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Analyzing Poverty in the Southern United States

Suhyun Jung
University of Tennessee - Knoxville

To the Graduate Council:

I am submitting herewith a thesis written by Suhyun Jung entitled "Analyzing Poverty in the Southern United States." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

Seong-Hoon Cho, Major Professor

We have read this thesis and recommend its acceptance:

Dan L. McLemore, Roland K. Roberts, Dayton M. Lambert

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

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Analyzing Poverty in the Southern United States

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Suhyun Jung
August 2009

Analyzing Poverty in the Southern United States

Abstract: This thesis deals with two related topics under the theme of "Analyzing Poverty in the Southern United States". The first part explores the role of government healthcare and education expenditure for poverty reduction, focusing particularly on how these relationships change over space and time in the Southern United States. It is found that healthcare expenditure is a significant contributor to poverty alleviation in both 1990 and 2000. The healthcare expenditure has a relatively high poverty-reducing effect in the Texas cluster and in the west part of the Mississippi Delta cluster in both years, while the poverty-reducing effect of healthcare expenditures disappears in 2000 in the Central Appalachia cluster. The effect of government expenditures on education decreased over time in the west part of the Mississippi Delta cluster but the education expenditure began to have a poverty-reducing effect in the Central Appalachia cluster in 2000. The second part focuses on disentangling the relationship between urban sprawl and poverty in the Southern United States. Results show that an increase in urban sprawl, as measured by wildland-urban interface (WUI), is associated with an increase in the urban poverty rate. The positive interrelationship between urban poverty and area of sprawl in metro counties supports the theoretical framework that urban poverty is both cause and effect of urban sprawl. With no other direct or indirect association between the poverty rate and urban sprawl, the positive interrelationship is explained by the movement of business centers to the suburban areas by sprawl development and immobility of the poor and the middle and upper class households' preference for the neighborhoods with lower poverty rates.

Table of Contents

PART 1. INTRODUCTION **1**

References 5

PART 2. PUBLIC EXPENDITURE AND POVERTY REDUCTION IN THE SOUTHERN UNITED STATES…… **9**

Abstract 10
Introduction 11
Methods and Procedures 15
Study Area and Data Description 20
Empirical Results 21
Conclusions 27
References 30
Appendix 38

PART 3. INTERRELATIONSHIP BETWEEN POVERTY AND URBAN SPRAWL IN THE SOUTHERN UNITED STATES **46**

Abstract 47
Introduction 48
Empirical Model 50
Study Area and Data Description 52
Empirical Results 54
Conclusions 58
References 60
Appendix 68

PART 4. SUMMARY **75**

Vita 78

List of Tables

TABLE 2-1. VARIABLE NAMES, DESCRIPTIONS, AND STATISTICS 39
TABLE 2-2. PARAMETER ESTIMATES OF THE GLOBAL-IV MODEL AND SUMMARY OF PARAMETER ESTIMATES OF THE GWR-IV MODEL (DEPENDENT VARIABLE = INDIVIDUAL POVERTY RATE) 41
TABLE 3-1. VARIABLE NAMES, DESCRIPTIONS, AND STATISTICS 69
TABLE 3-2. PARAMETER ESTIMATES OF THE SIMULTANEOUS-EQUATION MODEL 72

List of Figures

Figure 2-1. Poverty 'hot-spots' (high-poverty counties surrounded by high-poverty counties) in 1990 and 2000 based on local indicators of spatial association (LISA) using poverty rate 43
Figure 2-2. Marginal effect of per capita healthcare expenditure (assuming increase of $100) on the poverty rate in 1990 44
Figure 2-3. Marginal effect of per capita healthcare expenditure (assuming increase of $100) on the poverty rate in 2000 44
Figure 2-4. Marginal effect of per capita education expenditure (assuming increase of $100) on the poverty rate in 1990 45
Figure 2-5. Marginal effect of per capita education expenditure (assuming increase of $100) on the poverty rate in 2000 45
Figure 3-1. The Percentage of the Wildland-Urban Interface (WUI) Area at the County Level in the Southern United States 74

Part 1. Introduction

Introduction

Since 1964, when President Lyndon Johnson declared war on American poverty, researchers and policy makers have continuously struggled to develop ways of reducing poverty. Despite the government spending for poverty reduction, the South consists of severe poverty clusters, such as the Mississippi Delta, the Southeastern Cotton Belt, and central Appalachia regions (Partridge and Rickman 2007). On top of the persistent poverty, the recession which started at the end of 2007 is projected to cause large increases in poverty and push millions into deep poverty (Parrott 2008).

Various emergency stimulus packages have been introduced in responding to the recession. Most recently, Congress passed the American Recovery and Reinvestment Act of 2009 in February 2009. Particularly, this Act allocates nearly $140 billion for federal tax cuts, expansion of unemployment benefits and other social welfare provisions, and domestic spending in education, health care, and infrastructure. It is crucial to understand the effects of public expenditure on poverty reduction as there is obvious public's interest to understand how this Act is going to aid in the recovery of present U.S. economic situation.

In responding to the need for a better understanding of poverty and public policy, Partridge and Rickman (2006) have written a book aiming to describe the geographic landscape of poverty in the United States, to shed light on the processes that engender local concentrations of poverty, and draw implications for policy. The authors consider interregional equilibrium and disequilibrium perspectives on poverty. According to their theory, firms are attracted to low-wage areas and workforce departs from the areas, until poverty equilibrium is reached. Under the equilibrium perspective, local economic development policies are unlikely to improve the utilities of the initial residents because new migration will offset any wage gains arising from increased labor demand. Barriers to mobility, e.g., housing market constraints, transportation costs, migration costs, and imperfect information, contribute to deviations from equilibrium level of poverty rates that are likely to persist over time. Under the disequilibrium perspective, local economic growth may reduce local poverty rates.

Empirical evidence on whether the poverty rate tends to stay close to equilibrium level (e.g., Beeson and Eberts 1989; Blomquist, Bergerm and Hoehn 1988) or deviates from the equilibrium level (e.g., Glaeser et al. 1992; Kaldor 1970; Krugman 1991) is mixed. The patterns of spatial variation suggest that poverty rates are persistently unequal across regions (DeNavas-Walt, Bernadette, and Smith 2007; Friedman and Lichter 1998; Weber et al. 2005). For example, "Southern Black Belt," extending from southwest Tennessee to east-central Mississippi and then east through Alabama to the border with Georgia, has had persistently higher poverty rates than other regions within the South (Wimberley and Morris 1997).

Despite the importance given to regional variation in poverty reduction policies, the spatial dimension of American poverty has rarely been empirically explored. In rare study, Partridge and Rickman (2005) assessed the potential antipoverty benefits of economic development in high-poverty counties. The authors argued that high-poverty counties will experience reduced poverty if economic development policies successfully stimulate job growth and increase human capital. Partridge and Rickman (2007) identify key geographic differences among persistent-poverty counties. The authors conclude that place-based development policies should be considered for the counties with persistent poverty. While they correctly illustrate the importance of considering spatially varying economic development policy, how the geographic differences among poverty-counties vary over time is not addressed.

Along with high-poverty clusters, urban sprawl has been intensified in the region. Half of the top 10 most sprawling major U.S. metro areas are in the South (Smart Growth America 2000; Southeast Watershed Forum 2001). The South is the region with the largest increase in developed area between 1982 and 1997 and the region is also projected to have the most developed area of nearly 19 million hectare by 2025 (Alig, Kline, and Lichtenstein 2004). With no other direct or indirect association between the poverty rate and urban sprawl, there is a theoretical framework that urban poverty is both cause and product of urban sprawl because (1) racial discrimination concentrates poor communities of color in the central city, (2) urban sprawl excludes poor inner city people from educational and economic opportunities that occur in suburban areas, (3) the poor's immobility without cars, and (4) wealthier people's willingness to pay to avoid the proximity to the poor because of possible social problems, such as high crime rate and weak public schools (Bullard et al. 1999, Carruthers and Ulfarsson 2003, Colby 2007, Glaeser, Kahn, and Rappaport 2008, Powell 2007, Wiewel and Schaffer 2001,).

All of the previous studies considering the interaction between urban sprawl and urban poverty applied qualitative research methods and few, if any, studies explicitly quantify the relationship. Quantitative estimates of this relationship are essential for policy makers and urban planners to make informed decisions regarding sustainable development and socioeconomic equity.

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Part 2. Public Expenditure and Poverty Reduction in the Southern United States

Public Expenditure and Poverty Reduction in the Southern United States

Abstract: The objective of this research is to analyze the effects of government healthcare and education expenditure on poverty, focusing particularly on how these relationships change over space and time in the Southern United States. The spatially-varying local marginal effects of government healthcare and education expenditure on poverty rates from geographically weighted regression (GWR) using an instrument variable (IV) approach were mapped and superimposed on spatial clusters of high-poverty counties. The average local marginal effects of these government expenditures on poverty rates within each high-poverty cluster were summarized for the years 1990 and 2000.

Introduction

Since 1964, when President Lyndon Johnson declared war on American poverty, researchers and policy makers have continuously struggled to develop ways of reducing poverty. Through their efforts, a significant amount of research and government funding has been directed toward the poverty issue. For example, the Appalachian Regional Commission (ARC) was formed by the federal government in 1964 to improve the standard of living in the Appalachian region. This program included grants, direct loans, guaranteed loans, and direct payments for retirees (Reeder and Calhoun 2002). Despite the government spending for poverty reduction, the poverty rate in the United States still rose for four consecutive years from 11.3% in 2000 to 12.7% in 2004 and has remained fairly constant in more recent years, e.g., 12.3% in 2006 (DeNavas-Walt, Bernadette, and Smith 2007).

On top of the persistent poverty, the recession which started at the end of 2007 is projected to cause large increases in poverty and push millions into deep poverty (Parrott 2008). Various emergency stimulus packages have been introduced in responding to the recession. Most recently, Congress passed the American Recovery and Reinvestment Act of 2009 in February 2009. Particularly, this Act allocates nearly $140 billion for federal tax cuts, expansion of unemployment benefits and other social welfare provisions, and domestic spending in education, health care, and infrastructure. It is crucial to understand the effects of public expenditure on poverty reduction as there is obvious public’s interest to understand how this Act is going to aid in the recovery of present U.S. economic situation.

In responding to the need for a better understanding of poverty and public policy, Partridge and Rickman (2006) have written a book aiming to describe the geographic landscape of poverty in the United States, to shed light on the processes that engender local concentrations of poverty, and draw implications for policy. The authors consider interregional equilibrium and disequilibrium perspectives on poverty. According to their theory, firms are attracted to low-wage areas and workforce departs from the areas, until poverty equilibrium is reached. Under the equilibrium perspective, local economic development policies are unlikely to improve the utilities of the initial residents because new migration will offset any wage gains arising from increased labor demand. Barriers to mobility, e.g., housing market constraints, transportation costs, migration costs, and imperfect information, contribute to deviations from equilibrium level of poverty rates that are likely to persist over time. Under the disequilibrium perspective, local economic growth may reduce local poverty rates.

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A number of studies have been done developing regional poverty reduction strategies. Triest (1997) concluded that increased employment of the low-income population and increased educational opportunity would narrow the interregional gap in poverty. Rupasingha and Goetz (2007) suggested that government can increase investment in social capital to reduce the poverty rate by easing transaction costs paid by local associations. Swaminathan and Findeis (2004) found that welfare assistance to help poor workers had effects on poverty in metro areas. Allard, Tolman, and Rosen (2003) and Blank (2005) suggested that poverty reduction is more effective when spatially targeted governmental policies are designed.

Levernier, Partridge, and Rickman (2000) explored the reasons for the differences in poverty among counties in the United States. The authors found that developing education programs specifically targeted for minorities and non-Metropolitan Statistical Area (MSA) residents is one of the keys in reducing poverty. Despite the importance given to regional variation in poverty reduction policies, the spatial dimension of American poverty has rarely been empirically explored. In rare study, Partridge and Rickman (2005) assessed the potential antipoverty benefits of economic development in high-poverty counties. The authors argued that high-poverty counties will experience reduced poverty if economic development policies successfully stimulate job growth and increase human capital. Partridge and Rickman (2007) identify key geographic differences among persistent-poverty counties. The authors conclude that place-based development policies should be considered for the counties with persistent poverty. While they correctly illustrate the importance of considering spatially varying economic development policy, how the geographic differences among poverty-counties vary over time is not addressed.

The objective of this research is to analyze the effects of government healthcare and education expenditures on poverty, focusing on how this relationship changes over space and time among spatial clusters of poverty in the Southern United States. The government expenditures particularly on healthcare and education are considered because (1) the Southern United States includes areas with poor health, low education, and high infant mortality, e.g., the old plantation belt of the southern Coastal Plain and Cumberland Plateau country of Kentucky and West Virginia, and (2) government spending on healthcare and education are found to contribute to economic growth (Beale 2004; Bhargava et al. 2001; Bloom and Canning 2000; Fan, Zhang, and Zhang 2002; Jung and Theorbecke 2003; Probst et al. 2004; Triest 1997; Waidmann and Rajan 2000; Williams 2002).

In order to achieve the objective, first the spatial clusters of high-poverty counties which are surrounded by other high-poverty counties or poverty 'hot-spots,' identified by local indicators of spatial association (LISA) analysis, were used to screen counties for policies targeted at poverty alleviation. Second, the spatially-varying local marginal effects of government healthcare and education expenditure on poverty rates from geographically weighted regression (GWR) using an instrument variable (IV) approach were mapped and superimposed on spatial clusters of hot-spots. Third, the average local marginal effects of these government expenditures on poverty rates within each hot-spot cluster were summarized for the years 1990 and 2000.

In this study, a GWR approach, first proposed by Cleveland and Devlin (1988), was adopted to deal with the regional variation in poverty reduction policies and allowed for estimates of the value of marginal effects of government expenditures on poverty. The methodology allows regression coefficients to vary across space. The approach has recently been applied intensively to test local heterogeneity including research on poverty and a place-based policy role (Brunsdon, Fotheringham, and Charlton 1996, 1999; Cho, Bowker, and Park 2006; Cho, Jung, and Kim 2009; Cho et al. 2009; Deller and Lledo 2007; Fotheringham, Brunsdon, and Charlton 1998, 2002; Fotheringham and Brunsdon 1999; Huang and Leung 2002; Laffan and Bickford 2005; Lambert, McNamara, and Garret 2006; Leung, Mei, and Zhang 2000, 2003; Lo 2008; McMillen 1996; Partridge and Rickman 2007; Yu and Wu 2004; Yu 2006, 2007).

Methods and Procedures

Identifying clusters of high-poverty counties

To see whether poverty in the South is not spatially random, Moran's index was estimated. The index is a measure of the overall spatial relationship across geographical units and is defined as $I = [n\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(y_i - \bar{y})(y_j - \bar{y})]/[(\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij})\sum_{i=1}^{n}(y_i - \bar{y})^2]$, where n is the sample size, y_i is the poverty rate in county i with sample mean $\bar{y}$, and w_{ij} is the distance-based weight which is the inverse distance between centroids of counties i and j. Like a correlation coefficient, Moran's index takes on values greater than zero (signifying positive spatial autocorrelation, e.g., similar, regionalized, or clustered observations), equal to zero (indicating a random pattern), and less than zero (implying negative spatial autocorrelation, e.g., a dissimilar or contrasting pattern) (Goodchild 1986, p16-17).

If Moran's index demonstrates that the spatial distribution of the poverty rate in the South is not spatially random, local indicators of spatial association (LISA) (Anselin 1995) are estimated to identify spatial clusters of poverty. LISA values indicate the extent of spatial autocorrelation between the poverty rate in a particular county and the poverty rates in the counties around it. Through inference analysis, poverty 'hot-spots' are identified. These clusters can include a single county and its contiguous neighbors, or a larger set of contiguous counties for which the LISA values are statistically significant. The LISA value for county i is defined as:

$$LISA_i = [(y_i - \bar{y})/\sum_{i=1}^{n} y_i^2]\cdot\sum_{j=1}^{n} w_{ij}(y_j - \bar{y}).$$

Estimating spatially-varying marginal effects of government expenditures on poverty rates

The modeling system that estimates marginal effects of government healthcare and education expenditures on poverty rates extends past spatial studies of overall poverty rates, e.g., Gundersen and Ziliak 2004; Levernier, Partridge, and Rickman 2000; Madden 1996; and Partridge and Rickman 2007. Because government expenditure is largely determined by economic condition of a county that is closely associated with a poverty rate, government expenditure in the poverty equation needs to be endogenized (e.g., Fan and Chan-Kang 2009). The Durbin-Wu-Hausman test was conducted to test the null hypothesis that a regressor is exogenous (Davidson and MacKinnon 1993). Failure to reject the hypothesis of the government expenditure on education for the years 1990 and 2000 suggests that the government education expenditure is statistically exogenous. In contrast, rejecting the hypothesis of the government expenditure on healthcare for the years 1990 and 2000 suggests that the government healthcare expenditure is endogenous. Accordingly, instrumental variables (IV) approach is used to address the endogeneity between poverty rate and government expenditure on healthcare (Baer and Galvão 2008; Bokhari Gai, and Gottret 2007).

The model is characterized to account for this endogeneity:

$$p_t = \alpha_1 p_{t-1} + \alpha_2 \mathbf{W} p_{t-1} + \beta_1 \mathbf{Z} + \alpha_3 g_{1t} + \alpha_4 g_{2t} + u_t^p , \tag{1}$$

$$g_{1t} = \gamma_1 p_{t-1} + \gamma_2 \mathbf{W} p_{t-1} + \gamma_3 temp + \gamma_4 g_{2t} + \beta_2 \mathbf{Z} + u_t^{g_1} \tag{2}$$

where p_t and p_{t-1} are the county's poverty rate in the current and lagged time period, respectively; $\mathbf{W}$ is an $n \times n$ contiguity matrix with diagonal elements of 0 and off-diagonal elements of 1 for all counties that are contiguous to the county being studied; $\mathbf{Z}$ is a vector of other exogenous variables including economic, demographic, and social characteristics; g_{1t} and g_{2t} are government expenditures on healthcare and education in the current time period, respectively; *temp* is the mean temperature for January between 1941 and 1970; $\alpha_1, \alpha_2, \beta_1, \alpha_3, \alpha_4$ are conformable parameter vectors for the poverty equation; $\gamma_1, \gamma_2, \gamma_3, \gamma_4, \beta_2$ are conformable parameter vectors for the government expenditure on healthcare.

The mean temperature for January between 1941 and 1970 was used as a unique IV for the government expenditure on healthcare equation because government expenditure on healthcare is determined by the number of patients or hospitals, which is closely related with the mean temperature (Checklee et al. 2000). At the same time, mean temperature does not directly affect the county's poverty rate; thus the error in the poverty equation u_t^p is not correlated with g_{1t}.

The systems of equations (1) and (2) were estimated using the two-stage procedure based on two methods, ordinary least squares (OLS) and GWR. In the first stage, equation (2) was estimated using OLS and GWR regressions. In the second stage, the parameters in equation (1) were estimated by OLS and GWR, after replacing g_{1t} with their predicted values from the OLS and GWR in the first stage, respectively. Hereafter the "Global-IV model" denotes the use of OLS method while the "GWR-IV model" represents the use of GWR method. The GWR-IV model is:

$$g_{1t} = (\boldsymbol{\beta}_1 \otimes \mathbf{X}_1)\mathbf{1}_{g_1} + \varepsilon_1 \tag{3}$$

$$p_t = (\boldsymbol{\beta}_2 \otimes \mathbf{X}_2)\mathbf{1}_p + \varepsilon_2 \tag{4}$$

where $\mathbf{X_1}$ is a vector of variables including the mean temperature for January, p_{t-1}, $\mathbf{W}p_{t-1}$, and $\mathbf{Z}$; $\mathbf{X_2}$ is a vector of variables including predicted value of g_{1t} from the equation (3), p_{t-1}, $\mathbf{W}p_{t-1}$, and $\mathbf{Z}$; $\otimes$ is a logical multiplication operator in which each element of matrices $\boldsymbol{\beta_1}$, $\boldsymbol{\beta_2}$ are multiplied by the corresponding element of $\mathbf{X}$; $\mathbf{1}_{g_1}, \mathbf{1}_p$ are conformable vectors of 1's; and ε is a vector of random errors.

The closed form solution to equation (4) is:

$$\hat{\boldsymbol{\beta}}(u_i, v_i) = (\mathbf{X}^T \mathbf{W}(u_i, v_i)\mathbf{X})^{-1}\mathbf{X}^T \mathbf{W}(u_i, v_i)\mathbf{p} \tag{5}$$

where (u_i, v_i) denotes the location coordinates for the centroid of county i, $\hat{\boldsymbol{\beta}}(u_i, v_i)$ are localized parameters for county *i*, **p** is a vector of poverty rate p_t, and $\mathbf{W}(u_i, v_i)$ is an $n \times n$ matrix whose diagonal elements indicate each county's geographical weight for the county *i*.

The GWR-IV model assumes that counties close to county *i* have more weight in the estimation than the ones far from it, allowing estimation of spatially varying coefficients (Fotheringham, Brunsdon, and Charlton 2002). The GWR-IV model is estimated for 1990 and 2000 to evaluate the temporal dynamics of the effects of government expenditures on poverty, and for simplicity, the year subscript is suppressed.

Different kernel functions $K(d_{ij} / d_{\max}(q))$ determine the diagonal elements of the weight matrix, w_{ij}. That is, for all $d_{ij} \geq d_{\max}(q)$, $K(d_{ij} / d_{\max}(q)) = 0$ where d_{ij} is the Euclidean distance between points *i* and *j*, and $d_{\max}$ is the maximum distance between observation *i* and *q*, its nearest neighbors (optimal bandwidth). Fotheringham, Brunsdon, and Charlton (2002) suggest using a fixed Gaussian kernel, with $K(d_{ij} / b) = \exp\left[-(d_{ij} / b)^2 / 2\right]$; or an adaptive bi-square function, with $K(d_{ij} / d_{\max}) = \left[1 - (d_{ij} / d_{\max})^2\right]^2$ if *j* is one of the N^{th} nearest neighbors of *i* and $K(d_{ij} / d_{\max}) = 0$ otherwise. For the adaptive kernel, d_{max} is the maximum distance between observation *i* and its optimal number of neighbors.

The adaptive spatial kernel was used in this study because it has the desirable properties of a continuous weighting function within the context of the nearest neighbor definition. Nearest neighbors were hypothesized to influence each other based on a continuous decay function. But outside the nearest neighbor range, observations were assumed to have no influence on each other. The less dense counties are in an area, the wider and larger is the area represented by the optimal neighborhood size because the trace of the weight matrix was allowed to expand and contract at each regression point. A cross-validation (CV) approach was used to select the optimal bandwidth (Cleveland and Devlin 1988). The significance of the spatial variability of parameter estimates for each variable was tested by using a Monte Carlo procedure in the GWR 3.0 (Fotheringham, Brunsdon, and Charlton 2002).

A likelihood ratio (LR) statistic based on the Global-IV model was used to test whether the models for 1990 and 2000 should be estimated separately, or with a single, pooled regression. Denoting the maximum log-likelihoods for the 1990, 2000, and pooled regressions (with year dummy variable in the equation) as f_{1990}, f_{2000}, and f_P, respectively, with corresponding numbers of parameters k_{1990}, k_{2000}, and k_P, the LR statistic $2(f_{1990} + f_{2000} - f_P)$ is Chi-square distributed with $(k_{1990} + k_{2000} - k_P)$ degrees of freedom. Failure to reject the null hypothesis of parameter equality between the 1990 and 2000 regression would indicate that separate regression for the two years is appropriate.

Estimating average local marginal effects of government expenditures within each spatial cluster of poverty

The spatial clusters of high-poverty counties which are surrounded by other high-poverty counties or poverty ‘hot-spots,’ identified by LISA analysis were used to screen counties for policies targeted at poverty alleviation. The spatially-varying local marginal effects of government healthcare and education expenditure on poverty rates from GWR-IV model were mapped and were superimposed on spatial clusters of hot-spots. The average local marginal effects of the government expenditures on poverty rates within each hot-spot cluster were summarized for the 1990 and 2000. These summaries quantify the relative importance of government expenditure on healthcare and education in alleviating poverty, and they also examine how these effects have changed over time.

Study Area and Data Description

This study focuses on 1,423 counties in 16 states in the U.S. Census Bureau's South Division. The states are Texas, Oklahoma, Arkansas, Louisiana, Mississippi, Alabama, Tennessee, Georgia, South Carolina, North Carolina, Kentucky, Florida, Maryland, Delaware, Virginia, and West Virginia. After removing observations with missing data, the number of counties used was 1,421 for 1990 and 2000. The Southern United States was selected as the study area because of persistently higher poverty rates than other regions. In 2006, the South had the highest poverty rate at 13.8% while other regions had significantly lower rates: 11.5% in the Northeast, 11.2% in the Midwest, and 11.6% in the West (DeNavas-Walt, Bernadette, and Smith 2007).

The study employs four county-level datasets in a geographical information system (GIS): (a) demographic and industry structural data for 1990 and 2000 from the U.S. Census Bureau, (b) employment data for 1990 and 2000 from the Bureau of Labor Statistics, U.S. Department of Labor, (c) data on employment in art occupations, natural amenity scale, mean temperature for January, and Urban Influence Codes for 1993 and 2003 from the Economic Research Service, U.S. Department of Agriculture, and (d) county government expenditure data for 1987 and 1997 from the U.S. Census Bureau Government Finances. Government expenditures for 1987 and 1997 were chosen to capture the lagged effects of government expenditures on poverty rates in 1990 and 2000, respectively. County-area government finance data were used because they include all governmental expenditures, such as expenditures by municipalities, townships, special districts, and independent school districts (U.S. Census Bureau 2008). The 1993 and 2003 Urban Influence Codes were used as proxies for rural/urban counties in 1990 and 2000, respectively. Variable names, definitions, and descriptive statistics for the variables used in the models are presented in Table 1.

To account for inflation, per capita government expenditures on healthcare and education in 1990 were adjusted to 2000 dollars using the consumer price index for the south urban consumers (Bureau of Labor Statistics 2009)[1].

Empirical Results

The null hypothesis that the slope parameters from the Global-IV model (i.e., except the constants) are equal is rejected (LR = 843, df = 22, *p*-value < 0.001), suggesting that the inclusion of a year dummy variable in the pooled regression does not fully capture time differences over the decade and, thus, separate 1990 and 2000 regressions are appropriate. For the comparison of Global-IV and GWR-IV models, residual sum of squares, corrected Akaike Information Criterion (AIC), and F-test were used. The residual sum of squares for the Global-IV models (50,069 and 10,021 for 1990 and 2000, respectively) are higher than for the GWR-IV models (5,643 and 4,271 for 1990 and 2000, respectively). The corrected AICs for the GWR-IV models (6,372 and 5,801 for 1990 and 2000, respectively) are lower than those for the Global-IV models (27,899 and 27,365 for 1990 and 2000, respectively). F-values for the Global-IV versus the GWR-IV models for 1990 and 2000 are 69 and 25, respectively. The critical F-value at the 1% level (1.87) suggests that the GWR-IV models outperform the Global-IV models for both

[1] The Bureau of Labor Statistics uses the Census Bureau's definition of urban. It defines "urban" as comprising all territory, population, and housing units in urbanized areas and in places of 2,500 or more persons outside urbanized areas.

years. The optimal bandwidths using the CV function are 427 and 746 observations for 1990 and 2000, respectively.

Moran's indexes for the poverty rates for 1990 and 2000 are 0.45 and 0.40, respectively, reflecting high degrees of clustering of poverty rates. Figure 1 shows that the LISA analysis clearly identified three major clusters in Texas (the "Texas cluster"), Mississippi, Louisiana, and some parts of Alabama, Arkansas, Florida and Georgia (the "Mississippi Delta cluster"), and east Kentucky, the west side of West Virginia, and some counties in Virginia and Tennessee (the "Central Appalachia cluster"). These clusters were consistent between years showing the persistence of high-poverty areas between the two periods in the South.

The Global-IV residuals were spatially autocorrelated (spatial error LM statistics of 28 and 20 for 1990 and 2000, respectively). Re-estimation with GWR-IV reduced the magnitude of the LM statistics. However, spatial error autocorrelation remained in the GWR-IV residuals at the 1% for 1990 (spatial error LM statistics of 11 and 3 for 1990 and 2000, respectively). This result implies that although the GWR model significantly mitigates spatial autocorrelation, it does not always entirely correct it and, thus, the statistical results must be interpreted with caution. As a result, the GWR-IV model is treated as a complement rather than an alternative to the Global-IV model.

The null hypothesis of no spatial variability from the Monte Carlo test was rejected for the effects of government healthcare expenditure on poverty rates in both years ($\alpha = 0.05$). These results indicate that the effects of government healthcare expenditure on poverty are spatially heterogeneous for both years. In order to better understand the spatial and temporal variations of the effects of government healthcare and education expenditures on poverty, the local marginal effects of these variables, derived from the GWR-IV model, are superimposed on the three major clusters of poverty in Figures 2-5.

Control variables of the second stage estimates

Because each GWR-IV model generates too many coefficients, i.e., the $\hat{\beta}(u_i, v_i)$ matrix is $n \times (m+1)$, resulting in 29,841 different coefficients for the 1990 and 2000 regressions, respectively, the summaries of GWR-IV parameter estimates (i.e., lower quartiles, medians, and upper quartiles) are shown in Table 2 with Global-IV parameter estimates. Also, the p-values from the Monte Carlo tests of spatial variability in GWR-IV parameter estimates are provided in Table 2 for each time period.

The results of the second stage estimates for the Global-IV model show that the time lagged poverty rate has significant poverty-increasing effects for both 1990 and 2000 at the 1 percent level. A 1 percent increase of the poverty rate in 1980 and 1990 has the poverty-increasing effect in a county of 0.34 percent in 1990 and of 0.36 percent in 2000, respectively. This highlights the increasing lagged effect of the poverty rate over the time period in the Southern United States (Beale 2004; Calhoun, Reeder, and Bagi 2000). An increase in the lagged average of the poverty rate in surrounding counties by 1 percent increases the poverty rate of a county by 0.21 percent and 0.06 percent in 1990 and 2000, respectively. The positive effect of the lagged average of the poverty rate in surrounding counties suggests that the lagged poverty rate effect tends to be spatially clustered.

The age composition variables of ages 0-17, ages 18-24, and ages 65 and up show positive and significant effects on the poverty rate for both time periods. This reflects that counties with higher ratio of children (ages 0-17), college students (ages 18-24), and retirees (ages 65 and up) are more likely to have higher poverty rates than counties with a higher ratio of an economically active population (ages 25-65). This supports the finding by Rupasingha and Goetz (2007).

The ratio of female-headed households has been shown to have a positive and significant effect on the poverty rate at the 1 percent level for both time periods, reflecting that counties with more female-headed households tend to have higher poverty rates. The education-related variables, i.e., percentage of people who have difficulty speaking English and percentage of people completed at least some college education, are all significant at the 1 percent level for both time periods. Counties with larger population who have difficulty speaking English and counties with smaller population who completed at least some college education were found to have a greater poverty rate. The percentage of families that have 3 or more workers shows a negative and significant effect on the poverty rate at 1 percent level for both periods. The results of age composition, female-headed households, education-related variables, and families that have 3 or more workers show that having an economically active and capable population is an important factor in poverty alleviation.

The employment composition variables of manufacturing, public utility, and finance and insurance are shown to be negative and significant in 2000. This implies that the employment opportunities in these industries are highly correlated with a lower poverty rate in 2000. The employment in wholesale and retail trade is not significant in 1990, but it is positive and significant in 2000. The positive effect of wholesale and retail trade on the poverty rate in 2000 is unexpected. However, recently Goetz and Swaminathan (2006) and Goetz and Rupasingha (2006) found that “big box” retailers such as Wal-Mart are possible contributors to higher county-wide poverty rates. They claim that Wal-Mart stores create part-time jobs with low wages, devastate the local retail industry, and transfer income from the poor to the stockholders. The urban influence code is found to have a positive and significant effect on the poverty rate in both time periods, suggesting high poverty rates in rural areas.

Government expenditure variables of the second stage estimates

In the second stage of the Global-IV model, the parameter of healthcare expenditure is negative and statistically significant in both periods. An increase in per capita government expenditure on healthcare by $100 decreases the poverty rate by 3.06 percent in 1990, while an increase of the same amount of per capita government expenditure on healthcare decreased the poverty rate by 0.55 percent in 2000. The coefficient of government expenditure on education is not significant in both periods.

To highlight the spatial variations of the marginal effects of the healthcare and education expenditures on the poverty rate in the areas of poverty hot-spots, the GWR-IV parameters of healthcare and education variables were mapped and were superimposed on spatial clusters of poverty hot-spots in both time periods in Figures 2-5. The 1990 parameter estimates for each government expenditure variable were divided into four quartiles using the four gradual color schemes for both periods. When describing the figures below, the significantly high marginal effects of per capita government expenditure on poverty rate are defined as negative marginal effects greater than absolute value of the median parameter for 1990.

Figure 2 identifies a major cluster of counties with significantly high marginal effects of healthcare expenditure in 1990, i.e., 0.37 percent or more decrease in poverty rate by the increase of per capita healthcare expenditure by $100, mostly in the Texas cluster. An increase in per capita healthcare expenditure by $100 decreases the poverty rate by 0.92 percent in the Texas cluster. High marginal effects of healthcare expenditure also exist over the areas of Arkansas, the counties bordering Louisiana and Texas state lines, and counties bordering the Kentucky, Tennessee, and Virginia state lines in the Mississippi Delta cluster and Central Appalachia cluster, respectively. An increase in per capita healthcare expenditure by $100 decreases the poverty rate by 0.60 percent in the coincided area with high marginal effects of healthcare expenditure in the Mississippi Delta cluster and by 0.43 percent in the coincided area with high marginal effects of healthcare expenditure in the Central Appalachia cluster. In contrast, the same dollar increase in the rest of the Mississippi Delta cluster increases the poverty rate by 0.35 percent.

Figure 3 identifies counties with relatively high marginal effects of healthcare expenditure in 2000, i.e., 0.37 percent or more decrease in the poverty rate by the increase of per capita healthcare expenditure by $100, in all the counties of the Texas cluster and over the areas of western Louisiana, southeastern Georgia in the Mississippi Delta cluster. An increase in per capita healthcare expenditure by $100 decreases the poverty rate by 0.68 percent and 0.49 percent in the Texas cluster and in the coincided area with high marginal effects of healthcare expenditure in the Mississippi Delta cluster, respectively. In contrast, the same dollar increase in the rest of the three cluster regions increases the poverty rate by 0.37 percent. The Texas cluster continuously shows a relatively higher poverty-reducing effect of healthcare expenditure than the other clusters. The poverty reducing effect of healthcare expenditure in the Central Appalachia cluster disappears in 2000 while it starts to appear in the southern Georgia in the Mississippi Delta cluster.

Figure 4 identifies a cluster of counties with relatively high marginal effects of education expenditure, i.e., 0.05 percent or more decrease in the poverty rate by the increase of per capita education expenditure by $100, in the counties of northwestern Louisiana and southern Arkansas in the Mississippi Delta cluster in 1990. An increase in per capita education expenditure by $100 decreases the poverty rate by 0.08 percent in the coincided area with high marginal effects of education expenditure in the Mississippi Delta cluster and increases the poverty rate by 0.08 percent in the rest of the three cluster regions.

Figure 5 shows that high marginal effects of education expenditure, i.e., 0.05 percent or more decrease in the poverty rate by the increase of per capita education expenditure by $100, in the counties that lie on the borders of the Kentucky, Virginia, and West Virginia states lines, where the high marginal effects of education expenditure did not exist in 1990. An increase in per capita education expenditure by $100 decreases the poverty rate by 0.10 percent in the coincided area with high marginal effects of education expenditure in the Central Appalachia cluster, while the same amount of increase in per capita education expenditure decreases the poverty rate by 0.02 percent in the counties in Louisiana, Arkansas, and Mississippi that are included in the Mississippi Delta cluster.

Conclusions

This research analyzes temporal and spatial variations of the effects in healthcare and education expenditures on the poverty rate in the Southern United States. It is found that government healthcare expenditure is a significant contributor to poverty alleviation in both 1990 and 2000. The healthcare expenditure has a relatively high poverty-reducing effect in the Texas cluster and in the west part of the Mississippi Delta cluster in both years, while the poverty-reducing effect of healthcare expenditures disappears in 2000 in the Central Appalachia cluster. The effect of government expenditures on education decreased over time in the west part of the Mississippi

Delta cluster but the education expenditure began to have a poverty-reducing effect in the Central Appalachia cluster in 2000.

This study contributes to the growing literature on the effects of government expenditures on poverty alleviation in two new ways. First, using county data for the Southern United States, we examine how the effects of government expenditures on poverty have changed over time and compare these changes spatially. Second, we use spatial cluster analysis and spatial regression to identify spatial clusters of poverty and to examine the marginal effects of government expenditures on poverty alleviation in each of the identified poverty clusters.

The implications drawn from the marginal effects of government expenditures on poverty alleviation will likely interest policymakers and planners as these outputs will be a systematic guideline for the place-based poverty reduction policies for the counties with persistent poverty. For example, increasing government expenditure on healthcare using the stimulus packages through the American Recovery and Reinvestment Act of 2009 may need to be considered as a strategy for the reduction of the poverty rate in the counties in the Texas cluster because of its consistent higher marginal effect on reducing the poverty rate over the periods.

Despite the merit of mapping of the parameter estimates and highlighting spatial variation using GWR, there are potentially serious problems associated with the approach, as noted in the literature, that have not been addressed in this research. They are potential multicollinearity among local regression coefficients and extreme coefficients including sign reversals (Wheeler and Tiefelsdorf, 2005; Farber and Páez, 2007). Another caveat for this study is the absence of significance levels for the GWR-IV parameter estimates. Pseudo t-values generated from GWR 3.0 were not reported because they cannot be viewed with the same confidence as t-values in OLS models. This lack of confidence emanates from their calculation using neighboring spatial units repetitively (Yu 2007; Ali and Kestens 2006). Because of these issues, the statistical results of GWR reported in this study must be interpreted with caution and were not used in the analysis.

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Appendix

Table 2-1. Variable Names, Descriptions, and Statistics

Variable	Description	1990 Mean (S.D)	2000 Mean (S.D)
Dependent Variable			
Individual poverty rate	Poverty rate of individual whose income is below poverty threshold by the U.S. Census Bureau, 1989 and 1999 in percent (%)	20.05 (8.51)	16.94 (6.74)
Lag Variables			
Time lag of own-poverty rate	Individual poverty rate of 1980 for 1990 and 1990 for 2000	19.20 (7.62)	20.05 (8.51)
Time lag of surrounding-county poverty rate	Average of surrounding county individual poverty rate in 1980 for 1990 and in 1990 for 2000	19.18 (6.04)	20.02 (6.94)
Instrumental Variable			
Mean temperature for January	Mean temperature for January between 1941 and 1970	42.66 (6.94)	42.66 (6.94)
Demographic Variables			
Native American	Percentage of Native American over total population (%)	0.94 (3.15)	0.98 (3.03)
Asia – Pacific	Percentage of people from Asia – Pacific over total population (%)	0.44 (0.74)	0.65 (1.03)
Age 0-17 years	Percentage of persons 0-17 years of age over total population (%)	26.61 (3.50)	25.26 (3.15)
Age 18-24 years	Percentage of persons 18-24 years of age over total population (%)	9.85 (3.54)	9.25 (3.55)
Age 65 years and over	Percentage of persons 65 years or more over total population (%)	14.33 (4.18)	14.14 (3.84)
Female head	Percentage of female headed family with no husband present over total families (%)	15.17 (5.67)	17.04 (6.24)
People having difficulty speaking English	Percentage of people who have difficulty speaking English age between 16 and 64 over total population (%)	1.30 (2.97)	1.97 (3.10)
People completed at least some college	Percentage of people completed at least some college over population of 25 years plus (%)	31.14 (10.49)	35.73 (10.00)
Family with 3 or more Workers	Percentage of family that has 3 or more workers over total families (%)	10.79 (2.82)	9.27 (2.17)
Socioeconomic Variables			
Unemployment rate	Percentage of unemployed workers in age 16 plus (%)	6.62 (3.01)	4.59 (1.67)
Agriculture	Percentage of agriculture, forestry, and	6.62	4.78

	fisheries employment over total employment (%)	(6.24)	(4.96)
Manufacturing	Percentage of manufacturing, mining, construction employment over total employment (%)	30.96 (10.30)	27.04 (8.61)
Public utility	Percentage of transportation, communications, and other public utility employment over total employment (%)	6.67 (2.07)	7.17 (3.96)
Wholesale and retail trade	Percentage of wholesale and retail trade employment over total employment (%)	19.16 (3.49)	13.00 (4.16)
Finance and insurance	Percentage of finance, insurance, and real estate employment over total employment (%)	4.18 (1.68)	4.44 (1.74)
Arts	Percentage of arts class employment over total employment (%)	0.60 (0.37)	0.62 (0.38)
Environmental Variables			
Urban influence code	Urban influence code in 2003, ranges from 1 being large metro area of 1+ million residents to 12 being noncore not adjacent to metro or micro area and does not contain a town of at least 2,500 residents	5.34 (2.65)	4.90 (3.21)
Natural amenity scale	Natural amenity scale, which combines six measures of warm winter, winter sun, temperate summer, low summer humidity, topographic variation, and water area, ranges from -6.4 low amenities being to 11.2, negative being and positive being high amenities	0.36 (1.36)	0.36 (1.36)
Government Expenditure Variables			
Healthcare	Expenditure on health and hospitals in 1987 for 1990; in 1997 for 2000, \$/capita	123.44 (179.89)	209.53 (342.47)
Education	Expenditure on schools, colleges, educational institutions, and educational programs in 1987 for 1990; in 1997 for 2000, \$/capita	614.64 (212.01)	1078.29 (515.02)

Note: The data are at the county level for the period of 1990 and 2000 unless indicated differently.

Table 2-2. Parameter Estimates of the Global-IV Model and Summary of Parameter Estimates of the GWR-IV Model (Dependent variable = Individual poverty rate)

Variables	1990					2000				
	Global-IV model (S.E.)	GWR-IV				Global-IV model (S.E.)	GWR-IV			
		Low-quart	Median	Up-quart	P-value		Low-quart	Median	Up-quart	P-value
Intercept	-15.436 (7.611)	-9.968	1.163	5.868	0.000***	4.102** (1.948)	-4.394	4.392	7.008	0.000***
Lag Variables										
Time lag of own-poverty rate	0.340*** (0.071)	0.358	0.404	0.449	0.420	0.355*** (0.029)	0.308	0.375	0.480	0.000***
Time lag of surrounding-county poverty rate	0.206*** (0.077)	0.027	0.109	0.161	0.010***	0.056** (0.024)	0.033	0.063	0.083	0.250
Demographic Variables										
Native American	0.066 (0.053)	-0.002	0.051	0.087	0.020**	0.032 (0.025)	-0.074	-0.051	0.074	0.000***
Asia – Pacific	0.120 (0.315)	-0.636	-0.391	-0.018	0.080*	0.054 (0.100)	0.020	0.062	0.122	0.560
Age 0-17 years	0.736*** (0.162)	0.173	0.279	0.534	0.000***	0.164*** (0.046)	0.048	0.097	0.385	0.000***
Age 18-24 years	0.538*** (0.102)	0.289	0.394	0.449	0.570	0.297*** (0.038)	0.201	0.246	0.404	0.000***
Age 65 years and over	0.401*** (0.104)	0.053	0.144	0.356	0.000***	0.096** (0.041)	-0.011	0.049	0.248	0.000***
Female head	0.391*** (0.080)	0.297	0.368	0.490	0.000***	0.278*** (0.033)	0.169	0.269	0.317	0.000***
People having difficulty speaking English	0.443*** (0.078)	-0.063	0.263	0.375	0.000***	0.316*** (0.046)	0.285	0.326	0.401	0.100*
People completed at least some college	-0.090*** (0.035)	-0.140	-0.113	-0.082	0.220	-0.079*** (0.016)	-0.105	-0.086	-0.069	0.060*

Family with 3 or More Workers	-0.780*** (0.095)	-0.653	-0.566	-0.418	0.000***	-0.559*** (0.050)	-0.524	-0.482	-0.455	0.650
Socioeconomic Variables										
Unemployment rate	0.087 (0.109)	0.154	0.294	0.350	0.090*	0.121 (0.075)	0.103	0.202	0.357	0.130
Agriculture	-0.008 (0.052)	-0.022	0.064	0.166	0.000***	0.004 (0.027)	-0.047	0.004	0.035	0.040**
Manufacturing	-0.031 (0.040)	-0.133	-0.071	-0.018	0.000***	-0.046*** (0.015)	-0.059	-0.045	-0.033	0.150
Public utility	0.047 (0.094)	-0.044	0.035	0.077	0.260	-0.090** (0.039)	-0.108	-0.057	-0.018	0.170
Wholesale and retail trade	0.060 (0.083)	-0.128	-0.062	0.071	0.000***	0.096** (0.039)	0.009	0.056	0.076	0.040**
Finance and insurance	-0.123 (0.149)	-0.223	-0.115	-0.062	0.590	-0.132** (0.064)	-0.205	-0.149	-0.056	0.180
Arts	0.577 (0.675)	-0.318	0.137	0.754	0.590	-0.143 (0.266)	-0.109	0.071	0.286	0.480
Environmental Variables										
Urban influence code	0.285** (0.122)	0.067	0.173	0.239	0.040**	0.171*** (0.044)	0.066	0.083	0.133	0.110
Natural amenity scale	-0.204 (0.135)	-0.169	-0.047	0.172	0.030**	-0.065 (0.062)	-0.084	-0.052	-0.022	0.820
Government Expenditure Variables										
Healthcare (x 100)	-3.060** (1.380)	-0.667	-0.173	0.099	0.000***	-0.548** (0.256)	-0.532	-0.099	0.224	0.000***
Education (x 100)	0.075 (0.096)	-0.035	0.015	0.082	0.250	0.001 (0.017)	-0.067	-0.006	0.005	0.110

Notes: Number of observations is 1,421 for 1990 and 2000. * p < .10; ** p < .05; *** p < .01

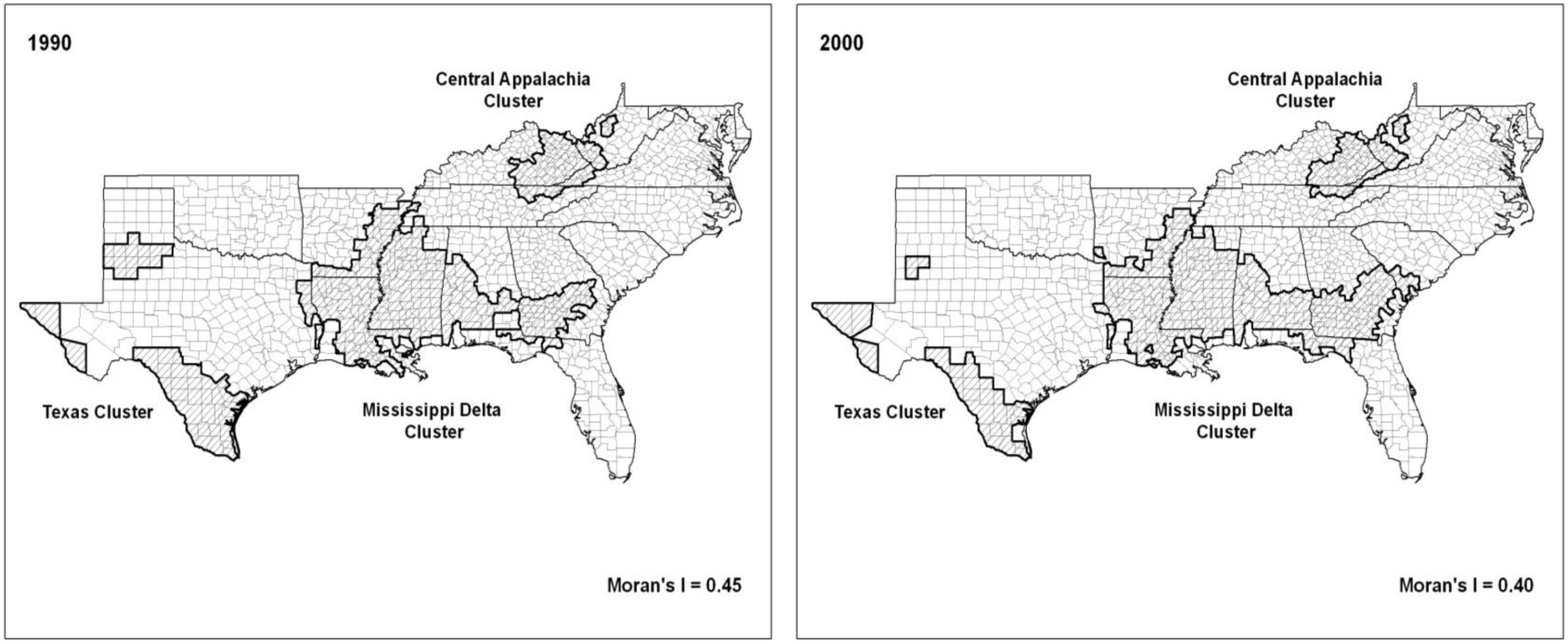

Figure 2-1. Poverty ‘Hot-Spots’ (High-Poverty Counties Surrounded by High-Poverty Counties) in 1990 and 2000 Based on Local Indicators of Spatial Association (LISA) Using the Poverty Rate

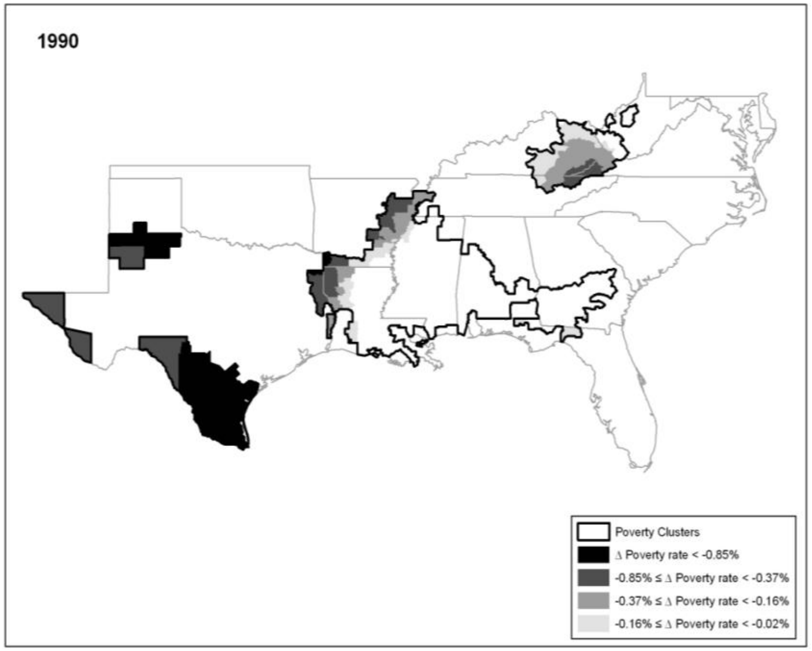

Figure 2-2. Marginal Effect of Per Capita Healthcare Expenditure (Assuming Increase of $100) on the Poverty Rate in 1990

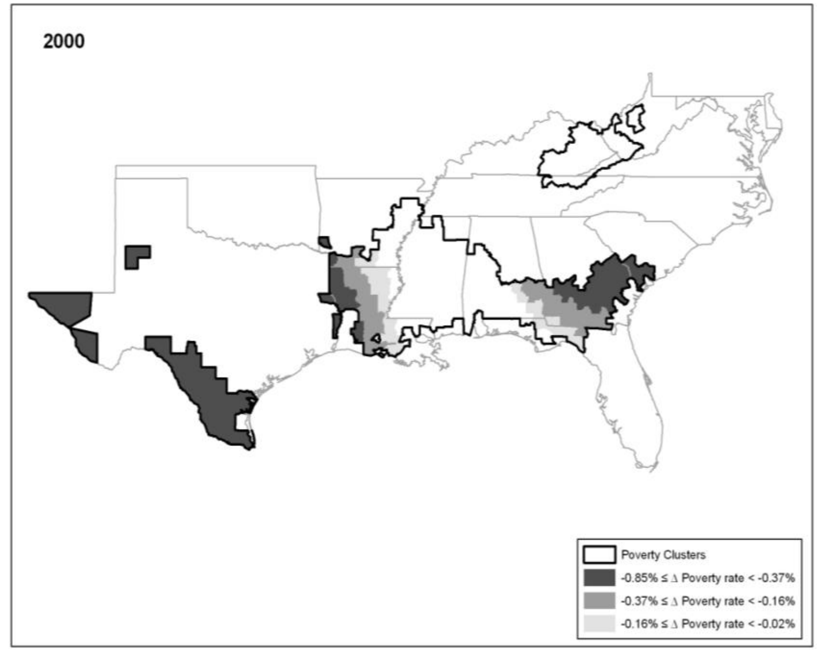

Figure 2-3. Marginal Effect of Per Capita Healthcare Expenditure (Assuming Increase of $100) on the Poverty Rate in 2000

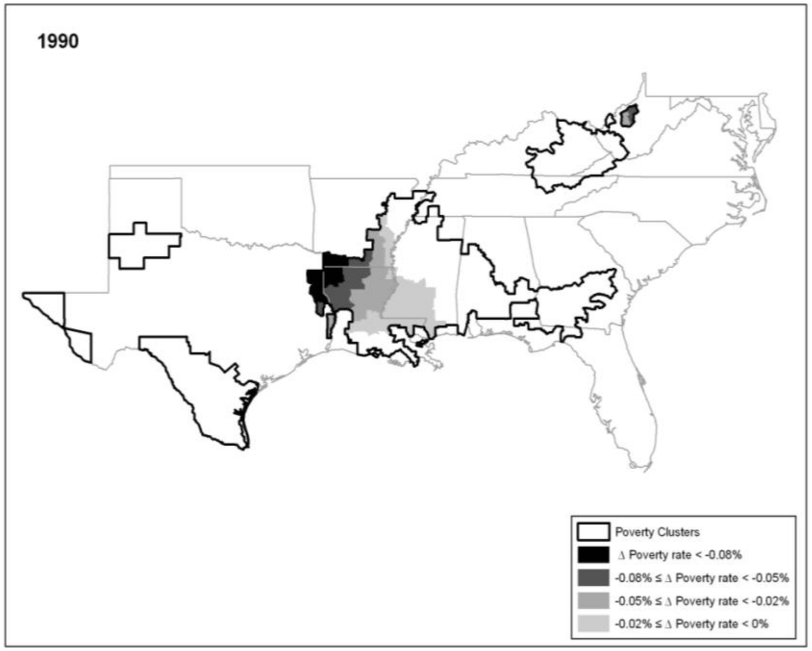

Figure 2-4. Marginal Effect of Per Capita Education Expenditure (Assuming Increase of $100) on the Poverty Rate in 1990

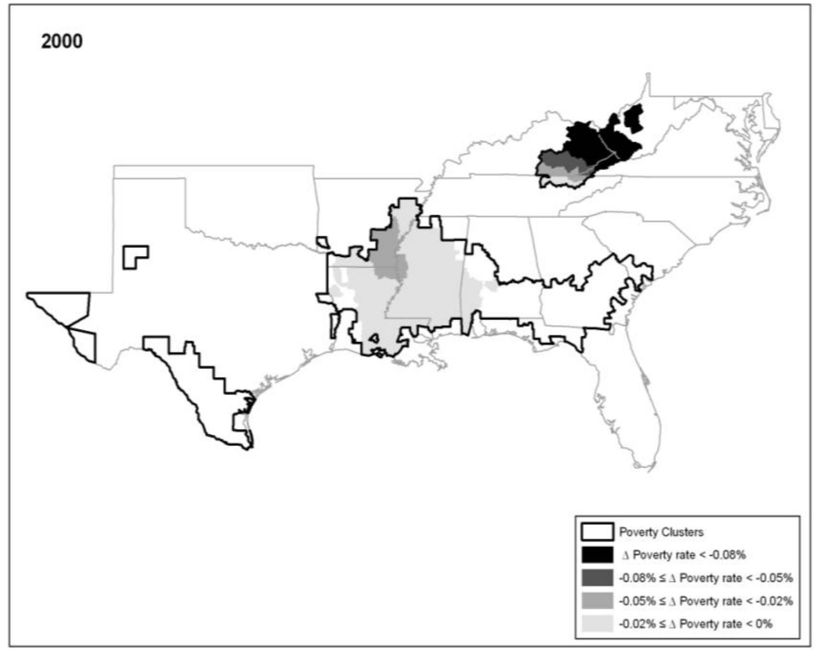

Figure 2-5. Marginal Effect of Per Capita Education Expenditure (Assuming Increase of $100) on the Poverty Rate in 2000

Part 3. Interrelationship between Poverty and Urban Sprawl in the Southern United States

Interrelationship between Poverty and Urban Sprawl in the Southern United States

Abstract: This research disentangles the relationship between urban sprawl and poverty in the Southern United States where urban sprawl has been intensified and high-poverty clusters have existed persistently. Results show that an increase in urban sprawl, as measured by wildland-urban interface (WUI), is associated with an increase in the urban poverty rate. The positive interrelationship between urban poverty and area of sprawl in metro counties supports the theoretical framework that urban poverty is both cause and effect of urban sprawl. With no other direct or indirect association between the poverty rate and urban sprawl, the positive interrelationship is explained by the movement of business centers to the suburban areas by sprawl development and immobility of the poor and the middle and upper class households' preference for the neighborhoods with lower poverty rates.

Introduction

Urban sprawl is reported to be the dominant form of growth in the United States since World War II (Nechyba and Walsh 2004). Urban sprawl is a term used to describe the leapfrogging of development beyond a city's outer boundary into smaller rural settlements (Hanham and Spiker 2005). Cities in the United States have increased in size while per capita housing density has decreased substantially due to sprawling development (Song and Zenou 2009). Urban land area in the contiguous United States quadrupled roughly from 15 million to 60 million acres between 1945 and 2002 (Lubowski et al. 2006). The average population density of urban area declined by 58% between 1920 and 1990 ─ from 6,160 persons per square mile to 2,589 persons per square mile (U.S. Census Bureau 1999).

Urban sprawl is claimed to have both positive and negative impacts. Positive impacts are mostly related to a suburban low-density lifestyle that includes big houses with large yards and close proximity to amenities (Downs 1998). Numerous studies report the negative effects of sprawl associated with economic and environmental impacts. Negative economic impacts comprise traffic congestion, inefficient use of land and resources, and excessive infrastructure to extend water, sewers, and roads to remote areas (Miceli and Sirmans 2007). These activities are believed to be correlated with environmental costs through loss of farmland, green space, and environmentally sensitive areas (Hess et al. 2001; Blais 2000).

A newly emerging consequence of sprawl receiving increased attention from elected officials and anti-sprawl advocates is its effect on urban poverty. It is argued that concentrated urban poverty is both a cause and product of urban sprawl because (1) racial discrimination concentrates poor communities of color in the central city, (2) urban sprawl excludes poor inner city people from educational and economic opportunities that occur in suburban areas, (3) the poor’s immobility without cars, and (4) wealthier people’s willingness to pay to avoid the proximity to the poor because of possible social problems, such as high crime rate and weak public schools (Bullard et al. 1999, Carruthers and Ulfarsson 2003, Colby 2007, Glaeser, Kahn, and Rappaport 2008, Powell 2007, Wiewel and Schaffer 2001,).

All of the previous studies considering the interaction between urban sprawl and urban poverty applied qualitative research methods and few, if any, studies explicitly quantify the relationship. Quantitative estimates of this relationship are essential for policy makers and urban planners to make informed decisions regarding sustainable development and socioeconomic equity. Thus, the objective of this research was to disentangle the relationship between urban sprawl and urban poverty. It was hypothesized that poverty rate of an urban county increases the area of urban sprawl within the county, which further increases the poverty rate.

The Southern United States was selected as a case study because of recent intensified urban sprawl and persistently high-poverty clusters. Half of the top 10 most sprawling major U.S. metro areas are in the South (Smart Growth America 2000; Southeast Watershed Forum 2001). The South is the region with the largest increase in developed area between 1982 and 1997 and the region is also projected to have the most developed area of nearly 19 million hectare by 2025 (Alig, Kline, and Lichtenstein 2004). In 2006, the South had the highest poverty rate at 13.8% while other regions had significantly lower rates, e.g., 11.5% in the Northeast, 11.2% in the Midwest, and 11.6% in the West (DeNavas-Walt, Bernadette, and Smith 2007). The South consists of severe poverty clusters, such as the Mississippi Delta, the Southeastern Cotton Belt, and central Appalachia regions (Partridge and Rickman 2007).

Empirical Model

The analysis proceeds using a simultaneous-equation regression model with endogenous variables of poverty rate and urban sprawl at the county level. The poverty rate equation extends past spatial studies of overall poverty rates, e.g., Madden (1996), Levernier, Patridge, and Rickman (2000), Gundersen and Ziliak (2004), and Patridge and Rickman (2007). The model is characterized by the structural equations:

Poverty equation: $p_t = \alpha_1 s_t + \alpha_2 p_{t-1} + \alpha_3 m s_t + \alpha_4 \mathbf{W} p_{t-1} + \beta_1 \mathbf{X}^p + u_t^p$, (1)

Sprawl equation: $s_t = \gamma_1 p_t + \gamma_2 s_{t-1} + \gamma_3 m p_t + \gamma_3 \mathbf{W} s_{t-1} + \beta_2 \mathbf{X}^s + u_t^s$, (2)

where *p* is poverty rate; *s* is the area of urban sprawl; *m* is metro dummy variable indicating whether the county is within a metropolitan statistical area; *t* and *t-1* are 2000 and 1990, respectively; $\mathbf{W}$ is an $n \times n$ contiguity matrix with diagonal elements of 0 and off-diagonal elements of 1 for all counties that are contiguous to own counties; **X** is a vector of other exogenous variables; β_1 and β_2 are conformable parameter vectors; $\alpha_1, \alpha_2, \alpha_3, \gamma_1, \gamma_2, \gamma_3$ are scalar parameters; u_t^p and u_t^s are error terms.

The poverty rate of own county in an earlier period p_{t-1} was included in the poverty equation to account for adjustment of partial disequilibrium levels of poverty rates caused by barriers to mobility, e.g., housing market constraints, transportation costs, migration costs, and imperfect information (Patridge and Rickman 2007). The influence of poverty rate in neighboring counties in an earlier time period was captured by $\mathbf{W}p_{t-1}$. An interaction term between metro dummy variable and sprawl measure ms_t captures the effect of urban sprawl on urban poverty after netting the confounding effect of sprawl and metropolitan area.

The sprawl measure of own county in an earlier period s_{t-1} was included in the sprawl equation to capture the time-lagged effect of spatial development pattern. The effect of urban sprawl in neighboring counties in an earlier time period was captured by $\mathbf{W}s_{t-1}$. An interaction term between metro dummy variable and poverty mp_t captures urban poverty on urban sprawl after netting the confounding effect of poverty and metropolitan area.

The vector of exogenous variables in the poverty equation $\mathbf{X}^p$ includes socioeconomic and demographic characteristics. Government spending on healthcare and education are also included to capture their contribution of economic growth (Beale 2004; Bhargava et al. 2001; Bloom and Canning 2000; Fan, Zhang, and Zhang 2002; Jung and Theorbecke 2003; Probst et al. 2004; Triest 1997; Waidmann and Rajan 2000; Williams 2002). The vector of exogenous variables in the sprawl equation $\mathbf{X}^s$ includes socioeconomic, demographic, and environmental characteristics.

Two-stage least squares (2SLS) was used to estimate the systems of equations in two stages. In the first stage, the following reduced-form equations were estimated:

$$p_t = \Pi_1' \mathbf{X_1} + v_1 , \quad (3)$$

$$s_t = \Pi_2' \mathbf{X_1} + v_2 , \quad (4)$$

where $\mathbf{X_1}$ is a vector of exogenous variables in the systems of simultaneous equations, given the normality of u_t^p and u_t^s, the covariance matrix of error terms υ_1 and υ_2 is:

$$\Omega = \begin{bmatrix} \sigma_1^2 & 0 \\ 0 & \sigma_2^2 \end{bmatrix} \quad (5)$$

The elements of the covariance matrix Ω in equation (5) and the reduced-form parameter vectors are all functions of the structural parameters in equations (1) and (2).

In the second stage, the equations (1) and (2) were re-estimated using ordinary least squares (OLS) with the predicted values from the reduced-form equations (3) and (4), respectively. Because the standard errors for each model in the second stage are based on predicted values, the standard errors are corrected based on variance-covariance matrices. The corrected standard errors for the poverty equation, for example, were obtained by

$$V_e(\prod_1') = \hat{\sigma}^2[\mathbf{X_2}'\mathbf{X_2}]^{-1} \tag{6}$$

where $\hat{\sigma}^2 = v_1'v_1/(N - K_1)$ in which N is the number of observations; K_1 is the number of variables in the vector of exogenous variables $\mathbf{X_2}$ in the poverty equation including p_{t-1}, $\mathbf{W}p_{t-1}$, and $\mathbf{X}^p$; and $v_1 = p_t - \Pi_1'\mathbf{X_1}$ (Wooldridge 2002, p 100). The corrected standard errors for the sprawl equation were obtained using the same procedure.

Study Area and Data Description

This study focuses on 1,423 counties in 16 states in the U.S. Census Bureau's South Division. The states are Texas, Oklahoma, Arkansas, Louisiana, Mississippi, Alabama, Tennessee, Georgia, South Carolina, North Carolina, Kentucky, Florida, Maryland, Delaware, Virginia, and West Virginia. After removing observations with missing data, the number of counties used was 1,417.

The study employs six county-level datasets in a geographical information system (GIS): (a) data on area of wildland-urban interface (WUI) for 2000 from SILVIS Lab (2005), (b) data on area containing mixed rural-urban housing for 1990 and demographic and industry structural data for 2000 from the U.S. Census Bureau (2001), (d) employment data for 2000 from the Bureau of Labor Statistics, U.S. Department of Labor (2001), (e) data on employment of art occupations, natural amenity scale, and classification of metro and non-metro counties from the Economic Research Service, U.S. Department of Agriculture (ERS, USDA, 2007), and (f) county government expenditure data for 1997 from the U.S. Census Bureau Government Finances.

The urban sprawl in 2000 was measured by wildland-urban interface (WUI) that was defined by SILVIS Lab (2005). The WUI is composed of both interface and intermix communities by the standards of 1) a minimum density of one structure per 40 acres for both communities and 2) continuous vegetation of more than 50% wildland vegetation for intermix and areas with housing in the vicinity of contiguous vegetation, within 1.5 mile of an area that is more than 75% vegetated, and has less than 50% vegetation for interface (Radeloff et al. 2005; SILVIS Lab 2005). The county-level distribution of WUI is mapped in Figure 3-1. All states in the Southern United States contain WUI area. Particularly, the southern Appalachians, northern Florida, and coastal areas of the Northeast have a higher percentage of WUI area than the rest of the regions. WUI is widespread not only in metropolitan areas, e.g., Atlanta, GA and Greensboro, NC, but also in rural areas (Cho and Newman 2005; Radeloff et al. 2005). The urban sprawl in 1990 was measured by the sum of areas of mixed rural-urban housing at the census-block group level using the ArcMap 9.2 software. This measure was used to serve as a proxy for the WUI because the WUI was not available for 1990.

The classification of metro and non-metro counties data from the ERS were defined by the Office of Management and Budget (OMB 2003). The metro counties are identified as (1) central counties with one or more urbanized areas, and (2) outlying counties that are economically tied to the core counties as measured by work commuting. Outlying counties are included if 25% of workers living in the county commute to the central counties, or if 25% of the employment in the county consists of workers coming out from the central counties. The non-metro counties are outside the boundaries of metro areas (ERS, USDA 2007).

The individual poverty rate, defined by the U.S. Census Bureau, was used in this study. Following the Office of Management and Budget's Statistical Policy Directive 14, the Census

Bureau uses a set of income thresholds that vary by family size and composition for the determination of the people in poverty (U.S. Census Bureau 2008). Every individual in a family is considered in poverty, if a family's total income is less than the income threshold determined by family size and composition. Then, the individual poverty rate is calculated dividing the number of individuals whose families are in poverty by total number of population in a county. Variable names, definitions, expected signs and descriptive statistics for the variables used in the simultaneous-equation model are presented in Table 1.

Empirical Results

Model Specification

The null hypothesis that all slope parameters are zero in the simultaneous-equation model is rejected for both poverty and sprawl equations with F-Stat values of 576 and 55, respectively. The R^2s are 0.90 and 0.29 for the poverty and sprawl equations, respectively. The results of the both regressions are shown in Table 2. The term "significant" refers to the standard significance at the level of 5%, henceforth, and the discussion below is limited to the significant variables.

Control Variables in the Poverty Equation

The positive and significant coefficient of the time lag of own-poverty rate indicates the existence of the slow disequilibrium adjustment of the poverty rate to the socioeconomic change. The positive and significant coefficient of the time lag of poverty rate in the surrounding counties implies spatial and temporal spillover effect. A 1 percent increase of the poverty rate in 1990 has the poverty-increasing effect of 0.45 percent in 2000 in own county, while the same increase of the poverty rate in 1990 in the surrounding counties increases the own-poverty rate in 2000 by 0.05 percent.

The positive and significant coefficient for the percentage of Asia-Pacific population indicates more poverty in the counties with a higher percentage of Asia-Pacific population, all else equal. The rate of persons 25-65 years of age shows a negative and significant effect on the poverty rate, indicating that the counties with higher proportion of population between age 25 and 65 have lower poverty rates. This result supports the finding by Rupasingha and Goetz (2007) that higher portion of economically active demographic group lowers poverty rate.

The coefficient of the ratio of female-headed household is positive and significant, indicating that counties with a higher proportion of female-headed families have higher poverty rate. This relationship has been found to be associated with higher average income for men than for women, cost of child care, and early investment of women in family and childbearing (Blank and Hanratty 1992; Levernier, Partridge, and Rickman 2000; Schiller 1995; Snyder and McLaughlin 2004; Wilson 1988).

An increase in percentage of population 25 years or older with at least some college education by 1 percent decreases the poverty rate by 0.11 percent. This finding highlights the importance of education in lowering poverty rate. An increase in rate of families with 3 or more workers by 1% decreases the poverty rate by 0.39 percent. An increase in unemployment rate by 1% increase the poverty rate by 0.31%. The results of age composition, female-headed households, education-related variable, families that have 3 or more workers, and unemployment variables show that having economically active and capable population and maintaining employment status are important factors in poverty alleviation.

The coefficients for the industrial composition variables of percentages of manufacturing, transportation, and finance and insurance are all negative and significant. These imply that the employments in manufacturing, transportation, and finance and insurance sectors have poverty-reducing effects. The average travel time to work has a negative and significant effect on poverty rate, indicating concentrates of poor communities in the central city (Manning 2003). The negative and significant effect of the vacancy rate on the poverty rate implies that higher vacancy rate is associated with a lower poverty rate. This could be explained by the fact that vacancy rate is highly correlated with recreational and second homes because it includes housing units that are not vacant in the southern United States (Cho et al. 2009, U.S. Census Bureau 2001).

Control Variables in the Sprawl Equation

The positive and significant coefficient of the time lag of own-sprawl implies the persistency of sprawl. The negative and significant coefficient of the time lag of sprawl in the surrounding counties implies that sprawl in 1990 in the surrounding counties absorbs own-sprawl in 2000. An increase in the area of sprawl in 1990 by 1 percent increases the area of own-sprawl in 2000 by 0.1 percent while the same increase in the surrounding counties in 1990 decreases the poverty rate of a county by 0.31 percent.

The variable of the proportion of population 25 and 65 is positive and significant in the sprawl equation, all else equal. This indicates that economically active population tends to live in counties with a greater level of sprawl. The population in this age group might have a stronger preference for houses in suburban areas with sprawling development patterns. The negative and significant effect of the vacancy rate implies that counties with lower vacancy rate are more likely to have a greater level of sprawl, all else equal. This suggests that the counties with better housing market conditions, reflected by lower vacancy rate, tend to have a greater level of sprawl (Dowall and Landis, 1982).

The positive and significant effect of housing density in the sprawl equation indicates that the counties with higher housing density tend to have a greater level of sprawl, all else equal.

Housing density is one of the major causes of fragmentation (Theobald, Miller, and Hobbs 1997; Swenson and Franklin 2000), partly because of a new road construction designed to access houses (Hawbaker et al. 2005). This fragmentation caused by a new construction of roads and houses is reflected in a greater level of WUI area. The negative and significant effect of the median house age shows that the counties with newer houses tend to have a greater level of sprawl, all else equal. This suggests that sprawl is associated with more recent housing development.

Interrelationship between Poverty and Urban Sprawl

The interaction term between the sprawl and metro dummy variable is 0.02 and significant in the poverty equation. This indicates that an increase in area of sprawl by 1% increases poverty rate in metro counties by 0.02%, ceteris paribus. In the sprawl equation, the coefficient of poverty is -0.74 and significant while the interaction term between the poverty rate and metro dummy variable is 0.29 and significant. This indicates that an increase in poverty rate by 1% decreases the area of sprawl by 0.74% in both metro and non-metro counties while the same increase in poverty rate increases area of sprawl in metro counties by 0.29%, ceteris paribus. This finding supports the hypothesis concentrated urban poverty is both a cause and product of urban sprawl.

The greater level of sprawl on the higher poverty rate in metro areas has been explained in the literature. Garreau (1991) discussed the movement of a population to the suburban areas, following the departure of jobs from the inner city as a result of housing sprawl. Also, Teitz and Chapple (1998) and Rupasingha, Goetz, and Freshwater (2002) pointed out the growing unemployment problem of the inner city residents because of growing costs to access to jobs resulting from the movement of firms to the suburbs and racial polarization. For example, 25%

of the offices in the United States were located in suburbs in 1970, but it changed to 60% in 1990 (Pierce 1993).

Typically, the housing units developed in suburbs have more stringent development requirements, e.g., limitations for multifamily housing and minimum lot size. The more stringent development requirements are found to increase housing prices so that most poor households cannot afford the suburban housings (Downs 1998; Green 1999; Quigley and Raphael 2005; Glaeser, Schuetz, and Ward 2006). As a result, a higher concentration of the poor in the inner city and a greater level of sprawl causes further racial segregation (Massey 1990; Oliver and Shapiro 1995; Coulton et al. 1995). Because many jobs in suburban areas are not reachable through public transit systems, the poor who live in the inner city and do not have a car cannot access those jobs in the suburban areas. Wiewel, Persky, and Sendzik (1999) described this causal relationship as the cost of inner-city poor for the benefit of suburban growth and criticized inequities in the distribution of its benefits and costs of urban sprawl.

The higher poverty rate on the greater level of sprawl in metro counties can be explained by the middle and upper class households' preference for the neighborhoods with lower poverty rates that are associated with less social problems, e.g., high crime rate and failing educational system (Glaeser, Kahn, and Rappaport 2008; Mills and Lubuele 1997; Powell 2007).

Conclusions

There have been a few studies using a qualitative research method to investigate the relationship between urban sprawl and poverty but no quantitative research has been done. The objective of this research was to estimate this relationship quantitatively in the Southern United States, where urban sprawl has been intensified and high-poverty clusters have existed persistently. A simultaneous-equations model with continuous endogenous variables of poverty and percentage of urban sprawl, as measured by wildland-urban interface (WUI) was used to evaluate the interrelationship.

Results show that an increase in urban sprawl is associated with an increase in the urban poverty. The positive interrelationship between the poverty rate and area of sprawl in metro counties supports the theoretical framework that urban poverty is both cause and product of urban sprawl. With no other direct or indirect association between the poverty rate and urban sprawl, the positive interrelationship is explained by the movement of business centers to the suburban areas by sprawl development and immobility of the poor and the middle and upper class households' preference for the neighborhoods with lower poverty rates. This finding implies the need for reframing the urban planning policy, e.g., "smart growth" plan, in the interests of sustainable development for the preservation of farmland and other critical environmental areas and also poverty alleviation strategy.

Despite the merit of using percentage of wildland-urban interface (WUI) at the county level as a sprawl measure, it is not a comprehensive gauge accounting all dimensions of sprawl. The measure based on the WUI, composed of both interface and intermix communities by the standards of minimum density, contiguity, and intermix used in this study, demonstrated an association between sprawl and poverty. However, the same association may or may not exist if different types of sprawl measures were to be used. For example, an urban-sprawl measure that is based on street connectivity, the degree to which blocks are small and walking between locations is possible, may lead to different results. This kind of urban-sprawl measure requires more micro-level data than the county level data used in this study.

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Appendix

Table 3-1. Variable Names, Descriptions, and Statistics

Variable	Hypothesized sign of the effect on		Description	Mean (S.D)
	Poverty	WUI		
Endogenous Variables				
Individual poverty rate		+	Percentage of individuals whose families' incomes are below poverty thresholds based on family size and number of children within the family and age of the householder over total population except institutionalized people, people in military group quarters, people living in college dormitories, and unrelated individuals under 15 years old (%)	16.93 (6.67)
Wildland-urban interface	+		Rate of composed area of both interface and intermix communities by the standards of 1) a minimum density of one structure per 40 acres for both communities and 2) continuous vegetation of more than 50% wildland vegetation for intermix and areas with housing in the vicinity of contiguous vegetation, within 1.5 mile of an area that is more than 75% vegetated, and has less than 50% vegetation for interface over total land area (%)	22.90 (20.19)
Lag Variables				
Time lag of own-poverty rate	+		Individual poverty rate of 1990	20.06 (8.45)
Time lag of surrounding-county poverty rate	+		Average of surrounding counties' individual poverty rate in 1990	20.03 (6.92)
Time lag of own-county interface		+	Percentage of CBG area with mixed urban and rural houses in each county over total area in time period of 1990 from the U.S Census Bureau	17.12 (18.73)
Time lag of surrounding-county interface		+	Average of surrounding counties' percentage of interface area in 1990	17.44 (9.95)
Interaction Variables				

Metro x WUI	+		The percentage of the WUI area is multiplied by the metro dummy variable	12.60 (21.22)
Metro x Individual poverty rate		+	The individual poverty rate is multiplied by the metro dummy variable	5.16 (7.38)
Demographic Variables				
Native American	+		Rate of Native American over total population (%)	1.01 (3.11)
Asia–Pacific	+		Rate of people from Asia – Pacific, who have origins in any of the original peoples of the Far East, Southeast Asia, the Indian subcontinent, Hawaii, Guam, Samoa, or other Pacific Islands over total population (%)	0.62 (0.94)
Age 25-65 years	+	+	Rate of persons 25-65 years of age over total population (%)	25.26 (3.15)
Female head	+		Rate of female headed family with no husband present over total number of families (%)	16.94 (6.10)
People completed at least some college	–	+	Rate of people with some college or more education over population of 25 years plus (%)	35.85 (9.99)
Family with 3 or more workers	–		Rate of family that has 3 or more workers over total families (%)	9.28 (2.12)
Socioeconomic Variables				
Unemployment rate	+		Rate of unemployed workers in age 16 plus (%)	4.62 (1.61)
Agriculture	+		Rate of agriculture, forestry, and fisheries employment over total employment (%)	4.54 (4.67)
Manufacturing	–		Rate of manufacturing, mining, construction employment over total employment (%)	27.38 (8.50)
Transportation	–		Rate of transportation, communications, and other public utility employment over total employment (%)	6.93 (3.75)
Wholesale and retail trade	–		Rate of wholesale and retail trade employment over total employment (%)	13.28 (3.90)

Finance and insurance	–		Rate of finance, insurance, and real estate employment over total employment (%)	4.43 (1.73)
Arts	–		Rate of arts class employment over total employment (%)	0.61 (0.36)
Average travel time	+	–	Average travel time to work (minutes)	25.96 (5.21)
Vacancy	+	–	Ratio of vacant houses to total houses (%)	13.78 (7.19)
Housing density		–	Number of houses per 100 acre	7.77 (14.93)
Median house age		–	Median age of house (year)	25.21 (6.53)
Environmental Variables				
Metro dummy			Metro areas are identified as (1) central counties with one or more urbanized areas, and (2) outlying counties that are economically tied to the core counties as measured by work commuting. Outlying counties are included if 25% of workers living in the county commute to the central counties, or if 25% of the employment in the county consists of workers coming out from the central counties. Metro is a dummy variable representing whether a county is metro (1) or not (0).	0.39 (0.49)
Natural amenity scale	–	+	Natural amenity scale, which combines six measures of warm winter, winter sun, temperate summer, low summer humidity, topographic variation, and water area, ranges from -6.4 low amenities being to 11.2, negative being and positive being high amenities	0.36 (1.36)
Government Expenditure Variables				
Healthcare	–		Expenditure on health and hospitals in 1997, $/capita	209.53 (342.47)
Education	–		Expenditure on schools, colleges, educational institutions, and educational programs in 1997, $/capita	1078.29 (515.02)

Note: The data are at the county level and for 2000 unless indicated differently in the table.

Table 3-2. Parameter Estimates of the Simultaneous-Equation Model

Variables	Poverty rate	Wildland-urban interface
Endogenous Variables		
Individual poverty rate		-0.738***
		(0.105)
Wildland-urban interface	-0.017	
	(0.012)	
Lag Variables		
Time lag of own-poverty rate	0.446***	
	(0.019)	
Time lag of surrounding-county poverty rate	0.049***	
	(0.019)	
Time lag of own-county interface		0.100***
		(0.031)
Time lag of surrounding-county interface		-0.310***
		(0.055)
Interaction Variables		
Metro x WUI	0.018**	
	(0.008)	
Metro x Individual poverty rate		0.291***
		(0.070)
Demographic Variables		
Native American	0.022	
	(0.020)	
Asian – Pacific	0.368***	
	(0.073)	
Age 25-65 years	-0.157***	0.894***
	(0.024)	(0.190)
Female head	0.177***	
	(0.013)	
People completed at least some college	-0.107***	-0.070
	(0.011)	(0.060)
Family with 3 or more Workers	-0.385***	
	(0.036)	
Economic and Structural Variables		
Unemployment rate	0.310***	
	(0.053)	
Agriculture	0.039	
	(0.021)	
Manufacturing	-0.046***	
	(0.011)	
Transportation	-0.105***	
	(0.028)	
Wholesale and retail trade	0.025	

	(0.024)	
Finance and insurance	-0.210***	
	(0.051)	
Arts	-0.263	
	(0.209)	
Average travel time	-0.042***	-0.029
	(0.013)	(0.115)
Vacancy	-0.024**	-0.549***
	(0.011)	(0.078)
Housing density		0.066***
		(0.014)
Median house age		-0.538***
		(0.084)
Environmental Variables		
Natural amenity scale	-0.007	0.402
	(0.049)	(0.405)
Government Expenditure Variables		
Healthcare (x 100)	0.018	
	(0.018)	
Education (x 100)	0.004	
	(0.012)	

Note: The asterisks represent p value. * $p < .10$; ** $p < .05$; *** $p < .01$

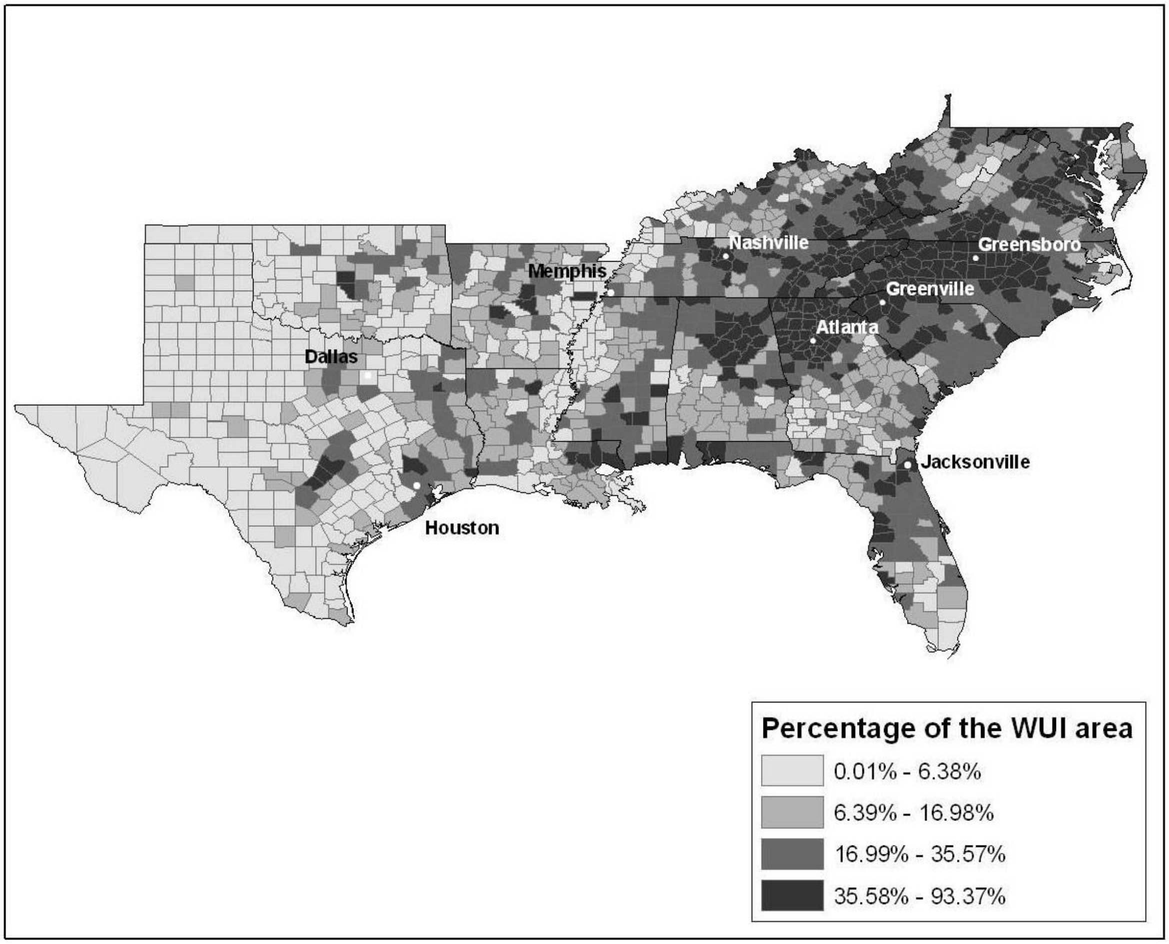

Figure 3-1. The Percentage of the Wildland-Urban Interface (WUI) Area at the County Level in the Southern United States

Part 4. Summary

Summary

This thesis deals with two related topics under the theme of “Analyzing Poverty in the Southern United States”. The first part contributes to the growing literature on the effects of government expenditures on poverty alleviation in two new ways. First, using county data for the Southern United States, we examine how the effects of government expenditures on poverty have changed over time and compare these changes spatially. Second, we use spatial cluster analysis and spatial regression to identify spatial clusters of poverty and to examine the marginal effects of government expenditures on poverty alleviation in each of the identified poverty clusters.

The implications drawn from the marginal effects of government expenditures on poverty alleviation will likely interest policymakers and planners as these outputs will be a systematic guideline for the place-based poverty reduction policies for the counties with persistent poverty. For example, increasing government expenditure on healthcare using the stimulus packages through the American Recovery and Reinvestment Act of 2009 may need to be considered as a strategy for the reduction of the poverty rate in the counties in the Texas cluster because of its consistent higher marginal effect on reducing the poverty rate over the periods.

Results found from the second part show that an increase in urban sprawl is associated with an increase in the urban poverty. The positive interrelationship between the poverty rate and area of sprawl in metro counties supports the theoretical framework that urban poverty is both cause and product of urban sprawl. With no other direct or indirect association between the poverty rate and urban sprawl, the positive interrelationship is explained by the movement of business centers to the suburban areas by sprawl development and immobility of the poor and the middle and upper class households’ preference for the neighborhoods with lower poverty rates. This finding implies the need for reframing the urban planning policy, e.g., “smart growth” plan, in the interests of sustainable development for the preservation of farmland and other critical environmental areas and also poverty alleviation strategy.

Vita

Suhyun Jung was born in Seoul, Korea on March 25, 1983, to Joohee Jung and Jungrae Kim. He graduated from Korea University in February, 2007, where he obtained a B.S. degree in Food and Resource Economics. Later, he attended the University of Tennessee, Knoxville, where he earned a M.S. degree in Agricultural Economics in August, 2009