**An Empirical Analysis of County-Level Determinants of Small Business Growth Poverty in Appalachia: A Spatial Simultaneous-Equations Approach**

Gebremeskel H. Gebremariam, Graduate Research Assistant

Tesfa G. Gebremedhin, Professor

Peter V. Schaeffer, Professor and Director

Division of Resource Management
Davis College of Agriculture, Forestry & Consumer Sciences
P. O. Box 6108
West Virginia University
Morgantown, WV 26506-6108

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## 1. Introduction

Persistent poverty is one of the most critical social problems facing policy makers in the United States. Despite decades of government intervention, and the spending of billions of public funds, many communities still remain in poverty. The economic boom of the 1990s not only failed to reduce poverty in all counties, but it was associated with rising poverty rates in certain counties (Rupasingha and Goetz, 2003). Counties in the Appalachia, for example, had above average poverty rates in 1990s. Thus, after a decade of unprecedented expansion of the economy of the United States, many regions in the Appalachia are still suffering from high unemployment, shrinking economic base, deeply rooted poverty, low human capital formation, and out migration (Deavers and Hoppe, 1992; Haynes, 1997; Dilger and Witt, 1994**;** Maggar, 1990). The slow growth of income and employment in the region, out-migration and the disappearance of rural households are both causes and effects of persistent high rates of poverty. This lagging economic development negatively affect the economic and social well-being of the rural population, the health of local businesses, and the ability of local governments to provide basic human services (Cushing and Rogers, 1996).

The changing structure of traditional industries and the impact of those changes on local communities have been sources of concern to many groups interested in the welfare of rural areas. State policy makers and local leaders have been placing a high priority on local economic development (Pulver, 1989; Ekstrom and Leistritz, 1988). Consequently, a better understanding of factors that influence the local employment earning capacity and quality of life issues has become important from county, state and regional policy perspectives with respect to designing human capital development programs needed for rural community development. Since many of the forces responsible for past economic and social changes in the rural communities will continue to affect rural families, it becomes necessary to study the rural economy and evaluate alternative policy measures to promote diverse and resilient local communities.

Improving the economic basis of the region requires an economic environment where business can prosper. The Appalachia, however, despite efforts of multilateral, national and local policy programs to induce economic prosperity and ameliorate poverty, has many economically depressed communities. To strengthen and diversify the economy, policy makers and local leaders need to know the characteristics and impact of small businesses on the local economy. Understanding the characteristics of poverty and the contribution of small businesses to economic growth of the local economy is crucial in designing specific and appropriate development policies. The targets of such policies are to improve and expand community-based capabilities and initiatives to assist small communities to retain and expand local small businesses.

## 2. Literature Review

### I. *County-Level Determinants of Small Business Growth*

When confronted with rising concerns about unemployment, job creation, economic growth and international competitiveness in global markets, the response at national level is to promote the creation of new small businesses (Reynolds, 1999). Most of the newly created jobs are generated by new businesses that start small (Acs and Audretsch, 2001; Audretsch et al., 2000, 2001; Thurik and Wennekers, 1999; Fritsch and Falck, 2003). These studies indicate that there has been a structural shift in the industrial sector towards a higher dependence on flexibility and knowledge-intensive production.

More recently, a growing literature has sought the determinants of variation in new business formation on regional basis (Reynolds, 1994; Acs and Armington, 2002; Fritsch, 1992; Audretsch and Fritsch, 1994; Hart and Gudgin, 1994; Keeble and Walker, 1994; Johnson and Parker, 1996; Davidson et al., 1994; Guesnier, 1994; Garofoli, 1994; Kangasharju, 2000;

Fotopoulos and Spence, 1999; and Callejon and Segarra, 2001). Each of these studies attempted to identify the most important influences underpinning spatial variations in new business formation. In these studies a set of regional characteristics concerning socioeconomic structure of the region are examined in order to explain the variations in new business formation. These include demand-side, supply-side and policy variables. The agglomeration effects that contribute to new firm formation can also come from supply factors related to the quality of the local labor market and business climate.

Higher personal household wealth, a higher proportion of home ownership, a high percentage of skilled labor, a higher rate of unemployment, and the size structure of existing enterprises can be factors influencing the rate of new business formation. Many researchers suggest that areas having many small firms are likely to have high rates of new firm formation (Christensen, 2000; Garofoli, 1994; Keeble and Walker, 1994; Audretsch and Fritsch, 1994; Hart and Gudgin, 1994; Evans and Leighton, 1990; Reynolds, 1994; Acs and Armington, 2002; Acs and Armington, 2004). Other studies (Fisher, 1997; Gabe and Bell, 2004; Highfield and Smiley, 1987) have also shown that public services have positive and statistically significant effects on business location and growth.

**II.** ***County-Level Determinants of Median Household Income***

There are studies on regional/local income growth which have focused attention on a broader set of possible average income growth determinants, which include geographic characteristics, initial conditions describing the regions (such as the average income, regional/local public expenditure, regional/local income tax rates, educational status of the population, resource endowment, etc.) and national policies directed towards the regional level (Glaeser et al., 1995; Persson, 1997; Aronsson et, al., 2001; Lundberg, 2003). For example, the size of the population of a region is positively correlated with real per capita personal income due to the beneficial effects of agglomeration economies of firm location (Duffy-Deno and Eberts, 1991).

There also exists evidence in the literature that local public expenditures on public health and hospitals, highways, local schools, higher education, police/fire protection, transfer payments/welfare, and other public services affect economic development as measured by different indicators such as net business establishments created, net employment gains, change in personal income, or/and change in per capita personal income by changes in employment and wages (Duffy-Deno and Eberts, 1991; Jones, 1990; Glaeser et al., 1995).

**3. Methodology**

The relationship between economic growth and its determinants has been studied extensively in the economic literature. The issue whether regional development can be associated with population driving employment changes or employment driving population changes (do 'jobs follow people' or 'people follow jobs'?) has, for example, recently attracted considerable interest. Empirical works on identification of the direction of causality in this 'jobs follow people' or 'people follow jobs' literature (Steinnes and Fischer, 1974) have resulted in the view that empirical models of regional development often reflect the interdependence between household residential choices and firm location choices. To account for this causation and interdependency, Carlino and Mills (1987) suggested and constructed a two-equation simultaneous system with the two partial location equations as its components. This model has subsequently been used by a number of regional science researchers in order to examine regional economic growth (see Boarnet, 1994; Duffy, 1994; Henry, Barkley, and Bao, 1997; Duffy-Dino, 1998; Barkley, Henry and Bao 1998,; Henry, Schmitt, Kritstesen, Barkley, and Bao, 1999; Edmiston, 2004). More recently, Deller, Tsai, Marcouiller, and English (2001) have expanded upon the original Carlino-Mills model to capture explicitly the role of income. According to the proposition of utility maximization in the traditional migration literature, households migrate to capture higher wages or income. The model expanded by Deller et al, (2001) is three-dimensional (jobs-people-income) and explicitly traces the role of income in regional growth process. It also explicitly captures the increasing concerns about job quality as measured by income levels those jobs can support. There have also been efforts to model the interactions between employment growth and human migration ( MacDonald, 1992; Clark and Murphy, 1996), per capita personal income and public expenditures (Duffy-Deno and Eberts, 1991), net migration, employment growth, and average income (earnings) (Greenwood and Hunt 1984; Greenwood et al., 1986; and Lewis, Hunt and Plantigna, 2002) in simultaneous-equations methods.

The theoretical base for the interdependencies between employment and income is the idea that households and firms are both mobile and that household location decisions maximize utility while firm location decisions maximize profits. That is, households migrate to capture higher wages or income and firms migrate to be near growing consumer markets. These actions in turn generate income to the regional (local) economy. The location decisions of firms, however, are expected to be influenced not only by population and income (i.e., growing consumer markets) but also by other factors such as local business climate, wage rates, tax rates, local public services, and regional location. Firm location decisions are also influenced by the substantial financial incentive that local governments offer in an effort to create jobs, spur income growth, and enhance the economic opportunities of the local population.

Based upon these assumptions, we construct the following central hypotheses in this research:

1. Business growth and household median income are interdependent and are jointly determined by regional covariates
2. Growth is conditional upon initial conditions.
3. Growth in a county is conditional upon growth in neighboring counties.

These hypotheses form the core research agenda for this study. Specifically, emphasis is put not only on examining the linkages among business growth and household median income, but also on investigating the elasticity of these variables with respect to each of the regional covariates. The elasticity analyses help to draw some policy recommendations for regional and rural development.

To test these hypotheses, we use a spatial simultaneous equations model of business growth and household median income. Following the Carlino and Mills tradition and building upon Deller et al. (2001) and Lewis et al.(2002), the basic model is specified as

$$\left\{ \begin{array}{l} EMP_{it}^{*} = f_1(MHY_{it}^{*} \,|\, \mathbf{X}_{it}^{em}) \\ \\ MHY_{it}^{*} = f_2(EMP_{it}^{*} \,|\, \mathbf{X}_{it}^{mh}) \end{array} \right\} \text{..........}(3.1)$$

where $EMP_{it}^{*}$ and $MHY_{it}^{*}$ are equilibrium levels of private business employment and median household income respectively, and i and t index county and time respectively. The vectors of additional exogenous variables that are included in the respective equations of the system of simultaneous equations are given by $\mathbf{X}_{it}^{em}$ and $\mathbf{X}_{it}^{mh}$ respectively.

The system of equations in (3.1) captures the simultaneity nature of the interactions between employment growth and median household income at equilibrium. The nature of interaction among the endogenous variables is dependent upon the initial conditions of a county.

In order to reduce the effects of the large diversity found in the data used in empirical analysis, a multiplicative (log-linear) form of the model is used. Such specification also implies a constant-elasticity form for the equilibrium conditions given in (3.1). A log-linear (i.e., log-log) representation of these equilibrium conditions can thus be expressed as:

$$EMP_{it}^{*} = \left(MHY_{it}^{*}\right)^{d_1} \times \prod_{k_1=3}^{K_1} \left(\mathbf{X}_{k_2 it}^{em}\right)^{x_{1k_1}} \rightarrow \ln\left(EMP_{it}^{*}\right) = d_1 \ln\left(MHY_{it}^{*}\right) + \sum_{k_1=3}^{K_1} x_{1k_1} \ln\left(\mathrm{X}_{k_1 it}^{em}\right) \qquad (3.2a)$$

$$MHY_{it}^{*} = \left(EMP_{it}^{*}\right)^{c_2} \times \prod_{k_2=3}^{K_2} \left(\mathrm{X}_{k_2 it}^{mh}\right)^{x_{2k_2}} \rightarrow \ln\left(MHY_{it}^{*}\right) = c_2 \ln\left(EMP_{it}^{*}{}_{it}\right) + \sum_{k_1=3}^{K_1} x_{1k_1} \ln\left(\mathrm{X}_{k_1 it}^{mh}\right) \qquad (3.2b)$$

where $c_2$ *and* $d_1$ are the exponents on the endogenous variables, $x_{ik_j}$ for $i, j = 1, 2$ are vectors of exponents on the exogenous variables, $\prod$ is the product operator, and $K_i$ for $i = 1, 2$ are the number of exogenous variables in the employment growth and median household income equations respectively. The log-linear specification has an advantage of yielding a log-linear reduced form for estimation, where the estimated coefficients represent elasticities. Duffy-Deno (1998) and MacKinnon, White, and Davidson, 1983) also show that, compared to a linear specification, a log-linear specification is more appropriate for models involving population and employment densities.

The literature (Edmiston, 2004; Hamalainen and Bockerman, 2004; Aronsson, Lundberg, and Wikstrom, 2001; Deller et al., 2001; Henry et al., 1999; Duffy-Deno, 1998; Barkley et al., 1998; Henry et al., 1997; Boarnet, 1994; Duffy, 1994, Carlino and Mills, 1987; Mills and Price, 1984) suggests that employment and median household income likely adjust to their equilibrium levels with a substantial lags (i.e., initial conditions). Following the literature a distributed lag adjustment is introduced and the corresponding partial-adjustment process for each of the equations given in (3.1) is of the form:

$$\frac{EMP_{it}}{EMP_{it-1}} = \left(\frac{EMP_{it}^{*}}{EMP_{it-1}}\right)^{\eta_{em}} \rightarrow \ln\left(EMP_{it}\right) - \ln\left(EMP_{it-1}\right) = \eta_{em} \ln\left(EMP_{it}^{*}\right) - \eta_{em}\left(EMP_{it-1}\right) \quad (3.3a)$$

$$\frac{MHY_{it}}{MHY_{it-1}} = \left(\frac{MHY_{it}^{*}}{MHY_{it-1}}\right)^{\eta_{mh}} \rightarrow \ln\left(MHY_{it}\right) - \ln\left(MHY_{it-1}\right) = \eta_{mh} \ln\left(MHY_{it}^{*}\right) - \eta_{mh} \ln\left(MHY_{it-1}\right) (3.3b)$$

where the subscript t-1 refers to the indicated variable lagged one period, one decade in this study, and $\eta_{em}$ and $\eta_{mh}$ are the speed of adjustment parameters that represent, respectively, employment and median household income adjust to their respective desired equilibrium levels. They are interpreted as the shares or proportions of the respective equilibrium rate of growth that were realized each period

Solving equations (3.3a) and (3.3b) for the equilibrium values gives:

$$\begin{aligned}\ln\left(EMP_{it}^{*}\right) &= \frac{1}{\eta_{em}}\left(\ln\left(EMP_{it}\right) - \ln\left(EMP_{it-1}\right) + \eta_{em}\ln\left(EMP_{it-1}\right)\right)\\ &= \frac{1}{\eta_{em}}EMPR_{it} + \ln\left(EMP_{it-1}\right) \qquad (3.4a)\end{aligned}$$

$$\begin{aligned}\ln\left(MHY_{it}^{*}\right) &= \frac{1}{\eta_{mh}}\left(\ln\left(MHY_{it}\right) - \ln\left(MHY_{it-1}\right) + \eta_{mh}\ln\left(MHY_{it-1}\right)\right)\\ &= \frac{1}{\eta_{mh}}MHYR_{it} + \ln\left(MHY_{it-1}\right) \qquad (3.4b)\end{aligned}$$

where EMPR and MHYR denote the employment growth rate and median household income growth rate respectively.

Substituting from equations (3.4a) and (3.4b) into equations (3.2a) and (3.2b) gives:

*Business (Employment) Growth Equation*:

$$\frac{1}{\eta_{em}}EMPR_{it} + \ln\left(EMP_{it-1}\right) = d_1\left(\frac{1}{\eta_{mh}}MHYR_{it} + \ln\left(MHY_{it-1}\right)\right) + \sum_{k_1=3}^{K_1} x_{1k_1}\ln\left(\mathrm{X}_{k_1it}^{em}\right)$$

$$EMPR_{it} = \eta_{em}\left\{d_1\left(\frac{1}{\eta_{mh}}MHYR_{it} + \ln\left(MHY_{it-1}\right)\right) + \sum_{k_1=3}^{K_1} x_{1k_1}\ln\left(\mathrm{X}_{k_1it}^{em}\right) - \ln\left(EMP_{it-1}\right)\right\}$$

$$EMPR_{it} = \beta_{11}MHYR_{it} + \gamma_{11}\ln\left(EMP_{it-1}\right) + \gamma_{12}\ln\left(MHY_{it-1}\right) + \sum_{k_1=3}^{K_1}\gamma_{1k_1}\ln\left(\mathrm{X}_{k_1it}^{em}\right) \qquad (3.5a)$$

*Median Household Income Growth Equation*:

$$\frac{1}{\eta_{mh}} MHYR_{it} + \ln\left(MHY_{it-1}\right) = c_2 \left( \frac{1}{\eta_{em}} EMPR_{it} + \ln\left(EMP_{it-1}\right) \right) + \sum_{k_2=3}^{K_2} x_{2k_2} \ln\left(\mathrm{X}_{k_2 it}^{mh}\right)$$

$$MHYR_{it} = \eta_{mh} \left\{ c_2 \left( \frac{1}{\eta_{em}} EMPR_{it} + \ln\left(EMP_{it-1}\right) \right) + \sum_{k_2=3}^{K_2} x_{2k_2} \ln\left(\mathrm{X}_{k_2 it}^{mh}\right) - \ln\left(MHY_{it-1}\right) \right\}$$

$$MHYR_{it} = \beta_{21} EMPR_{it} + \gamma_{21} \ln\left(EMP_{it-1}\right) + \gamma_{22} \ln\left(MHY_{it-1}\right) + \sum_{k_2=3}^{K_2} \gamma_{2k_2} \ln\left(\mathrm{X}_{k_2 it}^{mh}\right) \qquad (3.5b)$$

Equations (3.5a) and (3.5b) are the structural equations which constitute the basic simultaneous-equations model in my study. Thus, the general form of the model to be estimated and extended (to accommodate spatial effect) in subsequent sections can be given by:

$$\left\{ \begin{array}{l} EMPR_{it} = \beta_{11} MHYR_{it} + \gamma_{11} \ln\left(EMP_{it-1}\right) + \gamma_{12} \ln\left(MHY_{it-1}\right) + \sum_{k_1=3}^{K_1} \gamma_{1k_1} \ln\left(\mathrm{X}_{k_1 it}^{em}\right) \\ MHYR_{it} = \beta_{21} EMPR_{it} + \gamma_{21} \ln\left(EMP_{it-1}\right) + \gamma_{22} \ln\left(MHY_{it-1}\right) + \sum_{k_2=3}^{K_2} \gamma_{2k_2} \ln\left(\mathrm{X}_{k_2 it}^{mh}\right) \end{array} \right\} \ldots..(3.6)$$

Note that the speed of adjustment parameters $\{\eta\}$ become embedded in the coefficient parameters, $\beta$ and $\gamma$ .

Models such as (3.6) are estimated using data collected for cross sectional observations on aggregate spatial units such as counties. Such data sets, however, are likely to exhibit a lack of independence in the form of spatial autocorrelation. To capture such spatial autocorrelation effects (using a contiguity weight matrix **W**), (3.6) is extended as follows:

$$\begin{cases} EMPR_{it} = \beta_{11}MHYR_{it} + \lambda_{11}\mathbf{W}\left(EMPR_{it}\right) + \lambda_{12}\mathbf{W}\left(MHYR_{it}\right) + \gamma_{11}\ln\left(EMP_{it-1}\right) \\ \qquad + \gamma_{12}\ln\left(MHY_{it-1}\right) + \sum_{k_1=3}^{K_1}\gamma_{1k_1}\ln\left(\mathrm{X}_{k_1 it}^{em}\right) + \mathrm{u}_{it}^{em}, \text{where } \mathrm{u}_{it}^{em} = \rho_1\mathbf{W}\mathrm{u}_{it}^{em} + \varepsilon_{it}^{em} \\ MHYR_{it} = \beta_{21}EMPR_{it} + \lambda_{21}\mathbf{W}\left(EMPR_{it}\right) + \lambda_{22}\mathbf{W}\left(MHYR_{it}\right) + \gamma_{21}\ln\left(EMP_{it-1}\right) \\ \qquad + \gamma_{22}\ln\left(MHY_{it-1}\right) + \sum_{k_2=3}^{K_2}\gamma_{2k_2}\ln\left(\mathrm{X}_{k_2 it}^{mh}\right) + \mathrm{u}_{it}^{mh}, \text{ where } \mathrm{u}_{it}^{mh} = \rho_2\mathbf{W}\mathrm{u}_{it}^{mh} + \varepsilon_{it}^{mh} \end{cases} \quad .....(3.7)$$

where β, γ, $\lambda$, and $\rho$ are unobserved parameters $u_{it}^{em}$ and $u_{it}^{mh}$ are vectors of disturbances, and $\boldsymbol{\varepsilon}_{it}^{em}$ and $\boldsymbol{\varepsilon}_{it}^{mh}$ are vectors of innovations. $K_j$, $j = 1, 2$ represents the number of exogenous variables included in the jth equation. The system in (3.7) is a spatial autoregressive model in which both the spatial lags in the dependent variables and spatial autoregressive error terms are incorporated.

**4. Data**

The data for the empirical analysis are for the 417 Appalachian counties, which have been collected and compiled from County Business Patterns, Bureau of Economic Analysis, Bureau of Labor Statistics, Current Population Survey Reports, County and City Data Book, U.S. Census of Population and Housing, U.S. Small Business Administration, and Department of Employment Security. Data for county employment and county median household income are collected for 1990 and 2000. The dependent variables of the model, employment growth rate (EMPR) and median household growth rate (MHYR), are computed by taking the log difference of the respective 2000 and the 1990 levels. In addition, data for a number of control variables are collected for 1990 from the different sources (see table 1 for the data description).

**Table 1 about here**

**5. Estimation Issues and Results**

The model given in (3.7) is estimated using generalized spatial two stage least squares (GS2SLS) and generalized spatial three stage least squares (GS3SLS) procedures. This is done, respectively, in a three and a four step routines. The first three steps are common for both. In the first step, the parameter vector consisting of betas, lambdas and gammas $[\beta', \lambda', \gamma']$ are estimated by two stage least squares (2SLS) using an instrument matrix that consists of $\mathbf{X}, \mathbf{WX}, \mathbf{W}^2\mathbf{X}$, where **X** is the matrix that includes all control variables in the model, and **W** is a weight matrix. The disturbances for each equation in the model are computed by using the estimates for betas, lambdas and gammas from the first step. In the second step, these estimates of the disturbances are used to estimate the autoregressive parameter rho $(\rho)$ for each equation using Kelejian and Prucha's generalized moments procedure. In the third step, a Cochran-Orcutt-type transformation is done by using the estimates for rhos from the second step to account for the spatial autocorrelation in the disturbances. The GS2SLS estimators for betas, lambdas and gammas are then obtained by estimating the transformed model using $[\mathbf{X}, \mathbf{WX}, \mathbf{W}^2\mathbf{X}]$ as the instrument matrix.

Although the GS2SLS takes the potential spatial correlation in to account, it does not utilize the information available across equation because it does not take into account the potential cross equation correlation in the innovation vectors $(\varepsilon_{it}^{em}, \varepsilon_{it}^{mh})$. The full system information is utilized by stacking the Cochran-Orcutt-type transformed equations (from the second step) in order to estimate them jointly. Thus, in the fourth step the GS3SLS estimator of betas, lambdas, and gammas is obtained by estimating this stacked model. The GS3SLS estimator is more efficient relative to GS2SLS estimator.

**Table 2 about here**

The GS2SLS and GS3SLS parameter estimates of the system given in (3.7) for the 1990-2000 is presented in Table 2. A detailed discussion of the performance of each control variable is not pursued due to space limitation. But, some highlights of the analysis warrants discussion. Let us first see the results for the employment equation (EMPR). These results suggest a positive and significant parameter estimate for lambda1 that indicate that employment growth rate tends to spillover to neighboring counties and have a positive effect on their employment growth rates. The results also show a positive parameter estimate for lambda2 that indicate that median household income growth rates (MHYR) in neighboring counties tends to affect favorably EMPR in a given county. These are important from a policy perspective as they indicate that employment growth and growth in median household incomes in one county are not at the expense of EMPRs in neighboring counties. The results are also important from an economic perspective because these significant spatial lag effects indicate that EMPR does not only depend on characteristics within the county, but also on that of its neighbors. Hence, spatial effects should be tested for in empirical works involving employment growth rates and household income growth rates. Our model specification incorporates spatially autoregressive spatial process (effect) besides the spatial lag in the dependent variables. The results in Table 2 suggest a negative parameter estimate for rho1 indicating that random shocks into the system with respect to EMPR do not only affect the county where the shocks originated and its neighbors, but create negative shock waves across Appalachia.

The elasticity of EMPR with respect to the initial employment level (EMP90) is negative and statistically significant indicating convergence in the sense that counties with initial low level of employment at the beginning of the period (1990) tend to show higher rate of growth of business than counties with high initial level of employment conditional on the other explanatory variables in the model. This result supports prior results of rural renaissance in the literature (Deller et al, 2001; Lunderberg, 2003).

To control for agglomeration effects, our model includes initial county population size (POPs) and population density (POPd). As expected, the results show that POPs have positive and significant effects on EMPR. However, although it has the proper sign, POPd is not significant. In contradiction to the theoretical expectations, the results show initial human capital endowment as measured by the percentage of adults (over 23 years old) with college degree and above (POPCD) has the wrong sign. One interpretation of this result is that the jobs created in Appalachia during the study period were, on average low paying jobs which do not require high human capital. This interpretation may be corroborated by positive coefficient on POPHD (the percentage of adults (over 23 years old) with high school diploma or higher). We also include county unemployment rate (UNE) in our vector of exogenous variables as a measure of local economic distress. Our results suggest that high unemployment rate is associated with low business growth. This indicates that the poor economic environment in Appalachia did not provide incentive for individuals to form new business that can employ not only the owner, but others.

Establishment density (ESBd), which is the total number of private sector establishments in the county divided by the total county's population, is included in our model to capture the degree of competition among firms and crowding of businesses relative to the population. The average size of establishment (ESBs), defined as the total private sector employment divided by the total number of private establishments in the county, is also included to capture the effects of barriers to entry of new small firms on employment growth. The coefficient on ESBD is positive and significant indicating that Appalachia region is far below the threshold where competition among firms for consumer demands crowds businesses. According to our results, High ESBd is associated with growth in Employment (business growth), indicating that firms tend to locate near each other possibly due to localization and agglomeration economies of scale. The coefficient on ESBs is also positive and significant indicating existence of low barrier to new firm formation and employment generation in Appalachia during the study period.

One interesting observation from our results pertains to the role of local government on business growth. Our model predicts that local governments, through their spending and taxation functions, have critical roles in creating enabling economic environments for businesses to prosper. The results of our model, however, predict that local governments had not played significant roles in employment growth in Appalachia. Given the economic hardship and high level of underdevelopment in Appalachia, these results are indications that local governments should step up their efforts to create incentives in order to encourage business growth in the region.

Now let us turn to the results of the MHYR equation. Unlike the results of the EMPR equation, these results suggest a negative parameter estimate for lambda2 that indicates that MHYR tends to spillover to neighboring counties and have a negative effect on their employment growth rates,, although insignificant. . The results also show a negative parameter estimate for lambda1 that indicate that EMPR in neighboring counties tends to affect unfavorably MHYR in a given county. These are important from a policy perspective as they indicate that employment growth and growth in median household incomes in one county are at the expense of MHYRs in neighboring counties.

The results also indicate a positive parameter estimate for rho2 indicating that random shocks into the system with respect to MHYR do not only affect the county where the shocks originated and its neighbors, but create positive shock waves across Appalachia. The elasticity of EMPR with respect to the initial median household income (MHY90) is negative and statistically significant indicating convergence in the sense that counties with initial low level of median household income at the beginning of the period (1990) tend to show higher rate of growth of median household income than counties with high initial level of median household income conditional on the other explanatory variables in the model.

The coefficient on the index of social capital (SCIX) is positive and significant indicating counties with high level of social capital increase the wellbeing of their communities. The coefficients on the proportion of population of school age (POP5-17), the proportion of population above 65 years old (POP>65), on the proportion of female headed households (FHHF) indicate the expected signs, negative, positive and negative respectively. Counties with higher proportions of POP5-17 and FHHF tend to have lower level of median household income. Whereas, counties with higher proportion of POP>65 tend to have higher levels of MHY. These results are in line with the results in the literature.

The coefficients on beta1 and beta2 are positive indicating positive relationships between EMPR and MHYR. EMPR affects MHYR and MHYR affects EMPR but the strength of effects are different with the effect of EMPR on MHYR stronger (0.2825>0.1685).

## 5. Conclusions

The main issue in this paper has been to test the hypotheses that (1) business growth and median household income are interdependent and are jointly determined by regional covariates; (2) growth is conditional upon initial conditions; and (3) growth in county is conditional upon growth in neighboring counties. To test these hypotheses, we developed a spatial simultaneous equations model. GS2SLS and GS3SLS estimators are obtained by estimating the model using data covering the 417 Appalachian counties for the 1990-2000. We find evidences in support of all the three hypotheses. In particular, we find that EMPR in one county is positively affected by EMPR and MHYR in neighboring counties, whereas, MHYR in one county is negatively affected by EMPR and MHYR in neighboring counties. Our results also indicate the presence of spatial correlation in the error terms. This implies that a random shock into the system spreads across the region. The policy implications of the existence of these spatial spillover and spatial autoregressive effects is that there should be a regional approach to promoting business growth and income creation in Appalachia. The results also indicate convergence across counties in Appalachia with respect to EMPR and MHYR conditional upon the initial conditions of the explanatory variables in the model

**Table 1: Descriptive statistics for year 1990**

| Variable Code | Variable Description | Mean | Std Dev | Minimum | Maximum |
|---|---|---|---|---|---|
| Constant | | 1.00 | 0.00 | 1.00 | 1.00 |
| EMPR | Employment growth rate 1990-2000 | 0.17 | 0.25 | -0.69 | 1.79 |
| MHYR | Median Household income growth rate 1990-2000 | 0.48 | 0.31 | -0.49 | 1.40 |
| WEMPR | Spatial Lag of EMPR | 0.18 | 0.14 | -0.18 | 0.81 |
| WMHYR | Spatial lag of MHYR | 0.47 | 0.19 | -0.11 | 1.02 |
| POPs | Population 1990 | 10.30 | 0.94 | 7.88 | 14.11 |
| POPd | Population density 1990 | 4.28 | 0.90 | 1.85 | 7.75 |
| POP5-17 | Percent of population between 5 -17 years 1990 | 2.92 | 0.12 | 2.17 | 3.22 |
| POP25-44 | Percent of population between 25 -14 years old 1990 | 3.38 | 0.08 | 2.79 | 3.74 |
| POP>65 | Percent of population above 65 years old 1990 | 2.60 | 0.20 | 1.55 | 3.20 |
| FHHF | percent of female householder, family householder, 1990 | 2.32 | 0.20 | 1.81 | 3.19 |
| POPHD | Persons 25 years and over, % high school or higher, 1990 | 4.10 | 0.17 | 3.57 | 4.47 |
| POPCD | Persons 25 years and over, % Bachelor's degree or above, 1990 | 2.27 | 0.41 | 1.31 | 3.73 |
| OWHU | Owner-Occupied Housing Unit in percent, 1990 | 4.33 | 0.08 | 3.87 | 4.47 |
| MHU | Median Value of owner occupied housing 1990 | 10.74 | 0.26 | 9.67 | 11.68 |
| UNEMP | Unemployment rate 1990 | 2.15 | 0.35 | 1.22 | 3.25 |
| AGFF | % employed in Agr., forestry and fisheries 1990 | 3.62 | 2.66 | 0.00 | 17.10 |
| MANU | % employed in manufacturing 1990 | 3.14 | 0.57 | 0.79 | 3.98 |
| WHRT | % employed in wholesale and retail trade 1990 | 2.92 | 0.19 | 2.16 | 3.32 |
| FIRE | % employed Finance, Insurance and Real Estate 1990 | 1.23 | 0.33 | 0.00 | 2.23 |
| HLTH | % employed Health service 1990 | 1.95 | 0.34 | 0.74 | 3.44 |
| NAIX | Natural Amenities Index 1990 | 0.14 | 1.16 | -3.72 | 3.55 |
| ESBD | Establishment density 1990 | 2.93 | 0.34 | 1.87 | 4.09 |
| EFIR | Earnings in Finance Insurance and real Estate 1990 | 21075.08 | 96011.09 | 0.00 | 1638807.0 |
| CSBD | Commercial and Saving Banks deposits 1990 | 12.21 | 1.07 | 8.83 | 16.95 |
| DFEG | Direct federal expenditure and grants per capita 1990 | 7.99 | 0.38 | 6.98 | 10.18 |
| FGCE | Federal gover't civilian employment per 10,000 pop. 1990 | 60.48 | 101.03 | 0.00 | 1295.00 |
| PCTAX | Per capital local tax 1990 | 5.91 | 0.53 | 4.51 | 7.42 |
| PCPTAX | Property tax per capita 1990 | 5.52 | 0.62 | 3.91 | 7.36 |
| SCIX | Social Capital Index 1987 | -0.60 | 0.94 | -2.53 | 5.64 |
| HWD | Highway Density 1990 | 0.69 | 0.40 | -0.34 | 2.63 |
| ESBs | Establishment size 1990 | 2.53 | 0.30 | 1.49 | 3.60 |
| AWSR | Average annual wage and salary rate 1990 | 9.75 | 0.19 | 9.31 | 10.35 |
| EMP | Employment 1990 | 8.83 | 1.25 | 5.42 | 13.38 |
| INMG | In-migration 1990 | 7.09 | 1.00 | 4.54 | 10.52 |
| OTMG | out-migration 1990 | 7.04 | 0.97 | 4.50 | 10.55 |
| MHY | Median Household income 1989 | 9.94 | 0.23 | 9.06 | 10.68 |
| DGEX | Direct general exp. Per capita 1992 | 7.23 | 0.28 | 6.49 | 8.11 |

***Note:** All the variables are expressed in log terms except AGFF, EFIR, FGCE, SCIX, and NAIX*

**Table 2: Generalized Spatial 2SLS (GS2SLS) and Full Information Generalized Spatial 3SLS (GS3SLS) Estimation Results**

| | GS2SLS | | | | GS3SLS | |
|---|---|---|---|---|---|---|
| | *EMPR Equation* | | *MHYR Equation* | | *EMPR Equation* | *MHYR Equation* |
| *Variables* | *Coefficient* | *t-statistic* | *Coefficient* | *t-statistic* | *Coefficient* | *Coefficient* |
| Constant | -7.5180*** | -4.07 | 7.7602*** | 3.95 | -8.5462 | 8.5063 |
| EMPR | | | 0.2825 | 1.66 | | 0.6280 |
| MHYR | 0.1685 | 1.59 | | | 0.3808 | |
| WEMPR | 0.2492* | 1.94 | -0.1423 | -0.98 | 0.2775 | -0.1029 |
| WMHYR | 0.1657 | 1.44 | -0.0559 | -0.43 | 0.1129 | -0.2676 |
| POPs | 0.8367*** | 4.32 | 0.0877 | 0.78 | 0.7705 | -0.0332 |
| POPd | -0.0101 | -0.30 | | | -0.0119 | |
| POP5-17 | | | -0.1566 | -0.90 | | -0.1128 |
| POP25-44 | 0.2806 | 1.48 | | | 0.3087 | |
| POP>65 | | | 0.1046 | 0.98 | | 0.1641 |
| FHHF | | | -0.0031 | -0.03 | | -0.0039 |
| POPHD | -0.1589 | -1.03 | -0.2439 | -1.15 | -0.1482 | -0.1451 |
| POPCD | 0.0561 | 1.00 | -0.0989 | -1.35 | 0.0788 | -0.1132 |
| OWHU | -0.4079* | -1.77 | | | -0.3657 | |
| MHU | -0.0309 | -0.32 | 0.0955 | 0.76 | -0.0513 | 0.0789 |
| UNEMP | -0.0825** | -2.05 | 0.0442 | 0.79 | -0.0786 | 0.0695 |
| AGFF | -0.0055 | -1.11 | 0.0025 | 0.38 | -0.0060 | 0.0032 |
| MANU | 0.0856** | 2.65 | -0.0008 | -0.02 | 0.0767 | -0.0332 |
| WHRT | 0.3734*** | 4.50 | -0.0727 | -0.65 | 0.3696 | -0.1882 |
| FIRE | 0.0177 | 0.39 | -0.0471 | -0.86 | 0.0287 | -0.0616 |
| HLTH | -0.0079 | -0.20 | 0.0297 | 0.56 | -0.0158 | 0.0249 |
| NAIX | 0.0072 | 0.72 | -0.0063 | -0.47 | 0.0064 | -0.0075 |
| ESBD | 0.7049*** | 3.82 | 0.0242 | 0.27 | 0.6599 | -0.0609 |
| EFIR | -1.05216D-08 | -0.09 | | | -1.16242D-08 | |
| CSBD | 0.0406 | 1.14 | | | 0.0293 | |
| DFEG | | | 0.0002 | 0.01 | | -0.0022 |
| FGCE | 0.0001 | 0.60 | | | 0.0000 | |
| PCTAX | -0.0706 | -1.25 | | | -0.0619 | |
| PCPTAX | 0.0108 | 0.26 | | | 0.0108 | |
| SCIX | | | 0.0439* | 1.70 | | 0.0427 |
| HWD | -0.0020 | -0.04 | | | -0.0069 | |
| ESBs | 0.5536** | 2.87 | | | 0.5330 | |
| AWSR | 0.0912 | 0.94 | | | 0.0822 | |
| EMP | -0.8647*** | -4.70 | -0.0223 | -0.28 | -0.8138 | 0.1008 |
| INMG | 0.1122 | 1.38 | -0.1245 | -1.25 | 0.1429 | -0.1824 |
| OUTMG | -0.1382 | -1.65 | 0.0693 | 0.65 | -0.1385 | 0.1227 |
| MHY | 0.2334 | 1.32 | -0.7671*** | -4.35 | 0.3688 | -0.7910 |
| DGEX | 0.0608 | 1.33 | 0.0684 | 1.24 | 0.0399 | 0.0490 |
| $\sigma^2$ | | | | | *0.0319* | *0.0527* |
| $\rho$ | | | | | *-0.0428* | *0.1913* |
| *N* | *417* | | *417* | | | |
| *F-Statistic* | *10.88* | | *10.46* | | | |
| *Adj. R2* | *0.42* | | *0.34* | | | |

***Note:*** **, **, and *** denote statistical significance level at 10 percent, 5 percent and 1 percent respectively.*

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