0.12	-0.000000116721 (0.000000629046)	-0.03
SOY	0.000000716 (0.000000499)	0.21	0.000004079296** (0.000001468757)	0.47
MINDIS	0.265280934* (0.000120486)	4.69	-0.113562681439* (0.000045990614)	-1.98
MINDISSQ	-0.008912191* (0.001849748)		-0.002600692574** (0.001306755268)	
NEAR5	0.000001301* (0.000000137)	1.36	0.000001378171* (0.000000143947)	1.54

Table 5. Continued

Variable	Dependent Variable: ln(2002 broiler inventory+1)			
	East South Central		South Atlantic	
	Coefficient	Elasticity	Coefficient	Elasticity
PAC	0.1028969908* (0.004771744)	40.72	0.006232643494* (0.002121309022)	2.65
SEC	-33.077209704* (0.000018522)	-37.56	0.022935569409* (0.000003995943)	0.02
LIVESTOCK	0.000004356 (0.000006126)	0.14	0.000000317074 (0.000000341592)	0.03
WAGE	-0.328895246* (0.005351144)	-201.43	0.005667176028* (0.001991207627)	3.82
INC	-0.002829854* (0.000928947)	-3.59	-0.000096893824 (0.000146540832)	-0.27
INCSQ	0.000000045 (0.000000055)		0.000000001947 (0.000000002398)	
MKTVAL	0.002664384* (0.000995516)	5.25	0.000064048856 (0.000225774561)	0.18
MKTVALSQ	-0.000000241 (0.000000168)		0.000000000332 (0.000000008175)	
CONST	199.420039140* (0.000014178)		0.992698159605* (0.000003426067)	
N	342		483	
Log Likelihood	-817.42		-1197.79	
Spatial Error Test	1.55		1.37	

*,**,*** Statistical significance at the 1, 5, and 10% levels, respectively.
[a] East South Central Include counties of AL, KY, MS, and TN. South Atlantic Include counties of FL, GA, MD, NC, SC, VA, and WV.
[b] Elasticities are evaluated at the simple mean values of the sample's independent variables.
[c] number in the parenthesis indicate the parameter's standard error.
[d] LaGrange multiplier test, distributed with one degree of freedom, that tests the null hypothesis that the model's residuals are not spatially correlated.