IMPACT OF AUTO INDUSTRY AND ITS SPATIAL SPILLOVER EFFECT ON ALABAMA'S ECONOMIC GROWTH AND DEVELOPMENT

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Abstract

This paper studies the effect of automobile production on Alabama's economy. A spatial panel simultaneous equations model was developed using county data. The empirical findings suggest that automobile production increase the employment growth and per capita income growth of the counties which are closer to the automobile plant while other things equal, but reduce the population growth with closer distance to the automobile plant while other things equal. This may be due to the competition between automotive suppliers clustered around the automobile plant and real estate builders for land and other infrastructure facilities. This study also finds that jobs follow people and also people follow jobs. The existence of spatial lag indicates that growth of population; employment and per capita income are not only dependent on the characteristics of that county, but also on those of its neighbors. These interdependences provide the need of economic development policy coordination among the counties.

Keywords: Spatial effect, Automobile production, Spatial panel simultaneous equations model, Generalized Spatial Three-Stage Least Squares

JEL classification: R300, O120, O150

1. Introduction

Strategies to improve living conditions in the rural South are receiving increased attention (Wimberley et al, 2002). Local economic development becomes a major concern of state policy makers and local government (Isserman 1994). Since the Alabama state government has expanded economic incentives to attract auto industry to create additional employment and generate personal income, large auto mobile firms and its input suppliers migrated into several Alabama counties. The net impact of these industries on local employment, income and living standard become important for state policy makers and local leaders. Prior to 1997, Alabama produced not a single automobile. Due to the aggressive recruiting efforts by the state, auto production and its ancillary industries account for over 16% of the state's employment with an annual payroll of some $5.2 billion (Ahn 2005; AAMA 2008). In addition to providing jobs to offset losses in mining, agriculture, and textiles, the jobs are better paying: in 2004, the average weekly wage for auto manufacturing workers in the state was $ 1,318 compared to $761 for all manufacturing and $643 for all industries (EDPA 2008). Jobs in 40 of the state's 67 counties now are tied directly or indirectly to auto manufacturing (AAMA 2008).

Despite its growing importance, little scholarly work has been done to assess the impact of the auto industry on the state's economy or living standards. Gadzey et al. (2003) have estimated an econometric model, using 30 years of county – level data to determine whether state assistance to private firms increased the real value of manufacturing output. Results based on data through 1999 showed the subsidy effect to be positive as expected, and statistically significant. However, the measured effect was too small for the subsidies to be remunerative. This finding is important because it affirms charges of critics (Buchholz 2008) that the incentive packages given to auto companies were excessive. (Mercedes-Benz, Honda, and Hyundai each received incentive packages worth between $100 and $300 million (Ahn

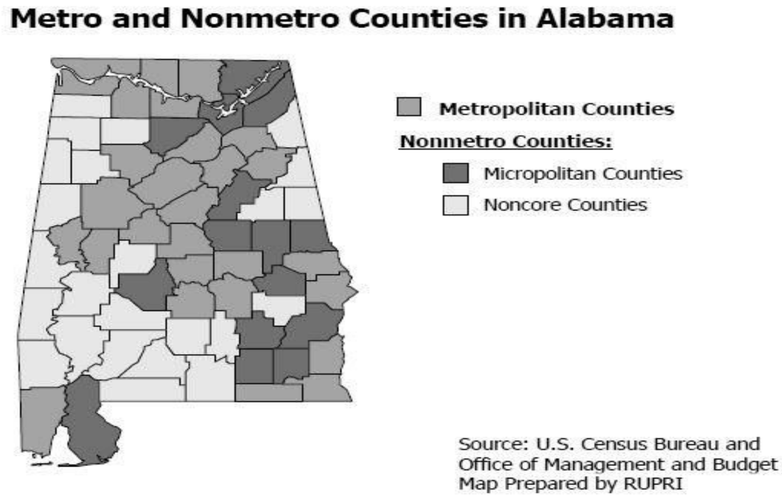
2005).) More generally, it raises questions about whether industrial policies to lure industry are a cost effective way to improve the living standards of rural residents, a major focus on this research.

Gadzey et al.'s findings are consistent with the substitution view of industrial subsidies (Wren 1996). This analysis terminates in 1999, and thus covers only two full years of auto production. The ripple effects of the industrial production were not considered in this analysis. Ripple effects of particular interest to students of rural development include employment, population, and income growth (Duffy-Deno 1998; Deller et al., 2001: Kim et al., 2005; Saint Onge et al., 2007; Hammond and Thompson, 2008; and Wu and Gopinath, 2008). Enlarging the analysis to include income, population, and employment effects, as proposed in this research, provides a more complete picture of the industry's impact on the state. The subsidy is measured as transfers of government funds to counties as recorded by the US Census Bureau and thus is non-specific to the auto industry. To circumvent this problem, and to provide a direct measure of impact, we propose using a simple count of auto production as the causal variable. Between 1998 and 2007 car and light truck production in the state increased from 68,800 to 739,019 units (EDPA, 2008), which provides sufficient variation to measure the impacts reliably using variable.

The purpose of the research is to determine the economic impact of automobile production on income, population, and employment growth in the Alabama's counties. This research improves on existing research in many ways. First, a simultaneous model permits us to pick up feedback effects among population, employment and per capita income. Second, we include the initial level of employment, per capita income and population, which allow us to test whether the each equation in the system converge with the respective to dependent variable. Third, we are able to estimate the differential impact of automobile production on income, population and employment growth in the distressed black belt counties by introducing interaction term of automobile production and these counties. Finally, we incorporate spatial components to capture the role of population, employment and per capita income of neighboring counties. A major goal of this research is to determine whether distressed counties in the state's Black Belt benefited from the auto boom. Of the 17 counties in the Black Belt, Governor Riley's Black Belt Action Committee has identified 12 as "distressed" as follows: Bullock, Choctaw, Dallas, Greene, Hale, Lowndes, Macon, Marengo, Perry, Pickens, Sumter, and Wilcox.

A recent study by Kinnucan et al. (2006) suggests industrial policies aimed at increasing employment or family income could have important effects on rural education. In Carlino and Mills' (1987) classic study, it was speculated that since "jobs follow people," in slow growing or declining regions, "public funds may be better spent on educating the resident population than used to lure employment". A purpose of this research is to shed light on the validity of this hypothesis by examining the extent to which growth in the auto industry benefited the state's slow growing or declining region, namely the Black Belt. Based on county Core Based Statistical Area classifications, figure 1 shows that there are 28 metropolitan counties, 15 micropolitan counties, and 24 noncore counties in Alabama. Approximately seventy one percent of Alabama's population resides in metropolitan counties, 18.4 percent resides in micropolitan counties, and the remaining 10.8 percent live in noncore counties (RUPRI, 2007). In many Alabama counties, the African American population accounts for a significant portion of total population. African Americans are majority population in eleven counties in Alabama.

Figure 1: Metro and Non-Metropolitan Counties in Alabama



The greatest spillover benefit of automobile plant in Alabama is the movement of input suppliers to Alabama counties. These input suppliers cluster around automobile plants and create additional employment and generate personal income. The multiplier effects of this income through consumer spending generate additional employment and income. One of the external economies of an automobile plant is the increasing attractiveness of Alabama to other automobile firms. One of the major advantages of industry clustering is the potential for labor pooling (Krugman, 1991). Workers usually locate near to the place where there are several firms and high demand for their skills because if they lose job in one firm there may be another firm to hire them. Firms also want a pool of skilled workers to hire easily more labor during high demand for their products. Another reason for the intra and inter industry clustering is the technological spillovers benefits (Romer, 1986: Krugman, 1991). Financial institutions and supporting service firms moves near to these industries and creates additional employment and personal income.

There might be negative spillovers of automobile firms on other industries. These large automobile firms increase the market demand for inputs and then increase the wages, rents and price of other inputs. These increased input costs deter new firms to migrate to and expansion of existing firms in the counties where these large firms locate. The congestion of public services and infrastructure due to the large firms and population increase is another reason for deterring new firms and expansion of existing firms. This congestion may force the local government to raise the tax rates and then deter the entering of new potential firms.

2. Methodology and Data

The point of departure in this analysis is the regional growth model estimated by Deller et al. (2001). This model extends the classic two-equation country growth model of Carlino and Mills (1987) to include income as an additional endogenous variable. It is based upon the assumption that utility-maximizing households migrate in search of utility derived from consumption of market and non-market goods, and profit maximizing firms become mobile when looking for regions that have lower production costs or higher market demand. Importantly, the extended model retains the essential character of the CM model by permitting household and firm location choices to be interdependent. The basic specification is a simultaneous-equation system of the form:

$$POP_t^* = f_1\ \left[(PCI_t^*, (I\otimes W)\ PCI_t^*), (EMP_t^*,\ (I\otimes W)\ EMP_t^*),\ (I\otimes W)POP_t^*,\ A_{t-i},\ BA_{t-i}, \middle| X_{t-i}^{pop}\right] \quad (1)$$

$$PCI_t^* = f_2\ \left[(POP_t^*, (I\otimes W)\ POP_t^*), (EMP_t^*,\ (I\otimes W)\ EMP_t^*),\ (I\otimes W)PCI_t^*,\ A_{t-i},\ BA_{t-i}, \middle| X_{t-i}^{pci}\right] \quad (2)$$

$$EMP_t^* = f_3\ \left[(POP_t^*, (I\otimes W)\ POP_t^*), (PCI_t^*,\ (I\otimes W)\ PCI_t^*),\ (I\otimes W)EMP_t^*,\ A_{t-i},\ BA_{t-i}, \middle| X_{t-i}^{emp}\right] \quad (3)$$

The equilibrium levels of population, per capita income and employment are assumed to be functions of the equilibrium values of the endogenous variables included in right hand and their spatial lags, and the vectors of the additional exogenous variables. Where, POP_t^*, PCI_t^*, and EMP_t^* are vectors of dimension NT x 1 of the equilibrium levels of population, per capita income and employment respectively; t denotes time. **I** is an identity matrix of dimension T and, W is a row standardized N x N spatial weights matrix with zero diagonal values. Each element of this spatial weights matrix, w_{ij} , represents a measure of proximity between observation i and observation j. Based on the queen based adjacency criteria, w_{ij} equal to $1/k_i$, where k_i is the number of nonzero elements in row i, if i and j are adjacent, and zero otherwise. Therefore, and $(I \otimes W)PCI_t^*$ stand for the equilibrium values of neighboring counties' effect . A_{t-i} is vector of dimension NT x 1 of automobile production. BA_{t-i} is the interaction term of the distressed black belt county and automobile production. Where *i* is 7 years. The matrices of additional exogenous variables that are included in the population, per capita income and employment equations are given by X_{t-i}^{pop} , X_{t-i}^{pci}, and X_{t-i}^{emp} respectively. These additional exogenous variables are included in the equations to control their effects on the dependent variables. This controlling makes estimates on the relationship between the variables we are interested more precise. Mills and Price (1984) who suggest that equilibrium employment, population and median household income are likely to adjust to their equilibrium values with a substantial lag. A lagged adjustment is introduced into our model. This partial-adjustment process replaced unobservable equilibrium then model takes the general form as follows:

$$\begin{aligned} POPG_t &= \alpha_1 + \beta_{11}EMPG_t + \beta_{12}PCIG_t + \lambda_{11}\big((I \otimes W)POPG_t\big) + \lambda_{12}(I \otimes W)PCIG_t \\ &\quad + \lambda_{13}(I \otimes W)EMPG_t + \delta_1 lnA_{t-i}^{pop} + \theta_1 BA_{t-i}^{pop} + \textstyle\sum_{k=1}^{K_1} \gamma_{1k} \ln(X_{t-i,k}^{pop}) \\ &\quad - \eta_{11}\ln(POP_{t-i}) - \eta_{12}\ln(PCI_{t-i}) - \eta_{13}\ln(EMP_{t-i}) + u_{t,1} \qquad (4) \end{aligned}$$

$$\begin{aligned} PCIG_t &= \alpha_2 + \beta_{21}POPG_t + \beta_{22}EMPG_t + \lambda_{21}\big((I \otimes W)POPG_t\big) + \lambda_{22}(I \otimes W)PCIG_t \\ &\quad + \lambda_{23}(I \otimes W)EMPG_t + \delta_2 lnA_{t-i}^{pci} + \theta_2 BA_{t-i}^{pci} + \textstyle\sum_{k=1}^{K_1} \gamma_{2k} \ln(X_{t-i,k}^{pci}) \\ &\quad - \eta_{21}\ln(POP_{t-i}) - \eta_{22}\ln(PCI_{t-i}) - \eta_{23}\ln(EMP_{t-i}) + u_{t,2} \qquad (5) \end{aligned}$$

$$\begin{aligned} EMPG_t &= \alpha_3 + \beta_{31}POPG_t + \beta_{32}PCIG_t + \lambda_{31}\big((I \otimes W)POPG_t\big) + \lambda_{32}(I \otimes W)PCIG_t \\ &\quad + \lambda_{33}(I \otimes W)EMPG_t + \delta_3 lnA_{t-i}^{emp} + \theta_3 BA_{t-i}^{emp} + \textstyle\sum_{k=1}^{K_1} \gamma_{3k} \ln(X_{t-i,k}^{emp}) \\ &\quad - \eta_{31}\ln(POP_{t-i}) - \eta_{32}\ln(PCI_{t-i}) - \eta_{33}\ln(EMP_{t-i}) + u_{t,3} \qquad (6) \end{aligned}$$

Where α_r, β_{rq} , λ_{rl}, δ_r , , γ_{rk} , η_{rl} for k=1,….,K_r ; r, l = 1,2, 3; and q= 1,2 are the parameter estimates of the model and K_r is the number of exogenous variables in the respective equations. $POPG_t$, $PCIG_t$ and $EMPG_t$ represent the log differences between the end and beginning period values of population, per capita income and employment respectively. Then, they represent the growth of respective variables. The variable, automobile production (***lnA**$_{t-i}$*), was constructed as ***ln*** (automobile production/ distance). The subscript t-i denotes to the variable lagged seven years, and η_r for r =1,2,3 are the speed of adjustment coefficients, the rate at which population, per capita income and employment adjust to their respective steady state equilibrium levels. $\mathbf{u}_{t,r}$ for r=1,2,3 are NT x 1 vectors of disturbances. A Moran's I test statistic suggested that there is the existence of spatial autocorrelation in the errors. The test results are given in Table 1.3. Therefore, the disturbance vector in the r^{th} equation is generated as:

$$\boldsymbol{u}_{t,r} = \rho_r\,(\boldsymbol{I}_T \otimes \boldsymbol{W})\,\boldsymbol{u}_{t,r} + \boldsymbol{\varepsilon}_{t,r}\,, \quad r = 1,2.3 \qquad (7)$$

This specification relates the disturbance vector in the r^{th} equation to its own spatial lag. A one-way error component structure was utilized to allow the innovations $(\varepsilon_1(t, r\ ))$ to be correlated over time, following Baltagi (1995). Therefore, the innovation in the r[th] equation is given by

$$\boldsymbol{\varepsilon}_{t,r} = \boldsymbol{Z}_{\mu}\, \boldsymbol{\mu}_r + \boldsymbol{\omega}_{t,r}\ , \quad r = 1,2,3. \tag{8}$$

Where $\boldsymbol{Z}_{\mu} = (I_N \otimes \iota_T)$, $\mu_r' = (\mu_{1r}, \mu_{2r}, , \mu_{Nr})$, $\omega_{t,r}' = (\omega_{11r}, \omega_{12r}, ., \omega_{1Tr}, \omega_{N1r}, ., \omega_{NTr})$

I_T and I_N are identity matrices of dimension T and N, respectively, ι_T is a vector of ones of dimension T, and $\otimes$ denotes the Kronecker product. $\boldsymbol{\mu}_r$ and $\boldsymbol{\omega}_{t,r}$ are random vectors with zero means and covariance matrix (suppressing the time index):

$$E\begin{pmatrix}\mu_r\\ \omega_r\end{pmatrix}(\mu_r'\ \omega_r') = \begin{bmatrix}\sigma^2_{\mu rr}\ I_N & 0\\ 0 & \sigma^2_{\omega rr}\ I_{NT}\end{bmatrix} \tag{9}$$

Where, $\boldsymbol{\mu}_r$ denotes vector of unit specific error components and $\boldsymbol{\omega}_r$ contains the error components that vary over both the cross- sectional units and time periods. The innovations $\boldsymbol{\varepsilon}_{t,r}$ are not spatially correlated across units but they are auto-correlated over time. However, this specification allows innovations from the same cross sectional unit to be correlated across equations. Therefore, the vectors of disturbances are spatially correlated across units and across equations as given in (10) the same specification was used by Kapoor, Kelejian, and Prucha (2007); Baltagi, Song, and Koh (2003)).

$$\boldsymbol{u}_{t,r} = \rho_r\, (\boldsymbol{I}_T \otimes \boldsymbol{W})\, \boldsymbol{u}_{t,r} + (\boldsymbol{I}_N \otimes \iota_T)\boldsymbol{\mu}_r + \boldsymbol{\omega}_{t,r}\ , \quad r = 1,2,3 \tag{10}$$

The intercepts ($\propto_r$ *for* $r = 1,2,3$) in equations (4) – (6) represent the combined influences of changes in the suppressed exogenous variables; the $\boldsymbol{\beta}_r$ for $r = 1,2,3$ coefficients are structural elasticities corresponding to the endogenous variables. A basic hypothesis to be tested is that the $\boldsymbol{\delta}_r$ coefficients are positive, i.e., an increase in automobile production causes population, employment, and income to increase, ceteris paribus. We add the interaction terms to test whether the automobile production boom differentially affected economic growth in the distressed Black Belt counties. We incorporate spatial components to capture the role of population, employment and per capita income of neighboring counties. This system of spatial equations control spatial spillover effect of neighboring counties (Nzaku and Bukenya, 2005; Trendle, 2009; Gebremariam,2010). Generalized Spatial Three-Stage Least squares (GS3SLS) approach outlined by Kelejian and Prucha (2004) into a panel data setting was used to estimate the model.

An important issue in regional development policy is whether "people follow jobs" or "jobs follow people." For example, if people follow jobs then policies to lure industry would be appropriate. Conversely, if jobs follow people, public funds might be better spent educating the resident population. The chicken or egg question can be tested by simple inspection of the t- ratios associated the $\boldsymbol{\beta}_{11}$ and $\boldsymbol{\beta}_{31}$ coefficients in equations (4) and (6). For example, if $\boldsymbol{\beta}_{11} = 0$ and $\boldsymbol{\beta}_{31} > 0$, then people follow jobs and the state should emphasize industrial development. Conversely, if $\boldsymbol{\beta}_{31} = 0$ and $\boldsymbol{\beta}_{11} > 0$, then jobs follow people and the state should emphasize educating the resident population. If $\boldsymbol{\beta}_{11} > 0$ and $\boldsymbol{\beta}_{31} > 0$ migration and employment are interrelated. In this instance, both development approaches are relevant and their relative effectiveness would depend on the relative size of the coefficients.

Data for sixty seven counties in Alabama are drawn from several sources (Table 1). These data were collected for study period from 1970 to 2007. We construct growth of population, employment and per capital income, using 7 years interval between the beginning and end period, like 1970-1977, 1980-1987, 1990-1997 and 2000-2007. We used 7 years interval to construct these growths because the latest data for automobile production was available in 2007 during this study period and census data were used for other variables. Independent variables include demographic, human capital, labor market, housing, amenity, automobile production, interaction term of automobile production and distressed black belt county and policy variables. McGranahan (1999) developed the Economic Research Service (ERS) natural amenities index, which combines the attractiveness of mild climate, varied topography, and proximity to surface water into one measure.

The initial values of the independent variables are used as 7 years lagged value. This formulation reduces the problem of endogeneity. All independent variables are in log form except those that can take negative or zero values. Automobile plants locate in only four counties of Alabama, namely Tuscaloosa, Talladega, Madison and Montgomery. The distance between the major city of these four counties and major city of all other counties were obtained from MapQuest. Ratio of automobile production and distance for each county were constructed by dividing automobile production of each plant by distance between major city of county where plant locates and the major city of each county. Then, sum of ratio of automobile production and distance were obtained by adding ratio of every company. The monetary value of per capita income, per capita property tax and local tax were deflated, using CPI. The descriptive statistics of the variables are given in Table 2.

A panel model for the study period is estimated. This model contains four time periods and 67 counties. Then, 268 observations are used in the panel model. Panel model can be used to control unobserved heterogenity and to investigate inter-temporal changes. Since the panel data provide more information and variables, the degree of freedom and efficiency increases and multicollinearity is less likely to occur. Following Baltagi (1995), one way error component structure model was utilized for the panel data in this empirical study. This system of equations has econometric issues regarding feedback simultaneity, spatial autoregressive lag, and spatial cross-regressive lag simultaneity with spatially autoregressive disturbances. These simultaneities create problems in estimation and identification of each equation. The order condition for identification in a linear simultaneous equations model is that the number of dependent variables on the right hand side of an equation must be less than or equal to the number of predetermined variables in the model but not in the particular equation. Lagged dependent variables also can be considered as predetermined variables. Kelejian and Prucha considered that the spatially lagged dependent variables can be treated as predetermined (Kelejian and Prucha, 2004). The order condition for each equation of the system in (4) – (6) is fulfilled.

Table 1: Variable Description and Data Sources

Variable	variable Description	unit	Source
POPG	Population Growth	%	A, B
PCIG	Per capita income Growth	%	A, B
EMPG	Employment Growth	%	A, B
pop	population	number	B
pci	per capita income	\$/person	B
emp	employment	number	B
auto	No. of automobile/distance	Number/mile	A, J, K
autoblack	Interaction of auto and Black Belt county		
unemp	unemployment rate	%	E
17years	% of population below 17years	%	C, D
65years	% of population above 65years	%	C, D
hsch	% of high school degree or above	%	C, D
bach	% of bachelor degree or above	%	C, D
pov	poverty rate	%	D
protax	per capita property tax	\$/person	D
tax	per capita local tax	\$/person	D
owner	owner occupied housing in percent	%	D
farm	% employed in farming	%	B
manu	%employed in manufacturing	%	B
serv	%employed in other sectors	%	B
amenity	Natural Amenities Index	ERS index	H
anfpin	average nonfarm proprietor's income	\$	B
hway	road density	mile/square mile	I
dista	distance from metro area	mile	J
metro	dummy variable for metro area	dummy value	
$(I \otimes W)POPG$	Spatial lag of POPG	%	A, B
$(I \otimes W)PCIG$	lag of PCIG	%	A, B
$(I \otimes W)EMPG$	Spatial lag of EMPG	%	A, B

A- Computed, B- US Department of Commerce, Bureau of Economic Analysis (REIS database), C- County & City Data Book, D- U.S Census Bureau, E- Bureau of Labor Statistics, F- American Medical Association, G-Federal Bureau of Investigation, H- Economic Research Service, USDA, I – US Bureau of Transportation Statistics, J- Map Quest, K - Mercedes-Benz U.S. International, Tuscaloosa, AL, Honda Manufacturing of Alabama, Lincoln, AL, Hyundai Motor Manufacturing Alabama, Montgomery, AL, Toyota Motor Manufacturing Alabama, Huntsville, AL, Automotive News Market Data Book

Hausman test (1983) for overidentification was done to investigate whether the additional instruments are valid in the sense that they are uncorrelated with the error term. That is $E(\mathbf{Q'u}_r)=0$, Where E is the expectation operator and **Q** is an instrument matrix that consist of a subset of linearly independent columns $\mathbf{X}, \mathbf{WX}, \mathbf{W}^2\mathbf{X}$, where **X** is the matrix that includes the control variables in the model. All equations are appropriately identified because the hypothesis of orthogonality for each equation cannot be rejected even at P= 0.05 as indicated by the NR_u^2 test statistic in Table 3. A Moran's I test statistic for each single equation suggested that there is the existence of spatial autocorrelation in the errors. The test results are given in Table 3.

Table 2: Descriptive Statistics for Alabama Counties

Variable	Description	Mean	Std Dev
POPG	Population Growth, t	1.05	0.09
PCIG	Per capita income Growth, t	1.14	0.1
EMPG	Employment Growth, t	1.1	0.14
pop	population, t-i	59149.84	93442.84
pci	per capita income, t-i	18225.76	4978.4
emp	employment, t-i	28441.48	55516.72
auto	No. of automobile/distance, t-i years	494.7	4892.61
autoblack	Interaction of auto and Black Belt county	55.24	283.85
unemp	unemployment rate, t-i years	8.8	4.93
17years	% of population below 17years, t-i	30.03	4.99
65years	% of population above 65years, t-i	12.74	2.53
hsch	% of high school degree or above, ,t-i	53.37	14.97
bach	% of bachelor degree or above, t-i	9.95	5.61
Pov	poverty rate, t-i	23.09	10.33
protax	per capita property tax, t-i	81.21	80.5
tax	per capita local tax, t-i	208.02	181.56
owner	owner occupied housing in percent, t-i	72.97	7.1
Farm	% employed in farming, t-i	9.03	6.69
manu	%employed in manufacturing, t-i	25.4	10.42
serv	%employed in other sectors, t-i	16.98	5.87
amenity	Natural Amenities Index, t-i	1.87	1.79
anfpin	average nonfarm proprietor's income, t-i	11312.53	4988.92
hway	road density, t-i	0.13	0.03
dista	distance from metro area	34.72	25.18
metro	dummy variable for metro area	1.31	0.66
(I⊗W)POPG	Spatial lag of POPG, t	1.05	1.06
(I ⊗W)PCIG	Spatial lag of PCIG, t	1.13	1.07
(I⊗W)EMPG	Spatial lag of EMPG, t	1.09	1.07

i is 7 years

When the spatial autoregressive lag and spatial cross-regressive lag simultaneities are present, the conventional three-stage least squares estimation to handle the feedback simultaneity would be inappropriate. Therefore, the Method of Moments approach was used rather than maximum likelihood because maximum likelihood would involve significant computational complexity. Generalized Spatial Three-Stage Least squares (GS3SLS) approach outlined by Kelejian and Prucha (2004) into a panel data setting was used to estimate the model.

3. Results and Discussion

The parameter estimates of the system were given in Table 3. In general, the results are consistent with previous studies on regional growth model. The results show the existence of simultaneities among endogenous variables. This indicates that there are strong interdependences among population growth, per capita income growth and employment growth. The negative and significant coefficient of lagged dependent variable in each equation indicates the conditional convergence with respect to the respective endogenous variable of each equation. This also implies that growth of population, per capita income and employment were higher in counties that had low initial level of population, per capita income and employment, respectively, compared to counties with high initial levels. In the equation of population growth, the coefficient of employment growth is positive as expected and significant at 1% level. The coefficient of employment growth (0.59) indicates that an increase in employment growth may result in-migrants and hence increase the population growth, other things being equal. The previous studies (Carlino and Mills, 1987 and Clark and Murphy, 1996) reported the same relationship that changes in employment are driving population. This is interpreted as people follow jobs. Coefficient for the ratio of automobile production to distance indicates that an increase in automobile production of a plant reduce the population growth with closer distance to the automobile plant. When automobile production in a given plant increases, number of automotive suppliers cluster around automobile plant. The competition for land and other infrastructure facilities between automotive suppliers and real estate builders deter people migration closer to automobile plant. Since the coefficient of the interaction term of automobile production and distressed Black County is insignificant, there is no differential impact of automobile production on population growth in distressed black counties.

The coefficient of spatial autoregressive lag is positive and significant. This indicates that population growth in neighboring counties positively influence the population growth of a given county through immigration due to the low housing and land value. The coefficient of cross-regressive lag with respect to employment growth is negative. This may be explained that people are moving to neighboring countries for jobs. These results show that the growth of population and employment in neighboring counties has spillover effect on the growth of population in a given county. Global Moran's I statistic and ρ_1 indicate there is spatial spillover effect with respect to the error terms. This indicates that random shocks to the system affect not only the country where the shock originates and its neighbors, but also create shock waves across the study area, because of the structure of the autoregressive errors.

In employment growth equation coefficients of population and per capita income growth indicate that employment growth in a given county is positively and highly associated with population growth and per capita income growth. The coefficient of population growth (1.42) indicates that an increase in the population growth is associated with the increase in the employment growth. This supports the hypothesis that jobs follow people. The coefficient of per capita income growth (0.58) shows that there is an increase in employment growth for the increase in per capita income growth. Carlino and Mills (1987) found that population is driving employment growth and also the increase in income led to employment growth. Coefficient of the automobile production is positive and significant at 5% level. This coefficient suggests that when automobile production of a given plant increases, the employment growth of a county increases, while other things being equal. Since the coefficient of the interaction term of automobile production and distressed Black County is insignificant, there is no differential impact of automobile production on employment growth in distressed black counties.

Table 3: Population, Employment and Per Capita Income Growth Equations

	POPG Equation		EMPG Equation		PCIG Equation	
Variable	*Coeff.*	*z-stat*	*Coeff.*	*z-test*	*Coeff.*	*z-test*
POPG			1.424	17.38	-0.148	-1.42
PCIG	-0.173	-2.02	0.587	5.13		
EMPG	0.594	16.01			0.377	6.33
pop	-0.069	-2.68	0.133	3.83	-0.077	-2.38
pci	-0.02	-0.46	0.139	2.24	-0.289	-5.68
emp	0.052	2.34	-0.102	-3.39	0.056	2
auto	-0.007	-4.18	0.006	2.39	0.007	3.1
autoblack	-0.002	-1.05	0.001	0.29	0.004	1.62
unemp	-0.049	-5.91	0.084	6.89	-0.054	-5.22
17years	0.001	0.02	-0.03	-0.54	0.063	1.23
65years	-0.06	-2.55	0.064	1.81	0.035	1.14
hsch	-0.028	-0.81	-0.001	-0.02	0.082	1.8
bach	-0.008	-0.62	0.022	1.14	-0.016	-1.01
pov	0.004	0.29	-0.009	-0.44	0.012	0.67
protax	0.005	0.55	-0.003	-0.25	-0.019	-1.77
tax	0.033	2.44	-0.06	-3	0.055	3.31
owner	0.011	0.4				
farm	0.008	1.35	-0.003	-0.35	-0.017	-2.41
manu	-0.005	-0.59	0.01	0.86	-0.009	-0.92
serv	-0.008	-0.6	0.02	1	-0.022	-1.24
amenity	0.013	3.89	-0.018	-3.7	0.001	0.34
anfpin	-0.029	-2.07	0.058	2.88	-0.052	-3.24
hway	0.025	2.25	-0.042	-2.59	0.032	2.28
dista	-0.008	-1.36	0.01	1.16	-0.002	-0.2
metro	-0.032	-1.44	0.033	1.01	0.019	0.68
(I⊗W) POPG	0.469	4.02	-0.812	-4.86	0.131	0.85
(I⊗W) PCIG	0.017	0.25	-0.147	-1.49	0.267	2.95
(I⊗W) EMPG	-0.376	-4.13	0.713	5.67	-0.283	-2.66
Constant	0.967	2.15	-2.529	-4.11	3.121	6.1
RHO(ρ)	-0.321	-8.33[b]	-0.538	-3.88[b]	-0.121	-1.18[b]
SIG V	0.001	29.1[b]	0.003	7.3[b]	0.003	12.24[b]
SIG 1	0.002	16.59[b]	0.004	3.52[b]	0.002	6.82[b]
NR^2 - $\chi 2$ (39,41,40)	31.77	0.7877[c]	31.283	0.8364[c]	44.135	0.3405[c]
Moran I	0.149	0.022	0.065	0.244	0.144	0.027
N	268		268		268	

b: t-static value, c: p-value

In the employment growth equation, coefficients of spatial auto regressive lag effect are positive and significant at 5% level. This implies that employment growth in a given counties depends on the averages of employment growth of neighboring counties. This positive autoregressive lag effect implies that the spillover effect of employment growth in neighboring counties positively affect the employment growth in a given county. New jobs may be created due to the positive spillover effect of industrial clustering and availability of supporting services. Employment growth in neighboring counties attracts job seekers to commute from a given county. The coefficient of cross regressive lag with respect to the population growth is negative. This means that population growth in neighboring counties may attract more firms from a given county. These results indicate that the population and employment growth in neighboring counties have spillover effect on the employment growth of a given county.

In the per capita income growth equation, the coefficient of employment growth (0.38) implies that an increase in the employment growth is associated with the increase in per capita income growth. This result is consistent with theoretical expectations. Nzaku and Bukenya

(2005) found that employment has a strong positive effect on per capita income. Coefficient of automobile production of a plant positively influences the per capita income of the county. When automobile production of a given plant increases, the per capita income growth of a county increases. Since coefficient of the interaction term of automobile production and distressed Black County is significant at 10% level, there might be differential impact of automobile production on per capita income growth in distressed black counties. Interaction term suggests that per capita income of distressed Black County may rise for an increase in automobile production. The coefficient of spatial auto regressive lag effect is positive and significant. The per capita income growths in neighboring counties have positive spillover effect on the per capita income growth of a given county. The coefficient of cross regressive lag effect with respect to employment growth is negative. The higher employment growth in neighboring counties makes neighboring counties more attractive to new firms and existing firms. These results imply that the per capita income growth of a particular county depends on the average of employment growth and per capita income growth of neighboring counties. This is important from policy perspectives because the per capita income depend not only on the characteristics of that county, but also on the characteristics of its neighbors.

4. Conclusion

This study concludes that automobile production increase the employment growth and per capita income growth of the counties which are closer to the automobile plant, but reduce the population growth with closer distance to the automobile plant. This study also finds that jobs follow people and also people follow jobs. The existence of spatial lag indicates that growth of population, employment and per capita income are not only dependent on the characteristics of that county, but also on those of its neighbors. These interdependences provide the need of economic development policy coordination among the counties.

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