Modeling Small Business Growth, Migration Behavior, Local Public Services and Household Income in Appalachia: A Spatial Simultaneous Equations Approach*

By

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Abstract: In this paper, a spatial simultaneous growth equilibrium model of small business growth, migration behavior, median household income and local public expenditures is developed. The model is empirically estimated by Generalized Spatial Three-Stage Least Squares estimator using count-level data from Appalachia for 1990-2000. The results suggest the existence of interdependence among the growth rates of small business, gross in-and out-migration, median household income and local public services in the form of feedback simultaneities, spatial autoregressive lag and spatial cross-regressive lag simultaneities. The findings also suggest the existence of conditional convergence with respect to endogenous variables of the model. The speeds of adjustment towards the steady states, however, are very slow which would cover many generations. The growth rate of median household income with a half–life time of about 9 years is the fastest and the growth rate of gross in-migration with a half-life time of about 180 years is the slowest to adjust. The findings also indicate the clustering of counties on the bases of their growth rates of median household incomes which would require the need for development policy coordination at the regional level, a region being defined as a group of counties, or the whole Appalachia. Another key finding of the study is also that Appalachian counties with higher initial population sizes were both destinations and sources of migrants during the study period.

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1. INTRODUCTION

Persistent rural poverty is one of the most stubborn social problems facing policy makers in the United States. Despite decades of intervention, and the spending of billions of public dollars, many rural communities remain mired 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). In traditionally lagging Appalachia, even after a decade of unprecedented expansion of the economy of the United States, many regions are still suffering from high unemployment, shrinking economic base, deeply rooted poverty, low human capital formation, and out migration (see the studies by Pollard, 2003; Black and Sanders, 2004). The slow growth of income and employment, out-migration and the disappearance of rural households are both causes and effects of persistent high rates of poverty. In the absence of vibrant firms, communities are, for instance, devoid of the capability to provide job opportunities for skilled labor and college graduates which leads to the out-migration of the same. The out-migration of educated people from such communities, in turn, erodes the income and property tax base that provides the major source of revenue to finance local public services such as schools, infrastructure, health, etc. This increases the tax price per remaining persons for any level of public spending. Consequently, the cost of providing local public services for the community at large increases. Over time, the quality and quantity of local public services deteriorates, and further out-migration results. The out-migration of skilled labor and declining population not only increase the cost of providing local public services, often resulting in a decline in the quality and quantity of these services but they also constrain the expansion and growth of small business by limiting the supply of labor and demand for small business products. Low quality and quantity of public services (such as education, health, etc.) reduces the earning capacity of residents and discourages business formation and growth. But, this fuels back into the cycle and ultimately results in the perpetuation of poverty and underdevelopment in the region. The problem is that of the existence of a vicious cycle of poverty that is locked in certain locations for generations.

Why do we see regions or counties in Appalachia with persistently low living standards while the US economy is growing? What factors explain why a spatial poverty trap exists in Appalachia? Do geographic proximities or spatial spillover effects have causal roles in determining communities' growth and development?

The relationship between economic growth and its determinants has been studied extensively in the economic literature. For example, 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 attracted considerable interest. Empirical research (Steinnes and Fischer, 1974) has 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) constructed a two-equation simultaneous system with the two partial location equations. More recently, Deller, Tsai, Marcouiller, and English (2001) expanded the original Carlino-Mills model to explicitly capture 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 the 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 Plantinga, 2003), and rate of gross in-migration, rate of gross out-migration, rate of income growth, rate of employment growth and rate of unemployment growth (Greenwood, 1975) in simultaneous-equations methods. Decisions and transactions of economic agents may also depend upon present and past behaviors of neighboring economic agents, which can yield spatial or spatiotemporal dependence. Most previous models, however, do not explicitly incorporate such spatial spillover effects.

Advances in spatial econometrics provide researchers with new avenues to address regression problems associated with the existence of spatial dependence in regional data sets. Most of the applications, however, have been in single-equation frameworks. Until recently, researchers have been in the undesirable position of having to choose between modeling spatial interactions in a single equation framework, or using multiple equations but losing the advantage of a spatial econometric approach (Rey and Boarnet, 2004). Although not an explicit spatial econometric approach, Steinnes and Fisher's (1974) model of population and employment levels was the first application that tried to incorporate spatial interactions in a simultaneous equations framework. To provide some degree of spatial interaction, they developed potential variables that aggregated community area population and employment into larger units. This enabled them to express community area population and community area employment as functions of a weighted average of employment in all community areas, and a weighted average of population in all community areas in the data set, respectively. Thus, both population and employment were endogenous variables and by use of lagged population and (instrumented) employment as regressors in the population equation and lagged employment and (instrumented) population in the employment equation, Steinnes and Fisher were able to show the direction of causality between population and employment change.

Recognizing the shortcoming of the Carlino-Mills model, Boarnet (1994) proposed a model which integrated the use of potential variables and spatial econometrics in a two-equation model of population and employment growth in New Jersey municipalities. In order to adjust for the difference in the place of residence and the place of work at the community level, he added spatial lags of the endogenous variables to the Carlino-Mills model. Since Boarnet thought that New Jersey municipalities are too small to be their own labor markets, he used a spatial cross-regressive lag model, in the sense that the right-hand side of each equation contains spatial lag of the endogenous variable from the other equation, creating spatial links across equations. Community population change depends on the change in employment aggregated over all communities within commuting distance. By the same token, community employment change depends on population change within commuting distance of the given community.

The Boarnet model was subsequently extended by Henry, Barkley, and Bao (1997) in an effort to analyze population and employment changes in rural areas and to reveal which kinds of forces are dominant. This model contains interaction terms between urban growth rates and the spatial lag variables as regressors. These linkages enabled them to examine how urban growth affects rural hinterland population and employment change. The parameter estimates on the interaction variables revealed if faster urban growth had a spread or backwash effect on proximate rural communities. Using Southern Functional Economic Areas, Henry *et al*.(1997) found a mix of spillover and backwash effects from urban core and fringe areas to their rural hinterlands. Henry, Schmitt, Kristensen, Bakley, and Bao (1999) also extended the work of Henry *et al*. (1997) by comparing empirical results across three countries (Denmark, France, and the United States) in order to evaluate how country differences in the local socio-economic conditions affect the linkage between urban growth and rural change. Their results indicate that rural population and employment changes in the regions of the three countries under study are sensitive to the performance of the urban core/fringe that is nearby. The general trends that emerge are of urban spread to rural places that have average or large labor market and population.

Herny, Schmitt, and Piguet (2001) also estimated the Carlino and Mills (1987), Boarnet (1994), and the Herny *et al*.(1997) models for six French regions and compared the results for several related spatial econometric models for simultaneous equation systems defined in the taxonomy developed in Rey and Boarnet (2004). Their results indicate that adding spatial cross-regressive terms to the Carlino-Mills model provides an important correction that results in empirical results consistent with the theory in the Carlino-Mills and Boarnet models. Besides, comparing the strength and direction of population effects on employment and vice versa, their results show that people follow jobs in rural France. Moreover, their results suggested general tendency of local spread masking both urban backwash and spread effects, depending on the pattern of urban growth between the core and the fringe.

A careful analysis of the results from such simultaneous growth models, however, shows that many of the exogenous variables in these models have proven to be weak, unstable, or statistically insignificant. Simultaneity bias could be one of the reasons for this. Most of these models, for example, treat the government sector exogenous to the system. But economic theory and empirical literature show that local government actions are endogenous to employment and population changes (Duffy-Deno and Eberts ,1991; Fay, 2000; Painter and Bae, 2001; Hashmati, 2001). Besides, the use of net population changes would involve substantial loss of information (Greenwood, 1975). Apart from being the major components of population changes, gross in- and out-migration contain more information in explaining the impacts of population dynamics on regional growth. This study develops a five-equation spatial simultaneous-equations model with the growth rates of private non-farm employment, gross in-migration, gross out-migration, median household income and local public expenditures per capita as its endogenous variables.

This study differs in major ways from previous studies. First, by expanding the 'jobs versus people' debate into 'jobs versus people (migration behavior) versus income versus local public services', it better explains the growth process and also captures the roles of regional income, migration behavior and local public services in the growth process. Second, local jurisdictions are usually subjected to central or state governments' regional polices that may result in spatial dependences in the error terms. If unaccounted for, the existence of such dependences leads to model misspecification. The presence of spatial autocorrelation in the error of each equation of the model in this study is tested using Moran's I test as suggested in Anselin and Kelejian (1997). Their presence in each equation led to the specification and estimation of a simultaneous-equations model with spatial autoregressive effects in the errors in addition to the spatial autoregressive lag and spatial cross-regressive lag effects.

The rest of the discussion is organized as follows. Section 2 discusses the details of the modeling strategy. Section 3 presents description of the variables and their sources. Section 4 discusses and presents the relevant estimation issues. The findings are presented and discussed in section 5. Finally, section 6 concludes the paper with a discussion of the summary of the findings and some policy implications.

2. MODEL DEVELOPMENT

The theoretical base for the interdependencies between population (migration behavior), 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. However, according to the principle of utility maximization, household location decisions are expected to be influenced not only by the location of job opportunities and income but also by other factors such as the provision of local public goods and services, social and natural amenities (and disamenities), demographic factors, and regional location. Similarly, the location decisions of firms 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. According to the median-voter models of local fiscal behavior, local public expenditures, however, approximate the choices of the utility-maximizing median voter and so depend on income and other revenue sources such as property taxes, income taxes, and factors that determine consumer preferences.

Regional factors that affect households', firms' and local governments' decisions are, however, more likely to exhibit lack of independence in the form of spatial autocorrelation. Spatial autocorrelation or spatial dependence refers to the statistical property where the dependent variable or error term at one location is correlated with observations on the dependent variable or error term at other locations (Anselin, 1988, 2003).

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

1. Business growth, migration behavior, median household income growth and local public expenditures per capita growth rate are interdependent and are jointly determined by county-level variables;
2. Business growth, migration behavior, median household income growth and local public expenditures per capita growth rate in any county are conditional upon initial conditions of that county; and
3. Business growth, migration behavior, median household income growth and local public expenditures per capita growth rate in a county are conditional upon business growth,

migration behavior, median household income growth and local public expenditures per capita growth rate in neighboring counties.

To test these hypotheses, I use a spatial simultaneous equations model of business growth, migration behavior, household median income and local public expenditures. Following in the Carlino and Mills tradition and building upon and extending Boarnet (1994), a model that incorporates own-county and neighboring counties effects is specified as follows in matrix notation:

$$\left\{\begin{array}{l} \mathbf{INM}_t^* = f_1[(\mathbf{OTM}_t^*, \mathbf{W\,OTM}_t^*), (\mathbf{EMP}_t^*, \mathbf{W\,EMP}_t^*) \\ \qquad ,(\mathbf{GEX}_t^*, \mathbf{W\,GEX}_t^*), (\mathbf{MHY}_t^*, \mathbf{W\,MHY}_t^*), \mathbf{W\,INM}_t^*, |\mathbf{X}_{t-1}^{in}] \\ \\ \mathbf{OTM}_t^* = f_2[(\mathbf{INM}_t^*, \mathbf{W\,INM}_t^*), (\mathbf{EMP}_t^*, \mathbf{W\,EMP}_t^*) \\ \qquad ,(\mathbf{GEX}_t^*, \mathbf{W\,GEX}_t^*), (\mathbf{MHY}_t^*, \mathbf{W\,MHY}_t^*), \mathbf{W\,OTM}_t^*, |\mathbf{X}_{t-1}^{ot}] \\ \\ \mathbf{EMP}_t^* = f_3[(\mathbf{INM}_t^*, \mathbf{W\,INM}_t^*), (\mathbf{OTM}_t^*, \mathbf{W\,OTM}_t^*) \\ \qquad ,(\mathbf{GEX}_t^*, \mathbf{W\,GEX}_t^*), (\mathbf{MHY}_t^*, \mathbf{W\,MHY}_t^*), \mathbf{W\,EMP}_t^*, |\mathbf{X}_{t-1}^{em}] \\ \\ \mathbf{GEX}_t^* = f_4[(\mathbf{INM}_t^*, \mathbf{W\,INM}_t^*), (\mathbf{OTM}_t^*, \mathbf{W\,OTM}_t^*) \\ \qquad ,(\mathbf{EMP}_t^*, \mathbf{W\,EMP}_t^*), (\mathbf{MHY}_t^*, \mathbf{W\,MHY}_t^*), \mathbf{W\,GEX}_t^*, |\mathbf{X}_{t-1}^{ge}] \\ \\ \mathbf{MHY}_t^* = f_5[(\mathbf{INM}_t^*, \mathbf{W\,INM}_t^*), (\mathbf{OTM}_t^*, \mathbf{W\,OTM}_t^*) \\ \qquad ,(\mathbf{EMP}_t^*, \mathbf{W\,EMP}_t^*), (\mathbf{GEX}_t^*, \mathbf{W\,GEX}_t^*), \mathbf{W\,MHY}_t^*, |\mathbf{X}_{t-1}^{mh}] \end{array}\right\} \ldots (1.1)$$

where $\mathbf{INM}_t^*$, $\mathbf{OTM}_t^*$, $\mathbf{EMP}_t^*$, $\mathbf{GEX}_t^*$, and $\mathbf{MHY}_t^*$ are equilibrium levels of gross in-migration, gross out-migration, private non-farm employment, per capita local public expenditures and median household income, respectively, and t indexes time. **W** is a spatial weights matrix which can be represented by $\mathbf{W} = \sum_{j=1,i=1}^{n} w_{ij}$. Each element w_{ij} in **W** represents a measure of proximity between observation (location) i and observation (location) j. and according to the adjacency criteria, w_{ij} is equal to one if observation (location) i is adjacent to observation (location) j, and zero otherwise. Therefore, $\mathbf{WINM}_t^*$, $\mathbf{WOTM}_t^*$, $\mathbf{WEMP}_t^*$, $\mathbf{WGEX}_t^*$, and $\mathbf{WMHY}_t^*$ represent the equilibrium values of neighboring counties' effect. The matrices of additional exogenous variables that are included in the respective equations of the system of spatial simultaneous equations are given by $\mathbf{X}_{t-1}^{in}$, $\mathbf{X}_{t-1}^{ot}$, $\mathbf{X}_{t-1}^{em}$, $\mathbf{X}_{t-1}^{ge}$, and $\mathbf{X}_{t-1}^{mh}$, respectively. The descriptions of these variables are given in the data section below. Note that equilibrium levels of gross in-migration, gross out-migration, private non-farm employment per capita local public expenditures and median household income are assumed to be functions of the equilibrium values of the respective right-hand included endogenous variables and their spatial lags, and the actual values of the vectors of the additional exogenous variables.

Based on the result of the PE-test, a multiplicative log-linear form of the model was used. The specification is discussed in greater detail in the section "Estimation Issues." The chosen specification implies a constant-elasticity form for the equilibrium conditions given in (1.1). A log-linear (i.e., log-log) representation of these equilibrium conditions can thus be expressed as:

$$\mathbf{INM}_t^* = \left(\mathbf{OTM}_t^*\right)^{a_1} \times \left(\mathbf{EMP}_t^*\right)^{b_1} \times \left(\mathbf{GEX}_t^*\right)^{c_1} \times \left(\mathbf{MHY}_t^*\right)^{d_1} \times \left(\mathbf{WINM}_t^*\right)^{e_1} \times \left(\mathbf{WOTM}_t^*\right)^{f_1} \times \left(\mathbf{WEMP}_t^*\right)^{g_1} \times \left(\mathbf{WGEX}_t^*\right)^{h_1} \times \left(\mathbf{WMHY}_t^*\right)^{l_1} \times \prod_{k_1=1}^{K_1} \left(\mathbf{X}_{k_1 t-1}^{in}\right)^{\mathrm{x}_{1k_1}} \tag{1.2a}$$

$$\mathbf{OTM}_t^* = \left(\mathbf{INM}_t^*\right)^{a_2} \times \left(\mathbf{EMP}_t^*\right)^{b_2} \times \left(\mathbf{GEX}_t^*\right)^{c_2} \times \left(\mathbf{MHY}_t^*\right)^{d_2} \times \left(\mathbf{WOTM}_t^*\right)^{e_2} \times \left(\mathbf{WINM}_t^*\right)^{f_2} \times \left(\mathbf{WEMP}_t^*\right)^{g_2} \times \left(\mathbf{WGEX}_t^*\right)^{h_2} \times \left(\mathbf{WMHY}_t^*\right)^{l_2} \times \prod_{k_2=1}^{K_2} (\mathbf{X}_{k_2 t-1}^{ot})^{\mathrm{x}_{2k_2}} \tag{1.2b}$$

$$\mathbf{EMP}_t^* = \left(\mathbf{INM}_t^*\right)^{a_3} \times \left(\mathbf{OTM}_t^*\right)^{b_3} \times \left(\mathbf{GEX}_t^*\right)^{c_3} \times \left(\mathbf{MHY}_t^*\right)^{d_3} \times \left(\mathbf{WEMP}_t^*\right)^{e_3} \times \left(\mathbf{WINM}_t^*\right)^{f_3} \times \left(\mathbf{WOTM}_t^*\right)^{g_3} \times \left(\mathbf{WGEX}_t^*\right)^{h_3} \times \left(\mathbf{WMHY}_t^*\right)^{l_3} \times \prod_{k_3=1}^{K_3} \left(\mathbf{X}_{k_3 t-1}^{em}\right)^{x_{3k_3}} \tag{1.2c}$$

$$\mathbf{GEX}_t^* = \left(\mathbf{INM}_t^*\right)^{a_4} \times \left(\mathbf{OTM}_t^*\right)^{b_4} \times \left(\mathbf{EMP}_t^*\right)^{c_4} \times \left(\mathbf{MHY}_t^*\right)^{d_4} \times \left(\mathbf{WGEX}_t^*\right)^{e_4} \times \left(\mathbf{WINM}_t^*\right)^{f_4}$$

$$\times \left(\mathbf{WOTM}_t^*\right)^{g_4} \times \left(\mathbf{WEMP}_t^*\right)^{h_4} \times \left(\mathbf{WMHY}_t^*\right)^{l_4} \times \prod_{k_4=1}^{K_4} \left(\mathbf{X}_{k_4 t-1}^{em}\right)^{x_{4k_4}} \qquad (1.2d)$$

$$\mathbf{MHY}_t^* = \left(\mathbf{INM}_t^*\right)^{a_5} \times \left(\mathbf{OTM}_t^*\right)^{b_5} \times \left(\mathbf{EMP}_t^*\right)^{c_5} \times \left(\mathbf{GEX}_t^*\right)^{d_5} \times \left(\mathbf{WMHY}_t^*\right)^{e_5} \times \left(\mathbf{WINM}_t^*\right)^{f_5}$$

$$\times \left(\mathbf{WOTM}_t^*\right)^{g_5} \times \left(\mathbf{WEMP}_t^*\right)^{h_5} \times \left(\mathbf{WGEX}_t^*\right)^{l_5} \times \prod_{k_5=1}^{K_5} \left(\mathbf{X}_{k_5 t-1}^{em}\right)^{x_{5k_5}} \qquad (1.2e)$$

where $a_i, b_i, c_i, d_i, e_i, f_i, g_i, h_i$ and l_i i=1,...,5 are the exponents on the endogenous variables and their spatial lags, x_{ik_q} for $i, q = 1,...,5$ are vectors of exponents on the exogenous variables, $\prod$ is the product operator, and K_i for $i = 1,...,5$ are the number of exogenous variables in the gross in-migration, gross out-migration, private non-farm employment, per capita local public expenditures 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, population and median household income likely adjust to their equilibrium levels with a substantial lag (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 (1.1) is of the form:

$$\frac{\mathbf{INM}_t}{\mathbf{INM}_{t-1}}=\left(\frac{\mathbf{INM}_t^*}{\mathbf{INM}_{t-1}}\right)^{\eta_{in}}\rightarrow \ln\left(\mathbf{INM}_t\right)-\ln\left(\mathbf{INM}_{t-1}\right)=\eta_{in}\ln\left(\mathbf{INM}_t^*\right)-\eta_{in}\ln\left(\mathbf{INM}_{t-1}\right) \quad (1.3a)$$

$$\frac{\mathbf{OTM}_t}{\mathbf{OTM}_{t-1}}=\left(\frac{\mathbf{OTM}_t^*}{\mathbf{OTM}_{t-1}}\right)^{\eta_{ot}}\rightarrow \ln\left(\mathbf{OTM}_t\right)-\ln\left(\mathbf{OTM}_{t-1}\right)=\eta_{ot}\ln\left(\mathbf{OTM}_t^*\right)-\eta_{ot}\left(\mathbf{OTM}_{t-1}\right) \quad (1.3b)$$

$$\frac{\mathbf{EMP}_t}{\mathbf{EMP}_{t-1}}=\left(\frac{\mathbf{EMP}_t^*}{\mathbf{EMP}_{t-1}}\right)^{\eta_{em}}\rightarrow \ln\left(\mathbf{EMP}_t\right)-\ln\left(\mathbf{EMP}_{t-1}\right)=\eta_{em}\ln\left(\mathbf{EMP}_t^*\right)-\eta_{em}\left(\mathbf{EMP}_{t-1}\right) \quad (1.3c)$$

$$\frac{\mathbf{GEX}_t}{\mathbf{GEX}_{t-1}}=\left(\frac{\mathbf{GEX}_t^*}{\mathbf{GEX}_{t-1}}\right)^{\eta_{ge}}\rightarrow \ln\left(\mathbf{GEX}_t\right)-\ln\left(\mathbf{GEX}_{t-1}\right)=\eta_{ge}\ln\left(\mathbf{GEX}_t^*\right)-\eta_{ge}\left(\mathbf{GEX}_{t-1}\right) \quad (1.3d)$$

$$\frac{\mathbf{MHY}_t}{\mathbf{MHY}_{t-1}}=\left(\frac{\mathbf{MHY}_t^*}{\mathbf{MHY}_{t-1}}\right)^{\eta_{mh}}\rightarrow \ln\left(\mathbf{MHY}_t\right)-\ln\left(\mathbf{MHY}_{t-1}\right)=\eta_{mh}\ln\left(\mathbf{MHY}_t^*\right)-\eta_{mh}\ln\left(\mathbf{MHY}_{t-1}\right) \quad (1.3e)$$

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

Since the model in this study has right-hand side endogenous variables, Moran I test as suggested in Anselin and Kelejian (1997) in models with endogenous regressors was used to detect the existence of spatial dependences in the disturbances. The results of the test show the existence of spatial autoregressive effect in each of the equations of the model. The results are given in Table 2.

Substituting from equations (1.2a) – (1.2e) into equations (1.3a) - (1.3e) to eliminate unknown equilibrium values and simplifying yields:

$$\begin{aligned}\mathbf{INMR}_t &= \alpha_1 + \frac{\eta_{in}a_1}{\eta_{ot}}\mathbf{OTMR}_t + \frac{\eta_{in}b_1}{\eta_{em}}\mathbf{EMPR}_t + \frac{\eta_{in}c_1}{\eta_{ge}}\mathbf{GEXR}_t + \frac{\eta_{in}d_1}{\eta_{mh}}\mathbf{MHYR}_t + \frac{\eta_{in}e_1}{\eta_{in}}\left(\mathbf{WINMR}_t\right)\\ &+ \frac{\eta_{in}f_1}{\eta_{ot}}\mathbf{WOTMR}_t + \frac{\eta_{in}g_1}{\eta_{em}}\mathbf{WEMPR}_t + \frac{\eta_{in}h_1}{\eta_{ge}}\mathbf{WGEXR}_t + \frac{\eta_{in}l_1}{\eta_{mh}}\mathbf{WMHYR}_t\\ &+ \eta_{in}a_1\ln\left(\mathbf{OTM}_{t-1}\right) + \eta_{in}b_1\ln\left(\mathbf{EMP}_{t-1}\right) + \eta_{in}c_1\ln\left(\mathbf{GEX}_{t-1}\right) + \eta_{in}d_1\ln\left(\mathbf{MHY}_{t-1}\right)\\ &+ \eta_{in}e_1\ln\left(\mathbf{WINM}_{t-1}\right) + \eta_{in}f_1\ln\left(\mathbf{WOTM}_{t-1}\right) + \eta_{in}g_1\ln\left(\mathbf{WEMP}_{t-1}\right) + \eta_{in}h_1\ln\left(\mathbf{WGEX}_{t-1}\right)\\ &+ \eta_{in}l_1\ln\left(\mathbf{WMHY}_{t-1}\right) + \eta_{in}x_{1k_1}\ln\prod_{k_1=1}^{K_1}\left(\mathbf{X}_{k_1t-1}^{in}\right) - \eta_{in}\ln\left(\mathbf{INM}_{t-1}\right) + \rho_1\mathbf{Wu}_{\mathrm{t}}^{\mathrm{in}} + \boldsymbol{\varepsilon}_{\mathrm{t}}^{\mathrm{in}}\end{aligned} \tag{1.4a}$$

$$\begin{aligned}\mathbf{OTMR}_t &= \alpha_2 + \frac{\eta_{ot}a_2}{\eta_{in}}\mathbf{INMR}_t + \frac{\eta_{ot}b_2}{\eta_{em}}\mathbf{EMPR}_t + \frac{\eta_{ot}c_2}{\eta_{ge}}\mathbf{GEXR}_t + \frac{\eta_{ot}d_2}{\eta_{mh}}\mathbf{MHYR}_t + \frac{\eta_{ot}e_2}{\eta_{ot}}\left(\mathbf{WOTMR}_t\right)\\ &+ \frac{\eta_{ot}f_2}{\eta_{in}}\mathbf{WINMR}_t + \frac{\eta_{ot}g_2}{\eta_{em}}\mathbf{WEMPR}_t + \frac{\eta_{ot}h_2}{\eta_{ge}}\mathbf{WGEXR}_t + \frac{\eta_{ot}l_2}{\eta_{mh}}\mathbf{WMHYR}_t\\ &+ \eta_{ot}a_2\ln\left(\mathbf{INM}_{t-1}\right) + \eta_{ot}b_2\ln\left(\mathbf{EMP}_{t-1}\right) + \eta_{ot}c_2\ln\left(\mathbf{GEX}_{t-1}\right) + \eta_{ot}d_2\ln\left(\mathbf{MHY}_{t-1}\right)\\ &+ \eta_{ot}e_2\ln\left(\mathbf{WINM}_{t-1}\right) + \eta_{ot}f_2\ln\left(\mathbf{WOTM}_{t-1}\right) + \eta_{ot}g_2\ln\left(\mathbf{WEMP}_{t-1}\right) + \eta_{ot}h_2\ln\left(\mathbf{WGEX}_{t-1}\right)\\ &+ \eta_{ot}l_2\ln\left(\mathbf{WMHY}_{t-1}\right) + \eta_{ot}x_{2k_2}\ln\prod_{k_2=1}^{K_2}\left(\mathbf{X}_{k_2t-1}^{ot}\right) - \eta_{ot}\ln\left(\mathbf{OTM}_{t-1}\right) + \rho_2\mathbf{Wu}_{\mathrm{t}}^{\mathrm{ot}} + \boldsymbol{\varepsilon}_{\mathrm{t}}^{\mathrm{ot}}\end{aligned} \tag{1.4b}$$

$$\begin{aligned}\mathbf{EMPR}_t &= \alpha_3 + \frac{\eta_{em}a_3}{\eta_{in}}\mathbf{INMR}_t + \frac{\eta_{em}b_3}{\eta_{ot}}\mathbf{OTMR}_t + \frac{\eta_{em}c_3}{\eta_{ge}}\mathbf{GEXR}_t + \frac{\eta_{em}d_3}{\eta_{mh}}\mathbf{MHYR}_t + \frac{\eta_{em}e_3}{\eta_{em}}\left(\mathbf{WEMPR}_t\right)\\ &+ \frac{\eta_{em}f_3}{\eta_{in}}\mathbf{WINMR}_t + \frac{\eta_{em}g_3}{\eta_{ot}}\mathbf{WOTMR}_t + \frac{\eta_{em}h_3}{\eta_{ge}}\mathbf{WGEXR}_t + \frac{\eta_{em}l_3}{\eta_{mh}}\mathbf{WMHYR}_t\\ &+ \eta_{em}a_3\ln\left(\mathbf{INM}_{t-1}\right) + \eta_{em}b_3\ln\left(\mathbf{OTM}_{t-1}\right) + \eta_{em}c_3\ln\left(\mathbf{GEX}_{t-1}\right) + \eta_{em}d_3\ln\left(\mathbf{MHY}_{t-1}\right)\\ &+ \eta_{em}e_3\ln\left(\mathbf{WINM}_{t-1}\right) + \eta_{em}f_3\ln\left(\mathbf{WOTM}_{t-1}\right) + \eta_{em}g_3\ln\left(\mathbf{WEMP}_{t-1}\right) + \eta_{em}h_3\ln\left(\mathbf{WGEX}_{t-1}\right)\\ &+ \eta_{em}l_3\ln\left(\mathbf{WMHY}_{t-1}\right) + \eta_{em}x_{3k_3}\ln\prod_{k_3=1}^{K_3}\left(\mathbf{X}_{k_3t-1}^{em}\right) - \eta_{em}\ln\left(\mathbf{EMP}_{t-1}\right) + \rho_3\mathbf{Wu}_{\mathrm{t}}^{\mathrm{em}} + \boldsymbol{\varepsilon}_{\mathrm{t}}^{\mathrm{em}}\end{aligned} \tag{1.4c}$$

$$\begin{aligned}\mathbf{GEXR}_t &= \alpha_4 + \frac{\eta_{ge}a_4}{\eta_{in}}\mathbf{INMR}_t + \frac{\eta_{ge}b_4}{\eta_{ot}}\mathbf{OTMR}_t + \frac{\eta_{ge}c_4}{\eta_{em}}\mathbf{EMPR}_t + \frac{\eta_{ge}d_4}{\eta_{mh}}\mathbf{MHYR}_t + \frac{\eta_{ge}e_4}{\eta_{ge}}\left(\mathbf{WGEXR}_t\right)\\ &+ \frac{\eta_{ge}f_4}{\eta_{in}}\mathbf{WINMR}_t + \frac{\eta_{ge}g_4}{\eta_{ot}}\mathbf{WOTMR}_t + \frac{\eta_{ge}h_4}{\eta_{em}}\mathbf{WEMPR}_t + \frac{\eta_{ge}l_4}{\eta_{mh}}\mathbf{WMHYR}_t\\ &+ \eta_{ge}a_4\ln\left(\mathbf{INM}_{t-1}\right) + \eta_{ge}b_4\ln\left(\mathbf{OTM}_{t-1}\right) + \eta_{ge}c_4\ln\left(\mathbf{EMP}_{t-1}\right) + \eta_{ge}d_4\ln\left(\mathbf{MHY}_{t-1}\right)\\ &+ \eta_{ge}e_4\ln\left(\mathbf{WINM}_{t-1}\right) + \eta_{ge}f_4\ln\left(\mathbf{WOTM}_{t-1}\right) + \eta_{ge}g_4\ln\left(\mathbf{WEMP}_{t-1}\right) + \eta_{ge}h_4\ln\left(\mathbf{WGEX}_{t-1}\right)\\ &+ \eta_{ge}l_4\ln\left(\mathbf{WMHY}_{t-1}\right) + \eta_{ge}x_{4k_4}\ln\prod_{k_4=1}^{K_4}\left(\mathbf{X}_{k_4t-1}^{ge}\right) - \eta_{ge}\ln\left(\mathbf{GEX}_{t-1}\right) + \rho_4\mathbf{Wu}_{\mathrm{t}}^{\mathrm{ge}} + \boldsymbol{\varepsilon}_{\mathrm{t}}^{\mathrm{ge}}\end{aligned} \tag{1.4d}$$

$$
\begin{aligned}
\mathbf{MHYR}_t &= \alpha_5 + \frac{\eta_{mh}a_5}{\eta_{in}}\mathbf{INMR}_t + \frac{\eta_{mh}b_5}{\eta_{ot}}\mathbf{OTMR}_t + \frac{\eta_{mh}c_5}{\eta_{em}}\mathbf{EMPR}_t + \frac{\eta_{mh}d_4}{\eta_{ge}}\mathbf{GEXR}_t + \frac{\eta_{mh}e_5}{\eta_{mh}}\left(\mathbf{WMHYR}_t\right) \\
&+ \frac{\eta_{mh}f_5}{\eta_{in}}\mathbf{WINMR}_t + \frac{\eta_{mh}g_5}{\eta_{ot}}\mathbf{WOTMR}_t + \frac{\eta_{mh}h_5}{\eta_{em}}\mathbf{WEMPR}_t + \frac{\eta_{mh}l_4}{\eta_{ge}}\mathbf{WGEXR}_t \\
&+ \eta_{mh}a_5\ln\left(\mathbf{INM}_{t-1}\right) + \eta_{mh}b_5\ln\left(\mathbf{OTM}_{t-1}\right) + \eta_{mh}c_5\ln\left(\mathbf{EMP}_{t-1}\right) + \eta_{mh}d_5\ln\left(\mathbf{GEX}_{t-1}\right) \\
&+ \eta_{mh}e_5\ln\left(\mathbf{WINM}_{t-1}\right) + \eta_{mh}f_5\ln\left(\mathbf{WOTM}_{t-1}\right) + \eta_{mh}g_5\ln\left(\mathbf{WEMP}_{t-1}\right) + \eta_{mh}h_5\ln\left(\mathbf{WGEX}_{t-1}\right) \\
&+ \eta_{mh}l_5\ln\left(\mathbf{WMHY}_{t-1}\right) + \eta_{mh}x_{5k_5}\ln\prod_{k_5=1}^{K_5}\left(\mathbf{X}^{ge}_{k_5t-1}\right) - \eta_{mh}\ln\left(\mathbf{MHY}_{t-1}\right) + \rho_5\mathbf{Wu}^{\mathrm{mh}}_{\mathrm{t}} + \boldsymbol{\varepsilon}^{\mathrm{mh}}_{\mathrm{t}} \qquad (1.4e)
\end{aligned}
$$

where $\mathbf{INMR}_t, \mathbf{OTMR}_t, \mathbf{EMPR}_t, \mathbf{GEXR}_t$ and $\mathbf{MHYR}_{\mathrm{t}}$ represent the log difference between the end and beginning period values of gross in-migration, gross out-migration, private non-farm employment, local government expenditures per capita, and median household income, respectively. They denote the growth rates of the respective variables. α_r and ρ_r, for $r = 1,...,5$, are unobserved parameters. $\mathbf{u}_t^{in}, \mathbf{u}_t^{ot}, \mathbf{u}_t^{em}, \mathbf{u}_t^{ge}$ and $\mathbf{u}_t^{mh}$ are n x 1 vectors of disturbances, and $\boldsymbol{\varepsilon}_t^{in}, \boldsymbol{\varepsilon}_t^{ot}, \boldsymbol{\varepsilon}_t^{em}, \boldsymbol{\varepsilon}_t^{ge}$ and $\boldsymbol{\varepsilon}_t^{mh}$ are n x 1 vectors of innovations. Note that the disturbance vector in the r th equation is generated as:

$$
\mathbf{u}_{t,r} = \rho_r \mathbf{W}\mathbf{u}_t + \boldsymbol{\varepsilon}_{t,r}, \quad r = 1,...,5 .
$$

This specification relates the disturbance vector in the rth equation to its own spatial lag. The vectors of innovations ($\varepsilon_{it,r}, \quad r = 1,...,5$ or $\boldsymbol{\varepsilon}_t^{in}, \boldsymbol{\varepsilon}_t^{ot}, \boldsymbol{\varepsilon}_t^{em}, \boldsymbol{\varepsilon}_t^{ge}$ and $\boldsymbol{\varepsilon}_t^{mh}$) are distributed identically and independently with zero mean and variance covariance equal to σ_r^2, for $r = 1,...,5$. Hence, they are not spatially correlated. The specification of the mode, however, allows for innovations that correspond to the same cross sectional unit to be correlated across equations. As a result, the vectors of disturbances are spatially correlated across units and across equations.

Equations (1.4a)-(1.4e) constitute a system of simultaneous equations with feedback simultaneity, spatial autoregressive lag simultaneity, spatial cross-regressive lag simultaneity, and spatial autoregressive disturbances. The endogenous variables of the model are

$\mathbf{INMR}_t, \mathbf{OTMR}_t, \mathbf{EMPR}_t, \mathbf{GEXR}_t$ and $\mathbf{MHYR}_t$ and if each equation is investigated separately, we notice that each of these variables is expressed in terms of the right hand included endogenous variables and their spatial lags, the logs of the predetermined (lagged) endogenous variables and their spatial lags, and the logs of other exogenous variables. From equations (1.3a)-(1.3e), however, we see that each of the logs of the predetermined (lagged) endogenous variables is included in the respective endogenous variables. Similarly, it can be shown that each of the spatial lags of the logs of the predetermined (lagged) endogenous variables is included in the spatial lags of the respective endogenous variables. Hence, in order to avoid multicollinearity, the model is estimated by excluding all the predetermined (lagged) endogenous variables, except the own lag, and all the spatial lags of the predetermined (lagged) endogenous variables.

3. DATA TYPE AND SOURCES

The data for the empirical analysis is for all 418 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. County-level data for employment, gross in-migration, gross out-migration, local government expenditures and median household income have been collected for 1990 and 2000. In addition, data for a number of control variables have been collected for 1990 from the different sources (see table 1 for the data description).

Dependent Variables

The dependent variables used in the empirical analysis include growth rate of employment, growth rate of gross in-and out-migration, growth rate of median household income and growth rate of per capita direct local government expenditures.

Growth Rate of Employment (EMPR): The growth rate of employment is measured by the log-difference between the 2000 and the 1990 levels of private non-farm employment. It is used as a proxy for the growth rate of small business. The justification for this measure is based on the results from empirical studies that indicate that newly created jobs are generated by new businesses that start small (Acs and Audretsch, 2001; Audretsch *et al*., 2000; Carree and Thurik, 1998, 1999; Wennekers and Thurik, 1999; Fritsch and Falck, 2003). Research by the U.S. Small Business Administration also shows that job creation capacity in the U.S. is inversely related to the size of the business. Between 1991 and 1995, for example, the net jobs created in enterprises employing fewer than 500 people was 3.843 million (1-4), 3.446 million (5-19), 2.546 million (20-99), and 1.011 million (100-499), respectively; whereas enterprises employing 500 or more people lost 3.182 million net jobs (U.S. Small Business Administration, 1999).

Growth Rate of Gross In-Migration (INMR): The growth rate of gross in-migration is measured by the log-difference between the levels of gross in-migration into a given county in 2000 and in 1990.

Growth Rate of Gross Out-Migration (OTMR): The growth rate of gross out-migration is measured by the log-difference between the levels of gross out-migration away from a given county in 2000 and in 1990. The gross in- and gross out-migration variables are used as measures of migration behavior in contrast to the use of net-migration. The use of both gross in-migration and gross out-migration variables is preferable to the use of variable relating to net-migration (see Bowman and Myers (1967) and Sjaastad (1962) for details on this issue). Greenwood (1975) also argued that the use of net-migration concept would involve a substantial loss of information and posses no apparent advantages that cannot also be achieved by regarding the effects of net migration as the sum of the effects of gross in- and gross out-migration. Note that the effects of migration on the sending and on the receiving counties depend critically on the characteristics of the migrants themselves and for any county in-migrants and out-migrants are not likely to have identical characteristics. Moreover, certain variables that are relevant to explaining gross in-migration are not relevant to explaining gross out-migration and the magnitudes of the influence of certain variables on gross in-migration is likely to be different from the magnitudes of these variables on gross out-migration. The models employed in this study attempt to explain the determinants and consequences of gross in- and gross out-migration without the explicit introduction of an individual decision functions. Rather, gross in- and gross out-migration are related to a number of aggregate variables.

Growth Rate of Median Household Income (MHYR): The log-difference between the 1999 and the 1989 levels of median household income in a given county is used to measure the growth rate of median household income. Median household income is used as an average overall measure of county-level income. Median household income is preferable to using the mean or average household income figure, because unlike the mean the median is not influenced by the presence of few extreme values.

Growth Rate of Direct Local Government Expenditures (GEXR): . Local governments spend money on local public services such as education, recreation, police, infrastructure, and others. The total local government expenditures at county-level on local public services divided by the total county population is used as a measure of local public services. The growth rate of direct local government expenditures per capita is measured by the log-difference between the 2002 and the 1992 levels of per capita local government expenditures.

The spatial lag of the Growth Rate of Employment (**WEMPR**), Growth Rate of Gross In-Migration (**WINMR**), Growth Rate of Gross Out-Migration (**WOTMR**), Growth Rate of Median Household Income (**WMHYR**), and Growth Rate of Direct Local Government Expenditures (**WGEXR**) are included on the right hand side of each equation of (1.4)-(1.4e). These spatially lagged endogenous variables are created by multiplying each of the dependent variables by a row standardized queen-based contiguity spatial weights matrix $\mathbf{W}$.

Independent Variables

A number of independent variables are used in the empirical analysis. These variables include demographic, human capital, labor market, housing, industry structure, and amenity and policy variables. In line with the literature, unless otherwise indicated, the initial values of the independent variable are used in the analysis. This type of formulation also reduces the problem of endogeneity. All the independent variables are in log form except those that can take negative or zero values. The descriptions of each of the independent variables of the models are given below.

Equations (1.4a) and (1.4b) contain vectors $\mathbf{X}^{in}_{k_1 t-1}$ and $\mathbf{X}^{ot}_{k_2 t-1}$, for $k_1 = 1,\ldots,K_1$, and , $k_2 = 1,\ldots,K_2$ that include exogenous variables, which are believed to affect gross in-migration into and gross out-migration from a county, respectively. These include: county unemployment rate (UNEMP), county area (AREA), county initial population size (POPs), percentage of owner occupied dwelling (OWHU), median contract rent of housing cost (MCRH), Natural Amenity Index (NAIX)[1], and local public expenditures per capita per unit of personal income tax per capita (EXTAX).

The county unemployment rate (UNEMP) indicates the extent of economic distress in the county and it is expected to exert a negative influence on net migration. POPs is included to account for the positive impacts of the potential spillover effects and good economic opportunities that are associated with larger population areas on migration. OWHU is included to measure community stability and neighborhood quality which are potential attractions to migrants. MCRH is included to account for the potential impacts the cost of renter occupied housing on in-migration. To account for the differential impact of the quality of places on migration behavior, NAIX is included in both equations. How much of the tax paid is put back in

[1] I use the Natural Amenity Index from http://www.ers.usda.gov/Data/NaturalAmenities/natamenf.xls created by David A. McGranahan (1999) from standardized mean values of climate measures (January temperature, January days of sun, July temperature, and July humidity), topographic variation and water area as proportion of county area.

the form of local public service may be more important in influencing migration behavior than the absolute amount of tax paid. EXTAX is included in both equations to account for this type of differential effects on migration behavior.

Equation (1.4c) includes a vector of control variables ($\mathbf{X}^{em}_{k_3 t-1}$) for $k_3 = 1,...,K_3$, which consists of, among others, human capital, agglomeration effects, unemployment, and other regional socio-economic variables that are assumed to influence county employment growth (business growth) rate. Human capital is measured as the percentage of adults (over 25 years old) with college degrees and above (POPCD), and the percentage of adults (over 25 years old) with high school diploma (POPHD) and it is expected that educational attainment is positively associated with employment growth (business growth). To control for agglomeration effects from both the supply and demand sides, the percentage of the population between 25 and 44 of age (POP25-44) is included and it is expected that agglomeration effects to have a positive impact on employment growth (business growth). The proportion of female household header families (FHHF) is included to control for the effect of local labor market characteristics on employment. The county unemployment rate (UNEMP) is also included as a measure of local economic distress. Although a high county unemployment rate is normally associated with a poor economic environment, it may provide an incentive for individuals to form new businesses that can employ not only the owners, but also others. Thus, we don know a priori whether the impact of UNEMP on employment growth is positive or negative. Establishment density (ESBd), which is the total number of private sector establishments in the county divided by the total county's population, is included to capture the degree of competition among firms and crowding of businesses relative to the population. The coefficient on ESBd is expected to be negative. Vector $\mathbf{X}^{em}_{k_3 t-1}$ also includes OWHU to capture the effects of the availability of resources to finance businesses and create jobs on employment growth in the county. The percentage of owner-occupied dwellings is expected to be positively associated with employment growth in the county. Also included in $X^{em}_{k_3 it-1}$ are property tax per capita (PCPTAX), percentage of private employment in manufacturing (MANU), percentage of private employment in whole sale and retail trade (WHRT), Social Capital Index (SCIX)[2] , NAIX, and highway density (HWD).

The vector of exogenous variables ($\mathbf{X}^{ge}_{k_4 t-1}$), $k_4 = 1,..., K_4$ in equation (1.4d) contains POPs, percentage of school age population (POP5-17), Serious Crime per 100,000 population (SCRM), Direct Federal Expenditure and Grants Per Capita (DFEG), Per Capita Personal Income Tax (PCTAX), Per Capita Long-Term Outstanding Debt (PCLD), and Per Capita Long-Term Debt (LTD).

Equation (1.4e) also contains a vector of exogenous variables ($\mathbf{X}^{mh}_{k_5 t-1}, k_5 = 1,..., K_5$), which includes, among others, POPs, $POPs^2$, FHHF, POPHD, UNEMP, MANU, WHRT, and SCIX.

The initial levels of employment (EMPt-1), gross in-migration (INMt-1), gross out-migration (OTMt-1), median household income (MHYt-1) and direct local government expenditures per capita (GEXt-1) are also included in the respective equations of (1.4a)-(1.4e). These variables are treated as predetermined variables because their values are given at the beginning of each period and hence are not affected by the endogenous variables. Table 1 provides the full list of the endogenous, the spatial lag and control variables, their descriptions and the sources of the data.

[2] I thank Anil Rupasingha, Stephan J. Goetz and David Freshwater (2006) for allowing me to use their data set on Social Capital Index for U. S. counties. They created a social capital index at the county-level by extracting principal components from associational density (associations such as civic groups, religious organizations, sport clubs, labor unions, political and business organizations), percentage of voters who vote for presidential elections, county-level response rate to the Census Bureau's decennial census, and the number of tax-exempt non-profit organizations

4. ESTIMATION ISSUES

Estimating equations (1.4a)-(1.4e) constitute a model with feedback simultaneity, spatial autoregressive lag simultaneity, and spatial cross-regressive lag simultaneity with spatially autoregressive disturbances. This creates a number of complications of which the question of whether or not each equation is identified and the choice of the estimator and instruments are the important ones. As to the question of identification, first, for each equation in the model, I checked that the number of the endogenous variables that appear on the right hand side of the equation is less than the number of control and additional endogenous variables that appear in the model but not in that equation. Second, in the cases where there are more instruments than needed to identify an equation, a test statistic is computed following Hausman (1983)[3] in order to investigate whether the additional instruments are valid in the sense that they are uncorrelated with the error term. That is $E\left(\mathbf{N}'\mathbf{u}_r\right)=0$, where E is the expectation operator and **N** is an instrument matrix as defined below. A fulfillment of this condition ensures that the instrument **N** allows us to identify the regression parameters $\left[\alpha',\beta',\lambda',\gamma'\right]$ of equations (1.4a)-(1.4e), where α' is a vector of slope coefficients and β',λ',γ' are vectors of coefficients on the right–hand side dependent variables, the spatial lag variables and the predetermined variables, respectively. All the equations of the model are appropriately identified because the hypothesis of orthogonality for each equation cannot be rejected even at p= 0.02 as indicated by the nR_u^2 test statistics in Table 2.

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[3] This test statistic is obtained as nR_u^2, where n is the sample size and R_u^2 is the usual R-squared of the regression of residuals from the second-stage estimation on all included and excluded instruments. In other words, simply estimate equations (1.4a)- (1.4e) by GS2SLS or any efficient limited-information estimator and obtain the resulting residuals, $\hat{u}_r$. Then, regress these on all instruments and calculate nR_u^2. The statistic has a limiting chi-squared distribution with degree of freedom equal to the number of over-identifying restrictions, under the assumed specification of the model.

As to the choice of estimator, we prefer Method of Moments approach to that of the maximum likelihood because the latter would involve significant computational complexity[4]. Incidentally, the conventional three-stage least squares estimation to handle the feedback simultaneity would be inappropriate in this context given the spatial autoregressive lag and spatial cross-regressive lag simultaneities terms. The Spatial Generalized Methods of Moments approach followed by Rey and Boarnet (2004) in a Monte Carlo analysis of alternative approaches to modeling spatial simultaneity is also in appropriate given that the model includes spatially autoregressive disturbances. Therefore, I follow the Generalized Spatial Three-Stage Least Squares (GS3SLS) approach outlined by Kelejian and Prucha (2004). The GS3SLS procedure is done in a four step routine. In the first step, the parameter vector consisting of alphas, betas, lambdas and gammas $\left[\alpha', \beta', \lambda', \gamma'\right]$ are estimated by two stage least squares (2SLS) using an instrument matrix **N** that consists of a subset of $\mathbf{X}, \mathbf{WX}, \mathbf{W^2X}$, where **X** is the matrix that includes all control variables in the model, and **W** is a row standardized queen-based contiguity weights matrix. The disturbances for each equation in the model are computed by using the estimates for alphas, betas, lambdas and gammas from the first step. In the second step, these estimates of the disturbances are used to estimate the autoregressive parameter ρ for each equation using Kelejian and Prucha's (2004) 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. Generalized Spatial Two-Stage Least Squares (GS2SLS) estimators for alphas, betas, lambdas and gammas can be obtained by estimating the transformed model using a subset of the linearly independent columns of

[4] In the maximum likelihood approach, the probability of the joint distribution of all observations is maximized with respect to a number of relevant parameters. This involves, among others, the calculation of the Jacobian determinant that appears in the log-likelihood function, which is computationally intensive, challenging and complex. The complexity even becomes overwhelming if the sample size is large, which is true in this case, and if the spatial weights matrices are not symmetric, which is also true in this case, even if the sample size is moderate (Kelejian and Prucha, 1999, 1998). I do not also expect the error terms in my model to be normally distributed unlike what the maximum-likelihood procedure would require.

$\left[\mathbf{X}, \mathbf{WX}, \mathbf{W}^2\mathbf{X}\right]$ as the instrument matrix. GS2SLS does not, however, utilize the information available across equation because it does not take into account the potential cross equation correlation in the innovation vectors $\boldsymbol{\varepsilon}_{it}^{in}, \boldsymbol{\varepsilon}_{it}^{ot}, \boldsymbol{\varepsilon}_{it}^{em}$ and $\boldsymbol{\varepsilon}_{it}^{mh}$. 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 estimators of alphas, betas, lambdas, and gammas are obtained by estimating this stacked model.

5. RESULTS AND DISCUSSION

Cross sectional data from all Appalachian counties for 1990-2000 are used for the empirical implementation of the model. The descriptive statistics for the variables in the model is given in Table 3. The Feasible Generalized Three-Stage Least Squares (FGS3SLS) parameter estimates are presented in Table 2. The parameter estimates are mostly consistent with the theoretical expectations. The coefficients on the endogenous variables in all equations of the system, with the exception of the coefficients on MHYR in the EMPR equation, are statistically highly significant. This indicates the existence of very strong *feedback simultaneities* among the dependent variables of the spatial simultaneous equations system. The results also show many strong *spatial autoregressive lag* and *spatial cross-regressive lag simultaneities*. Besides, all of the coefficients on the lagged dependent variables are statistically highly significant, indicating the existence of conditional convergence with respect to each of the endogenous variables conditional on the set of exogenous variables included in each equation of the model. In general, the above three observations support the three basic hypotheses set in this study.

Employment (Business) Growth Rate

The results in Table 2 indicate that the growth rate of employment (EMPR) in a county is strongly dependent on the growth rates of gross in-migration (INMR), gross out-migration (OTMR) and direct local government expenditures (GEXR). Each of these variables, in turn, is strongly affected by the growth rate of employment (EMPR). The coefficient on INMR, for example, is positive and statistically significant at the one percent level. The coefficient on the EMPR in the INMR equation is also positive and statistically significant at the one percent level. These indicate that counties with high growth rate in gross in-migration are favorable for small business growth and the growth in small business further leads to increases in the growth of gross in-migration into the counties. Similarly, the interdependence between the growth rates of employment and gross out-migration is very strong. The coefficient for OTMR is negative and statistically significant at the one percent level. The coefficient for EMPR in the OTMR equation is also negative and statistically significant at the one percent level. This means counties with high out-migration have factors that discourage small business growth and absence of small business growth, in turn, encourages out-migration.

Concerning the relationship between the rate of growth of direct local government expenditures and the rate of growth of employment, the results show that the rate of growth in direct local government expenditures has strong negative impact on the rate of growth of employment. This is indicated by the negative and statistically significant, at the one percent level, coefficient on GEXR in the EMPR equation. This may seem to be inconsistent with theoretical expectations. But, the effects of government expenditure depend on the nature/type of that expenditure. Government expenditures on education, health care, fire protection, crime prevention, are more likely to increase labor productivity and hence generate employment. On the other hand, government expenditures on unemployment insurance, welfare payments, etc. have disincentives to work and are more likely to reduce labor productivity and hence growth and employment (Helms, 1985; Jones,1990). The results in this study reflect this reality in Appalachia. Traditionally, Appalachia has had higher than average payments from federal assistance programs such as Food Stamps, Social Security Disability Insurance (SSDI), and

Temporary Assistance for Needy Families (TANF) and Supplemental Security Income (SSI) (Black and Sanders, 2004).

To control for the potential effects of spatial spillover effects on the rate of growth of employment, spatial lags of the endogenous variables are included in the EMPR equation. The results suggest a negative and significant parameter estimate on the spatial autoregressive lag variable (WEMPR). This coefficient represents the spatial autoregressive simultaneity and indicates that the growth rate of employment in a given county tends to spillover to neighboring counties and has negative effects on their rates of growth of employment. The results also show a positive and significant parameter estimate on the spatial cross-regressive variable with respect to the rate of growth of gross out-migration (WOTMR) indicating that an increase in the rate of growth of gross out-migration in neighboring counties tends to encourage business (employment) in a given county. This is possible because the out-migrants from neighboring counties may end up in the county providing the capital and labor that are required for business expansion. The results also show negative spatial cross-regressive effects with respect to the growth rate of gross in-migration. This would mean that increases in gross in-migration in neighboring counties tend to discourage business (employment) in a given county. This is consistent with economic theory because migrating firms and people take the capital and labor as well as the skills that are necessary for business expansion out of the given county leading to the decline in employment and business growth in that county. The coefficient on WGEXR is negative and significant at the one percent level. This result suggests that increases in the rate of growth of local government expenditures in neighboring counties tend to decrease the rate of growth of employment in a given county. This is possible because government expenditures, for example, in highways, crime protection, pollution control, in neighboring counties may encourage firms to decide to relocate their activities on the other side of the county borders, leading to a decline in employment in the given county.

All these results are important from a policy perspective as they tend to indicate that the growth rate of employment in one county has negative spillover effects to the growth rate of employment in neighboring counties. Counties tend to be in competition in their efforts to encourage business location in their jurisdictions. The results are also important from an economic perspective because the significant spatial autoregressive lag and spatial cross-regressive lags 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, growth rate of gross in- and out-migration, growth rate of median household income, as well as growth rates in local government expenditures. The model specification in this study also incorporates spatial autoregressive error component in order to control for the effects of unobservable spatial process (effect) besides the spatial lag in the dependent variables. The results in Table 2 indicate a positive parameter estimate for rho3 indicating that random shocks into the system with respect to the growth rate of employment do not only affect the county where the shocks originated and its neighbors, but create positive shock waves across Appalachia.

To control for agglomerative effects, the model also includes measures of population statistics such as the percentage of population between 25 and 44 years old (POP25_44). The results show that POP25_44 has positive and significant effects on EMPR, even after the potential spatial spillover effects are controlled for. This result is consistent with the literature (Acs and Armington, 2004a) which indicates that a growing population increases the demand for consumer goods and services as well as the pool of potential entrepreneurs which encourage business formation. This result is important from a policy perspective. It indicates that counties with high population concentration are benefiting from the resulting agglomerative and spillover effects that lead to localization of economic activities, in line with Krugman's (1991a, 1991b) argument on regional spillover effects. Consistent with the theoretical expectations, the results also show initial human capital endowment as measured by the percentage of adults (over 25 years old) with at least college degree (POPCD) is positive and statistically significant at the one percent level. Highly educated people in most case have more access to research and development facilities, and perhaps a good insight to the business world and thus a clear idea about the present and the future needs of the market. As Christensen (2000) contends, entrepreneurs with good education are also more likely to know how to transform innovative ideas into marketable products. Thus, people with more educational attainment tend to establish business, and to be more successful when they do, more often than those with less educational attainments. This result is also consistent with Acs and Armington's (2004b) findings which indicates that the agglomerative effects that contribute to new firm formation could come from the supply factors related to the quality of local labor market and business climate. More educated people would mean more human capital, embodied in their general and specific skills, which is useful for implementing new ideas to create and to grow new businesses. One possible implication of these findings is that regions or counties with different levels of human capital endowment and different propensities of locally available knowledge to spill over and stimulate new firm formation tend to have different rates of new firm formation, survival and growth.

The percent of female householder families (FHHF) is another conditioning demographic variable included in the model. FHHF affects both the supply-side (as source of labor input) and the demand-side (as source of demand for consumer goods) of the market. The coefficient on FHHF is positive and statistically significant almost at the one percent level, indicating that FHHF has strong positive impact on EMPR. Thus, this result suggests that Appalachian counties with higher proportion of female household header in their communities tend to show higher growth in business or employment. This could be as a result of increases in female labor force participation rate. Female labor force participation has been increasing in Appalachia. Black and Sanders (2004), for example, showed that the average county-level labor force participation for women increased by 4 percent, while it declined by 6 percent for men during the 1990s.

The coefficient on the variable representing the percentage of home owned by their occupants (OWHU) is negative and significant at ten percent level. This result indicates that high home ownership is negatively associated with business formation in Appalachia. This is contrary to theoretical expectation that high home ownership is an indication that there is a capacity to finance new business by potential entrepreneurs, either by using the house as collateral for loan or as indication of availability of personal financial resources to start new business. The result, however, shows the reality in Appalachia. During the study period, in Appalachia, home ownership was positively correlated with level of economic distress- home ownership was higher in distressed counties (76 percent) and lowest in attainment counties; higher in Central Appalachia (76 percent) than in Northern or Southern sub regions (more developed); and Appalachia non-metro areas had higher ownership rates (76 percent) than its metro areas (72 percent) (Pollard, 2003). Thus, the result from the estimation indicates that home ownership is not a good indicator of the availability of resources to start new business in Appalachia.

The percentage of people employed in manufacturing (MANU) and the percentage of people employed in whole sale and retail trade (WHRT) are included in the EMPR equation to control for the influence of sectoral concentration of employment on the overall employment or business growth rate. The coefficient on MANU is positive and statistically significant at the one percent level, indicating a direct relationship between growths in overall employment or business expansion and manufacturing employment at the beginning of the periods. The coefficient on WHRT is also positive and significant at the 1 percent level, indicating the positive role played by the service sector in expanding employment and business in Appalachia during the study period. Thus, these results tend to suggest that Appalachian counties who had higher proportion of their labor force employed in manufacturing and whole sale and retail trade at the beginning the periods experienced higher growth rates in overall employment. This is not unrealistic because during most of the study period Appalachia has experienced a shift from coal mining-based economic activities to manufacturing and even more to services. The coefficient on WHRT is higher and even more significant than the coefficient on MANU in the EMPR equation, indicating that the contribution of WHRT to overall employment growth was higher and more sustained than that of MANU. This, in turn may indicate that industrial restructuring might have helped the service sector to grow faster than manufacturing.

The coefficient on the per capita property income tax (PCPTAX) is negative and statistically significant. Note that property tax has both direct cost and input mix effects which have opposing effects on employment and business expansion. Property tax could be levied on land or capital or both. The direct cost effect on location decision is negative. Once location is determined, the input mix effect could, however, be in the opposite direction. An increase in property tax on capital could push existing firms towards land and labor-intensive industries, expanding employment opportunities. Similarly, an increase in property tax on land could push existing firms towards capital and labor-intensive industries, again, expanding employment opportunities. Thus, *a priori*, the impact of property tax on business growth and employment is at best ambiguous. The negative coefficient in this study could be an indication that the negative direct cost effect dominates the input mix effect, indicating per capita property income taxes have been associated with lower business and employment growth rate in Appalachia during the study period.

The coefficient on the Natural Amenity Index (NAIX) is positive and statistically significant at the ten percent level indicating that amenity rich counties are favorable for business growth. This result is inconsistent with McGranahan (1999) who found weaker overall association between natural amenities and employment change. High-way density (HWD) is included in the EMPR equation to measure the influence of accessibility to business and employment growth. The positive and statistically significant coefficient on HWD shows a positive association between the concentration of roads and employment growth. This result suggests that Appalachian counties with higher road densities show increases in the growths of employment, compared to counties with low road densities, during the study period. This finding is consistent with both theory and empirical findings (see Carlino and Mills, 1987).

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 this model to capture the degree of competition among firms and crowding of businesses relative to the population. The coefficient on ESBd is positive and statistically significant at the one percent level, indicating that Appalachia region has not reached the threshold where competition among firms for consumer demands crowds businesses. According to the results, high ESBd is associated with high growth in employment (business growth), indicating that firms tend to locate near each other possibly to benefit from localization economies of scale.

Finally, the elasticity of EMPR with respect to the initial employment level (EMPt-1) is negative and statistically significant indicating convergence in the sense that counties with initial low level of employment at the beginning of the period tend to show higher rate of growth of business towards to their respective steady-state values than counties with high initial levels 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). The speed of adjustment η_{em} is calculated as 0.1165 and it indicates that about 11.65 percent of the equilibrium rate of growth in employment was realized during the ten-year period (1990-2000). That is 1.165 percent annually, giving a half-life time of 59.22 years.

Gross In-Migration Growth Rate

The results from the INMR equation also indicate that the growth rate of gross in-migration into a county is dependent on the growth rates of employment, gross out-migration, median household income and direct local government expenditures. These interdependences are explained by the statistically significant coefficients on the endogenous variables of the model. Since the interdependence between EMPR and INMR as well as the implications of this interdependence is explained in the EMPR equation above, it is not discussed here. Suffice it to say that the results from this study give support to previous findings from the human-capital-based migration researches where migration is viewed as an investment and that real income and the probability of employment as important determinants of interregional migration (Greenwood and Hunt, 1989; Lundberg, 2003).

The coefficient on OTMR in the INMR equation is positive and statistically significant at the one percent level. The coefficient on INMR in the OTMR equation is also positive and statistically significant at the one percent level. These results tend to show that INMR and OTMR in a given county are directly related, indicating that counties with high (low) gross in-migration growth rates are also counties with high (low) gross out-migration growth rates. This is possible because out-migrants and in-migrants could be people with different labor characteristics. A study by Obermiller and Howe (2004) shows that more people with lower-status jobs, lower incomes, less education and people more likely to live in poverty moved to Appalachia, while those with higher incomes, more education and higher job status moved out during the 1990s. Besides, since migration is selective of that portion of the population that is highly mobile, a growing share of in-migrant in a county reflects a growing share of migration-prone residents, which is likely to increase out-migration from the county. The migration literature also indicates that migrants in one period are more likely than non-movers to move in subsequent periods (Greenwood, 1975; Miller, 1969; Stone, 1971)

The coefficient on the MHYR variable in the INMR equation is positive and statistically significant at the one percent level. This indicates that gross in-migration growth rate in a given county is positively and significantly affected by the growth rate of median household income in that county. This is consistent with theoretical expectation where migration is expected to be away from counties with low median household income growth rates to counties with relatively high median household income growth rates.

Consistent with theoretical expectations, the results in Table 2 also suggest a strong negative interdependence between gross in-migration growth rate (INMR) and the growth rate of local public expenditures (GEXR). The coefficient on GEXR in the INMR equation is negative and statistically significant at the one percent level. This result supports previous migration researches in both the Tiebout (1956) and non-Tiebout tradition. Local government expenditures that are financed through higher taxes, particularly property taxes, tend to deter in-migration and encourage out-migration. Note that the coefficient on GEXR in the OTMR equation is positive and significant which further support this assertion. Property taxes have their deterrent effects on in-migration through changes in employment as discussed above, in reference to the impact of PCPTAX on EMPR. Previous studies, for example, by Mead (1982) and Schachter and Althaus (1989) have also generated similar results. The implications of this finding is that many poorer communities in Appalachian region which are forced to levy higher taxes to finance local public services at a certain level would not be able to attract people and even loose people. As the counties/communities continue to loose people, the per capita tax price of local public service for the remaining population increases which further leads to deterioration in the respective communities.

Turning to the spatial autoregressive lag and spatial cross-regressive lag effects, the coefficient on the spatial autoregressive lag variable is positive and statistically significant indicating the presence of positive spatial autocorrelation with respect to the growth rate of gross in-migration. The coefficient on the spatial cross-regressive lag variables with respect to employment (WEMPR) is also positive and statistically significant at the five per cent level. This indicates that the growth rate of gross in-migration into one county is positively associated with the growth rate of employment in neighboring counties. This is very interesting finding because it indicates that people commute to neighboring counties to work. But as people commute to neighboring counties to work, employment/business in those neighboring counties expands and attracts in-migrants. The flow of in-migrants into neighboring counties further leads to business/employment expansion in those counties. Since, as discussed above, the growth rates of employment in neighboring counties are inversely related, the counties whose residents are commuting to the neighboring counties for work, might face a lower growth rate in employment/business. Neither the coefficients on WOTMR, and WMHYR in the INMR equation, nor the coefficients on WINMR in the OTMR and MHYR equations are statistically significant, indicating weak cross-regressive lags simultaneities between INMR on one hand and OTMR and MHYR on the other hand. The coefficient on WGEXR is positive but insignificant.

The results in Table 2 also suggest a negative parameter estimate for rho1 indicating that random shocks into the system with respect to gross in-migration growth rate do not only affect the county where the shocks originated and its neighbors, but create negative shock waves across Appalachia.

Population size (POPs) at the initial period has a positive and strong effect on in-migration into a given county. The positive and statistically significant coefficient on POPs is an indication that people migrate to areas (counties) with high concentration of population. Note also that the coefficient on POPs in the out-migration equation is positive and statistically significant at the one per cent level, indicating that counties with high population concentration encourage out-migration and vice versa. These two results suggest that Appalachian counties with higher initial population sizes were both destinations and sources of migrants during the study period.

The coefficient on the Median Contract Rent of Specified Renter-Occupier (MCRH) is positive and statistically significant at the one percent level. This is not consistent with the theoretical expectations. One would normally expect that an increase in the cost of rental housing discourage in-migration by increasing the cost of migration. But it is important to look at MCRH as representing both the availability as well as the cost of rental housing. The expectation that increases in the cost of rental housing to discourage in-migration is based on the assumption that enough rental housing is available in all potential in-migration regions. The availability and the cost (affordability) of rental housing have opposing effects on in-migration. The result in this study suggests that the positive effect of availability dominates the negative effect of rental cost. This observation gives support to the results in Hamalainen and Bockerman (2004) which suggest a lack of rental housing in potential in-migration regions deter out-migration from high unemployment regions.

Finally, the coefficient on INMt-1 is negative and statistically significant indicating convergence in the sense that counties with initial low level of in-migration at the beginning of the period tend to show higher rate of growth of INMR than counties with high initial gross in-migration conditional on the other explanatory variables in the model The speed of adjustment η_{in} is calculated as 0.0382 and it indicates that about 3.82 percent of the equilibrium rate of growth in in-migration was realized during the ten-year period (1990-2000). That is 0.382 percent annually, giving a half-life time of 180.63 years.

Gross Out-Migration Growth Rate

The results from the gross out-migration growth rate equation also show very strong interdependences among the endogenous variables of the model. These strong *feed-back simultaneities* are indicated by the statistically significant coefficients on the respective endogenous variables. The coefficient on EMPR, for example, is negative and statistically significant at the one percent level. The coefficients on INMR and GEXR are positive and statistically significant at the one and the five percent levels, respectively. The implications of these two results are discussed in the EMPR and INMR equations, respectively. The results also show negative and statistically significant at the one percent level coefficient on MHYR. A negative and statistically significant coefficient on MHYR indicates that Appalachian counties that registered high median household income growth rates tend to experience relatively small gross out-migration growth rates. This is consistent with economic theory and the results of the human capital based migration literature. Economic theory postulates that economic condition affects migration behavior and the relevant income measure for a potential migrant to consider is the present discounted value of his/her stream of expected future returns, both current income level and expected future levels enter into potential migrant's present-value calculation. Thus, areas/counties with relatively high median household income growth rate are expected not only to attract potential in-migrants but also keep potential out-migrants from migrating out. This would imply that counties with relatively high MHYR tend to experience lower gross out-migration growth rates, other things remain constant. The result in this study also gives support to Greenwood (1975, 1976) who found that high income localities experienced significantly less gross out-migration.

Turning to the spatial autoregressive lag and spatial cross-regressive lag effects, the coefficient on the spatial autoregressive lag variable is not significant which indicates the absence of spatial autocorrelation with respect to the growth rate of gross out-migration. This suggests that gross out-migration growth rate in one counties has no impact on gross out-migration growth rates in its neighbors. As discussed above, one of the factors that determine gross out-migration growth rate in a given county is its labor market characteristics. No feedback simultaneity between neighboring counties gross out-migration growth rate, therefore, tends to suggest that the economies of Appalachian counties are not integrated as far as their labor markets are concerned. The spatial cross-regressive lag simultaneities are not also strong. The coefficient on WMHYR is negative and statistically significant at the ten percent level. Macroeconomic theory postulates that humans migrate out from areas with slow rate of growth of median household income/ per capita income to areas with relatively higher rate of growth of income. Accordingly, one would expect that an increase in median household income in neighboring counties to increase the rate of growth of gross out-migration in a given county. The result in this study, however, does not give support to such expectations. One possible reason why this might be so is that potential migrants may still be able to benefit from the increases in neighboring counties' income by commuting a cross county borders.

The results in Table 2 also suggest a positive parameter estimate for rho2 indicating that random shocks into the system with respect to gross out-migration do not only affect the county where the shocks originated and its neighbors, but create positive shock waves across Appalachia.

Similar to the case of in-migration growth rate equation, the coefficients on initial population size (POPs) is positive and statistically significant at the one percent level. This result indicates that counties with high initial population sizes have experienced high gross out-migration growth rates.

The coefficient on UNEMP is negative and statistically significant at the five percent level. Normally, one would expect that people to move away from high-unemployment counties to low-unemployment counties. This result, however, suggests that the growth rate of out-migration (OTMR) in a given county is negatively associated with the initial level of unemployment in that county. One possible explanation of this observation, similar to what Lansing and Mueller (1967) have argued, is that unemployment tends to be highest in the least mobile groups in the labor force. It should also be noted that prospective unemployment rather than the level of unemployment rate is the major determinant of migration. Imperfect information about labor market conditions may make people to be more reluctant to relocate during times of high unemployment (Ezzet-Lofstrom, 2003). Besides, the lack of rental housing in the potential in-migration counties/regions could deter out-migration from the high-unemployment counties/regions.

Finally, the results presented in Table 2 indicate the existence of significant conditional convergence in the out-migration growth rate equation. This is indicated by the negative and statistically significant coefficient on the lagged dependent variable for out-migration (OTMRt-1). This result suggests that Appalachian counties with low initial level of out-migration showed higher growths in out-migration growth rates compared to counties with higher initial levels of out-migration, conditional upon the other exogenous variables that are included in the OTMR equation. The speed of adjustment η_{ot} is calculated as 0.0726 and it indicates that about 7.26 percent of the equilibrium rate of growth in gross out-migration was realized during the ten-year period (1990-2000). That is 0.726 percent annually, giving a half-life time of 95.04 years.

Median Household Income Growth Rate

The interdependences among the endogenous variable are also witnessed in the MHYR equation. The coefficient on EMPR is positive and statistically significant at the one percent level, indicating that MHYR in a given county is positively and strongly affected by the rate of growth of employment in that county. This is consistent with theoretical expectations. Higher rate of growth of employment means higher employment opportunities, which in turn provide a strong attraction for migrants that leads to net in-migration. The contemporaneous effect with respect to the growth rate of in-migration and the growth rate of out-migration on the growth rate of median household income is positive and negative respectively. If migrants' endowments of human capital in the form of education, accumulated skills, or entrepreneurial talents are higher compared to the receiving population, then their skills, inventiveness and innovativeness would contribute to local productivity. Migrants may also own physical and financial capital that they may bring with them and invest in the receiving county. Moreover, migrants may contribute to the growth of markets and to the achievement of scale and agglomerations economies. Such demand effects are the sources of growth in per capita personal incomes. The opposite happens in the case of out-migration. The results in this study strongly show the existence of migrant-induced labor demand shifts that offset the migrant-induced labor supply shifts in Appalachian counties during the study period.

Concerning the relationship between the rate of growth of direct local government expenditures and the rate of growth of median household income, the results show that the rate of growth in direct local government expenditures has positive impact on the rate of growth of median household income. The effects of government expenditure depend on the nature/type of that expenditure. Government expenditures on education, health care, fire protection, crime prevention, are more likely to increase labor productivity and hence income.

The results in Table 2 also suggest a positive and statistically significant, at the one percent level, spatial autoregressive lag effect, indicating that the rate of growth of median household income in a given county is positively affected by the rate of growth of median household income in neighboring counties. This strong spatial spillover effect is an indication that there is clustering of counties in Appalachia on the bases of their growth rate of median household incomes. The spatial cross-regressive lag effects with respect to WEMPR and WGEXR are not strong, indicating that MHYR in a given county is not strongly related to

WEMPR and WGEXR in neighboring counties. The spatial cross-regressive lag effect with respect to WINMR, however, is negative and statistically significant. This result suggests that increases in the rate of growth of in-migration in neighboring counties tend to decrease the rate of growth of median household income in a given county. This is possible because in-migration induced increases in income in neighboring counties may further attract firms and labor from the given county, reducing its average income level. The positive and statistically significant coefficient on WOTMR has the opposite effect.

The results in Table 2 also suggest a negative parameter estimate for rho5 indicating that random shocks into the system with respect to median household income do not only affect the county where the shocks originated and its neighbors, but create negative shock waves across Appalachia.

The coefficient on the variable that measures the proportion of the population 25 years and above with high school diploma (POPHD) is negative and statistically significant at the one percent level. This implies that Appalachian counties with higher proportion of adult residents with high school diplomas at the beginning of the period show subsequent decline in MHYR. This result seems to be inconsistent with the expectations of economic theory as well as with the empirical findings in growth literature. It, however, reflects the reality in Appalachia during the study period. More people with more education, higher job status and higher income moved out, while those with lower education, low occupational status and people in poverty moved into Appalachia (Obermiller and Howe, 2004). Thus, counties with higher proportion of people with high school and above diplomas at the beginning of the period might have lower growth of income as a result of the out-migration of the educated and the wealthy people. The coefficient for the Index of Social Capital is also positive and statistically significant indicating that counties with high level of social capital increase the wellbeing of their communities. This result is consistent with the expectation of economic theory.

Finally, the negative and statistically significant coefficient on MHYRt-1 is an indication that there was conditional convergence with respect to the rate of growth in median household income in Appalachia during the study period. This means that counties with low initial median household income grew faster than did counties with higher initial median household income. The speed of adjustment η_{mh} is calculated as 0.7604 and it indicates that about 76.04 percent of the equilibrium rate of growth in median household income was realized during the ten-year period (1990-2000). That is 7.60 percent annually, giving a half-life time of 9.08 years.

Direct Government Expenditures Growth Rate

Similar to the case in the other equations, the estimates from the GEXR equation show the existence of significant feed-back simultaneity. All of the endogenous variables have statistically significant effect on the growth rate of direct local government expenditures per capita. The contemporaneous effect with respect to the rate of growth of out-migration (OTMR) on the rate of growth of direct local government expenditures per capita, for example, is positive and statistically significant at the one percent level. This result indicates that high growth rate in direct local government expenditures per capita is positively associated with high growth rate of gross out-migration which is consistent with the expectation of economic theory. Migrants have important impacts on the demand of locally provided public goods and services as well as on the revenue that support the provision of these public goods and services by changing the size and the density of population of a region or a county. Out-migration reduces the possibility of gaining economies of scale in the provision of public services. Excessive out-migration creates excess capacity and very high costs of maintaining overstock of public infrastructure, such as schools, police facilities, fire protection, etc., in the area of origin.

The contemporaneous effect with respect to the growth rate of in-migration (INMR) on the growth rate of direct local government expenditures per capita is negative and statistically significant at the one percent level. This result indicates that the growth rate of direct local government expenditures per capita in a given county is negatively associated with the growth rate of in-migration to that county. One possible explanation for this observation is that in-migration may lead to increase in population and its density in the receiving region that enable local government to realize the advantages of economies of scale in the provision of public services. In that case, although total local government expenditures may increase, per capita could still decline if the advantages of economies of scale are realized.

The contemporaneous effect with respect to the growth rate of employment (EMPR) on the growth rate of direct local government expenditures per capita is also negative as expected and statistically significant. Increases in EMPR create income opportunities for unemployed people who might otherwise be welfare dependents, consequently increasing local government expenditures.

The coefficient on MHYR is positive and statistically significant at the one percent level. This result is consistent with theoretical expectations. Increases in per capita income provide local governments with more tax revenues that support the provision of more public goods and services, which in turn lead to higher local public expenditures. This result give support to empirical findings in Painter and Bae (2001) that indicate a positive and significant increases in per capita income on government expenditures.

As expected, the results in Table 2 also show the existence of strong and positive spatial autoregressive lag effect with respect to GEXR, as indicated by the positive and statistically significant, at the one percent level, coefficient on WGEXR in the GEXR equation. This result shows that the rate of growth of direct local government expenditures in a given county is positively associated with the rates of growth of direct local government expenditures in neighboring counties. These interdependences could arise because (1) local governments may finance public spending through a tax on mobile capital and since the level of tax base in a jurisdiction depends both on own and on other jurisdictions' tax rates, strategic interaction results; (2) beneficial or harmful effects could spill over onto residents of neighboring counties from expenditures on local public services in a given count; and (3) imperfectly informed voters in a given county use the performance of other governments as a yardstick to evaluate their own governments, which , in turn, lead to local governments to react to the action of their neighbors, resulting in local governments mimicking each others' behavior. The result in this study gives support to the findings in Case, Hines and Rosen (1993), Kelejian and Robinson (1993), and Besley and Case (1995) which indicate public expenditures in a given county is positively and significantly affected by public expenditures in neighboring counties. Three of the spatial cross-regressive lag simultaneities are also strong and have the expected effects.

The results in Table 2 also suggest a negative parameter estimate for rho4 indicating that random shocks into the system with respect to direct local government expenditures per capita do not only affect the county where the shocks originated and its neighbors, but create negative shock waves across Appalachia.

As expected, the coefficient on POPs is negative and statistically significant at the one percent level. Economic theory postulates that the size of population plays important roles in per capita spending on non-rival goods such as transportation and communication as well as merit goods and other economic services. The negative coefficient on POPs, thus, indicates the advantages of economies of scale in the provision of local public services in Appalachia during the study period. This result also supports empirical findings in Falch and Rastto (1997), Fay (2000), and Hashimati (2001) which show that population has negative on per capita government expenditures.

The proportion of school age population denoted by POP5-17 is included in the model to control for the differential impact of population age structure on local government expenditures. As expected, the coefficient on POP5-17 is positive and statistically significant. Increases in the proportion of school age population create pressure for increases in local spending on education, in the form of expanding services and cost of expanding capacity. The results in this study are also consistent with the empirical findings in Marlow and Shiers (1999) and Alhin and Johansson (2001) which indicate that an increase in the proportion of young people generates pressure for increases in public spending in education.

As expected, the coefficient on SCRM (serious crime per 100,000 populations) is positive and statistically significant at the one percent level. This result indicates that increases in SCRM leads to increases in local government expenditures in the form of police and crime prevention and protection expenses. The coefficients on DFEG (direct federal expenditures and grants per capita), and PCTAX (income tax per capita) and LTD (long-term debt per capita) are also all positive and statistically significant at the one percent levels. Since both DFEG is one of the components of local government revenue, it is expected to have positive effects on the rate of growth of direct local government expenditures per capita. Thus, the results in this study are consistent with the expectations of economic intuition. The results also give support to empirical findings in Fisher and Navin (1992) and Henderson (1968) which show that local public expenditure per capita is positively related to grants in-aid per capita from higher governments. Similarly, since PCTAX is also one of the components of local government revenue, increases in PCTAX would provide local government with more money to spend on local public services. To control for the impacts of the ability of local government to borrow from external sources in order to finance the provision of local public services, LTD (Long-Term Debt per capita) is also included in the model. A positive and significant coefficient on LTD would mean that local governments in Appalachian counties were not constrained in their capacity to borrow from external sources in order to finance local public services during the study period.

The coefficient on PCTD (total debt outstanding per capita) is negative and statistically significant at the ten percent level. This result is consistent with theoretical expectations in that the amount of total debt outstanding accumulated constrains local governments their capacity to further borrow apart from their obligation to pay their debts now. The effect would be decreases in local public expenditures.

Finally, the negative and statistically significant coefficient on GEXRt-1 is an indication that there was conditional convergence with respect to the rate of growth in direct local government expenditures in Appalachia during the study period. This means that counties with low initial direct local government expenditures had higher growth in direct local government expenditures than counties with higher initial direct local government expenditures. The speed of adjustment η_{ge} is calculated as 0.2843 and it indicates that about 28.43 percent of the equilibrium rate of growth in local public expenditures was realized during the ten-year period (1990-2000). That is 2.84 percent annually, giving a half-life time of 24.30 years.

6. CONCLUDING SUMMARIES AND POLICY IMPLICATIONS

Generally, the results from these model estimations are consistent with the theoretical expectations and empirical findings in the equilibrium growth literature and provide support to the basic hypotheses of this study. First, the parameter estimates showed the existence of *feedback simultaneities* among the endogenous variables of the model. The coefficients on the endogenous variables in almost all equations of the model are statistically significant at least at the five percent levels. This indicates that the interdependences among employment growth rate, gross in-migration growth rate, gross out-migration growth rate, median household income growth rate and direct local government expenditures growth rate are very strong. The directions of causation as indicated by the signs of the coefficients are also consistent with the theoretical expectations. This finding is important from economic policy perspective because it indicates that sector specific policies should be integrated and harmonized in order to achieve the desirable outcome. Under this circumstance, looking at the direct impact of a change in a given policy can not tell the whole story. What is more important is the total (direct plus indirect) impact of a change in a given policy.

Second, estimations results also show the existence of conditional convergence with respect to the respective endogenous variable of each equation of the model. This is indicated by the negative and statistically highly significant coefficients on the lagged dependent variables of the model. This implied that the rates of growth of employment, gross in-migration, gross out-migration, median household income and direct local government expenditures were higher in counties that had low initial levels of employment, gross in-migration, gross out-migration, median household income and direct local government expenditures, respectively compared to counties with high initial levels of the same.

Third, the results from the parameter estimation of spatial model indicated the existence of spatial autoregressive lag effects and spatial cross-regressive lag effects with respect to many of the endogenous variables of the model. Besides, results for Global Moran's I statistics indicated the existence of spatial spillover effect with respect to the error terms of the model. These results would imply that employment growth rate, gross in-migration growth rate, gross out-migration growth rate, median household income growth rate, and direct local public expenditures growth rate in a given county are dependent on the averages of employment growth rates, gross in-migration growth rates, gross in-migration growth rates, median household income growth rates, and direct local public expenditures growth rate of neighboring counties in the study area. The existence of spatial dependences in the error terms is an indication that random shocks into the system with respect to each of these endogenous variables do not only affect the county/counties where the shock originated and its/their neighbors, but also create shocks waves across the study area (Appalachia).

These findings are important from an economic perspective because the existence of these spatial lag effects indicates that the growth rates of employment, gross in-migration, gross out-migration, median household income, and direct local public expenditures per capita in a given county are not only dependent on the characteristics of that county, but also on that of its neighbors. This further indicates for the need to do spatial effect tests in empirical research works involving the growth rates of employment, gross in-migration, gross out-migration, median household income, and direct local government expenditures per capita. These findings are also important from a policy perspective as they indicate cross-county interdependences among the growth equilibrium model endogenous variables which would necessitate economic development policy coordination at the regional level. A region, here, could be a group of counties with similar socio-economic conditions or the whole Appalachia region. Poverty reduction policies, for example, may be better coordinated among counties in Central Appalachia, where there is high concentration of poverty compared to the other sub-regions. But it is also important to note that the whole Appalachia may be affected by the ripple effect- a neighbor of my neighbor type. The weights matrix is designed to account for these types of effects.

As discussed above, the results in this study show a positive interdependence between the growth rate of employment (the proxy for small business growth) and the growth rate of median household income. Given the fact that Appalachia is dominated by widely dispersed small communities with relatively small local and regional markets, these results are significantly important. This implies that local government actions that promote small business can have significant effects on income generation.

References

Acs, Z. J. and C. Armington, 2004a, “The Impact of Geographic Differences in Human Capital on Service Firm Formation Rates,” *Journal of Urban Economics*, **56**: 244-278.

__________, 2004b, “ New Firm Survival and Human Capital,” Discussion Papers on Entrepreneurship, Growth and Public Policy, No. 1404, Group Entrepreneurship, Growth and Public Policy, MPI Jena.

Acs, Z. J. and D. B. Audretsch, 2001, “The Emergence of the Entrepreneurial Society,” Presentation for the Acceptance of the 2001 International Award for Entrepreneurship and Small Business Research, 3 May, Stockholm.

Ahlin, A. and E. Johansson, 2001, “Individual Demand for Local Public Schooling: Evidence from Swedish Survey Data,” *International Tax and Public Finance*, **8**(4): 331-351.

Anselin, L. 2003, “Spatial Externalities, Spatial Multipliers and Spatial Econometrics,” *International Regional Science Review*, **26**(2): 153-166.

________. 1988. *Spatial Econometrics: Methods, and Models,* Dordrecht: Kluwer Academic

________, and Harry H. Kelejian, 1997, “Testing for Spatial Error Autocorrelation in the Presence of Endogenous Regressors,” *International Regional Science Review*, **20**: 153-182.

Aronsson, T., J. Lundberg and M. Wikstrom**,** 2001, “Regional Income Growth and Net Migration in Sweden, 1970-1995,” *Regional Studies*, **35**(1): 823-830.

Audretsch, D.B., M.A. Carree, A.J. van Stel and A.R. Thurik**,** 2000, “Impeded Industrial Restructuring: The Growth Penalty,” Research Paper, Center for Advanced Small Business Economics, Erasmus University, Rotterdam, Netherlands.

Barkley, D.L., M.S. Henry, and S. Bao, (1998), “The Role of Local School Quality and Rural Employment and Population Growth,” *Review of regional Studies,* **28** (summer): 81-102.

Besley, Timothy and Anne C. Case, 1995, “Incumbent Behavior: Vote-Seeking, Tax-Setting and Yardstick Competition,” *American Economic Review,* **85**(1): 25-45.

Black, Dan A. and Seth G. Sanders, 2004, “Labor Market Performance, Poverty, and Income Inequality in Appalachia,” http://www.arc.gov/images/reports/labormkt/labormkt.pdf

Boarnet, M.G., (1994), “An Empirical Model of Intra-metropolitan Population and Employment Growth,” *Papers in Regional Science*, **73** (April): 135-153.

Bowman, Mary J. and Robert G. Myers, 1967, "Schooling Experience, and Gains and Losses in Human Capital through Migration, "*Journal of the American Statistical Association*, **62** (319): 875-898.

Carlino, O.G. and E.S. Mills, 1987, "The Determinants of County Growth," *Journal of Regional Science*, **27**(1): 39-54.

Carree, M.A. and A.R. Thurik, 1998, "Small Firms and Economic Growth in Europe," *Atlantic Economic Journal*, **26**(2): 137-146.

Carree, M.A. and A.R. Thurik, 1999, "Industrial Structure and Economic Growth," in Audretsch, D.B. and A.R. Thurik (eds.), *Innovation, Industry Evolution and Employment*, Cambridge, UK: Cambridge University Press.

Case, A., H.S. Rosen and J.R. Hines, 1993, "Budget Spillovers and Fiscal Policy Interdependence: Evidence from States," *Journal of Public Economics*, **52**: 285-307.

Christensen, G., 2000, "Entrepreneurship Education: Involving Youth in Community Development," Nebraska Department of Education, Marketing and Entrepreneurship Education, Lincoln, NE.

Clark, D. and C.A. Murphy, 1996, "Countywide Employment and Population Growth: An Analysis of the 1980s," *Journal of Regional Science*, **36**(2): 235-256.

Deller, Steven C., Tsung-Hsiu Tsai, David W. Marcouiller, and Donald B.K. English, 2001, "The Role of Amenities and Quality of Life in Rural Economic Growth," *Journal of American Agricultural Economics*, **83**(3): 352-365.

Duffy, N.E., (1994), "The Determinants of State Manufacturing Growth Rates: A Two-Digit-Level Analysis," *Journal of Regional Science*, **34**(May): 137-162.

Duffy-Deno, K.T., (1998), "The Effect of Federal Wilderness on County Growth in the Inter-mountain Western United States," *Journal of Regional Sciences*, **38**(February): 109-136.

Duffy-Deno, Kevin T. and Randall W. Eberts, 1991, "Public Infrastructure and Regional Economic Development: A Simultaneous Equations Approach," *Journal of Urban Economics*, **39**: 329-343.

Edmiston, Kelly D., 2004, "The Net Effect of Large Plant Locations and Expansions on Country Employment," *Journal of Regional Science*, **44**(2): 289-319.

Ezzet-Lofstrom, Roxanne, 2003, "Out-Migration Decisions: The Role of Regional Amenities," Political Economy Working Paper 07/03, The University of Texas at Dallas.

Falch, T. and J. Rattso, 1997, "Political and Economic Determinants of School Spending in Federal States: Theory and Time-Series Evidence," *European Journal of Political Economy*, 13: 299-314.

Fay, M., 2000, "Financing the Future: Infrastructure Needs in Latin America, 2000-05," Finance, Private Sector Development, and Infrastructure Sector Unit, Latin America and the Caribbean Region, World Bank.

Fisher, Ronald C. and John C. Navin, 1992, "State-Local Fiscal Behavior: An Analysis Inter-jurisdictional Differences, 1962-1987," *Public Finance Quarterly*, **20**: 433-449.

Fritsch, M. and O. Falck, 2003, "New Firm Formation by Industry over Space and Time: A Multilevel Analysis," Discussion Paper, German Institute for Economic Research, Berlin.

Greenwood, Michael J., 1975, "Research on Internal Migration in the United States: A Survey," *Journal of Economic Literature*, **13**: 397-433.

_________, 1976, "A Simultaneous Equation Model of White and Non-White Migration and Urban Change," *Economic Inquiry*, **14**: 1-15.

Greenwood, M. J. and G.L. Hunt, 1984 "Migration and Interregional Employment Redistribution in the United States," *American Economic Review*, **74**(5): 957-969.

Greenwood, Michael. J. and Gary. L. Hunt, 1989, "Jobs versus Amenities in the Analysis of Metropolitan Migration," *Journal of Urban Economics*, **25**: 1-16.

Greenwood, Michael J., Gary L. Hunt and John M. McDowel, 1986, "Migration and Employment Change: Empirical Evidence on Spatial and Temporal Dimensions of the Linkage," *Journal of Regional Science*, **26**(2):23-234.

Hamalainen, Kari, and Petri Bockerman, 2004, "Regional Labor Market Dynamics, Housing, and Migration," *Journal of Regional Science*, **44**(3): 543-568.

Hashmati, A., 2001, "On the Causality between GDP and Health Care Expenditure in the Augmented Solow Growth Models," Swedish Working Paper Series in Economics and Finance, 423.

Hausman, J., 1983, "Specification and Estimation of Simultaneous Equations Models," in Z. Griliches and m. Intriligator, eds., *Handbook of Econometrics*, Amsterdam: North Holland.

Helms, L. Hay, 1985, "The Effects of State and Local Taxes on Economic Growth: A Time Series-Cross Sectional Approach," *Review of Economics and Statistics*, **67**: 574-582.

Henderson, James M., 1968, “Local Government Expenditures: A Social Welfare Analysis,” *Review of Economics and Statistics*, **50** (2): 156-163.

Henry, M.S., D.L. Barkley, and S. Bao, 1997, “The Hinterland’s Stake in Metropolitan Growth: Evidence from Selected Southern Regions,” *Journal of Regional Science*, **37**(August): 479-501.

Henry, M.S., B. Schmitt, K Kristensen, D.L. Barkley, and S. Bao, 1999, “Extending Carlino-Mills Models to Examine Urban Size and Growth Impacts on Proximate Rural Areas,” *Growth and Change*, **30** (Summer): 526-548.

Henry, Mark S., B. Schmitt and V. Piguet, 2001, “Spatial Econometric Models for Simultaneous Systems: Application to Rural Community Growth in France,” *International Regional Science Review*, **24**(2): 171-193.

Kelejian, Harry H. and D.P. Robinson, 1993 “A suggested Method of Estimation for Spatial Interdependent Models with Auto-correlated Errors, and an Application to a County Expenditure Model,” *Papers in Regional Sciences*, **72** (3):297-312.

Kelejian, Harry H. and Ingram R. Prucha, 1998, “A Generalized Two-Stage Least Squares Procedure for Estimating a Spatial Autoregressive Model with Spatial Autoregressive Disturbances,” *Journal of Real Estate, Finance and Economics*, **17**(1): 99-121.

_________, 1999, “A Generalized Moments Estimator for the Autoregressive Parameter in a Spatial Model,” *International Economic Review*, **40**: 509-533.

__________, 2004, “Estimation of Simultaneous Systems of Spatially Interrelated Cross Sectional Equations,” *Journal of Econometrics*, **118**: 27-50.

Jones, Bryan D., 1990, “Public Policies and Economic Growth in the American States,” *The Journal of Politics*, **52(**1): 219-233.

Krugman, P. 1991a, “Increasing Returns and Economic Geography,” *Journal of Political Economy*, **99**: 483-499.

_____, 1991b, *Geography and Trade*, Cambridge, MA: MIT Press.

Lansing, J. B. and E. Mueller, 1967, “The Effects of Geographic Mobility on Income,” *Journal of Human Resources*, **2**(4): 449-460.

Lewis, David J., Gray L. Hunt and Andrew J. Plantinga, 2003, “Does Public Land Policy Affect Local Wage Growth,” *Growth and Change*, **34**(1): 64-86.

Lundberg, J. 2003, “On the Determinants of Average Income Growth and Net Migration at the Municipal Level in Sweden,” *Review of Regional Studies*, **33**(2): 229-253.

MacDonald, John F., 1992, "Assessing the Development Status of Metropolitan Areas," in Edwin S. Mills and John F. MacDonald (ed.), *Sources of Metropolitan Growth*, New Brunswick, NJ: Center for Urban Policy Research.

Mackinnon, J.G., H. White, and R. Davidson. 1983. "Tests for Model Specification in the Presence of Alternative Hypotheses: Some Further Results," *Journal of Econometrics*, **21**, 53-70.

Marlow, M. L. and A.F. Shiers, 1999, "Do Law Enforcement Expenditures Crowd-Out Public Education Expenditures?" *Applied Economics*, **31**(2): 255-266.

McGranahan, David A., 1999, "Natural Amenities Drive Rural Population Change," http://www.ers.usda.gov/publications/aer781/aer781i.pdf.

Mead, A. C., 1982, "A Simultaneous Equations Model of Migration and Economic Change in Non-metropolitan Areas," *Journal of Regional Science*, **22**: 513-327.

Miller, Ann R., 1969, "The Migration of Employed Persons to and from Metropolitan Areas of the United States," *Journal of the American statistical Association*, **62** (December):1418-1432.

Mills, E.S., and R. Price, (1984), "Metropolitan Suburbanization and Central City Problems," *Journal Urban Economics*, **15**: 1-17.

Obermiller, Phillip J. and Steven R. Howe, 2004, "Moving Mountains: Appalachian Migration Pattern, 1995-2002," *Journal of Appalachian Studies*, **10**(3):359-371.

Painter, G. and K. Bae, 2001, "The Changing Determinants of State Expenditure in the United States: 1965-1992," *Public Finance and Management*, **1**(4): 370-392.

Pollard, Kelvin M., 2003, "Appalachia at the Millennium: An Overview of Results from Census 2000," Washington, D.C.: Population Reference Bureau, at www.arc.gov/index.do?nodleld=1847

Rey, Sergio J. and Marlon G. Boarnet, 2004, "A Taxonomy of Spatial Econometric Models for Simultaneous Equations Systems," in L. Anselin, R.J.G.M. Florax and S.J. Rey, (eds.), *Advances in Spatial Econometrics: methodology, Tools and Applications*, Berlin: Springer.

Rupasingha, A. and S.J. Goetz, 2003, " County Amenities and Net Migration," Paper Presented in WRSA Annual Meeting, Rio Rico, Arizona, Feb 26-March 1, 2003.

Rupasingha, Anil, Stephan J. Goetz, and David Freshwater, 2006, "The Production of Social Capital in U. S. Counties," *The Journal of Socio-economics*, **35**: 83-101.

Schachter, Joseph and Paul G. Althaus, 1989, “An Equilibrium Model of Gross Migration,” *Journal of Regional Science*, **29**: 143-160.

Sjaastad, Larry A., 1962, “The Costs and Returns of Human Migration,” *Journal of Political Economy*, **70**: 80-93.

Steinnes, Donald N. and Walter D. Fisher, 1974, “An Econometric Model of Intra-urban Location,” *Journal of Regional Science*, **14**: 65-80.

Stone, Leroy O., 1971, “On the Correlation between Metropolitan Area In- and Out-Migration by Occupation,” *Journal of the American Statistical Association*, **66** (December): 693-701.

Tiebout, Charles M., 1956, “A Pure Theory of Location Expenditure,” *Journal of Political Economy*, **64**: 415-424.

U.S. Small Business Administration (SBA), 1999, *The State of Small Business: A Report of the President*, Washington D.C.: U.S. Government Printing Press.

Wennekers, S .and A.R. Thurik, 1999, “Linking Entrepreneurship and Economic Growth,” *Small Business Economics*, **13**(1): 27-55.

Table 1: Variable Description and Data Sources

Variable Code	Variable Description	Source
Endogenous Variables		
EMPR	Growth Rate of Employment, 1990-2000	Computed
INMR	Growth Rate of Gross In-Migration, 1990-2000	Computed
OTMR	Growth Rate of Gross Out-Migration, 1990-2000	Computed
MHYR	Growth Rate of Median Household Income, 1989-1999	Computed
GEXR	Growth Rate of Local Public Expenditures Per Capita, 1992-2002	Computed
Spatially lagged Endogenous Variables		
WEMPR	Spatial Lag of EMPR	Computed
WINMR	Spatial Lag of INMR	Computed
WOTMR	Spatial Lag of OTMR	Computed
WMHYR	Spatial Lag of MHYR	Computed
WGEXR	Spatial Lag of GEXR	Computed
Initial Condition Variables		
EMPt-1	Employment, 1990	County & City Data Book
INMt-1	In-migration, 1990	Internal Revenue Service
OTMt-1	Out-migration , 1990	Internal Revenue Service
MHYt-1	Median Household Income, 1989	Bureau of Economic Analysis
GEXt-1	Local Public Expenditures per Capita, 1992	U.S. Bureau of the Census
Regional and Policy Variables		
AREA	Land Area in square miles 1990	U.S. Bureau of the Census
POPs	Population ,1990	U.S. Bureau of the Census
POP2	Population-square,1990	U.S. Bureau of the Census
POP5-17	Percent of population between 5 -17 years , 1990	U.S. Bureau of the Census
POP25-44	Percent of population between 25 -44 years old , 1990	U.S. Bureau of the Census
FHHF	Percent of Female Householder, Family Householder, 1990	County & City Data Book
SCRM	Serious crime per 100,000 population, 1990	County & City Data Book
POPHD	Persons 25 years and over, % high school, 1990	County & City Data Book
POPCD	Persons 25 years and over, % bachelor's degree or above, 1990	County & City Data Book
OWHU	Owner-Occupied Housing Unit in percent, 1990	U.S. Bureau of the Census
MCRH	Median Contract Rent of Specified Renter-Occupied , 1990	U.S. Bureau of the Census
UNEMP	Unemployment Rate , 1990	Bureau of Labor Statistics
MANU	Percent employed in manufacturing , 1990	County & City Data Book
WHRT	Percent employed in wholesale and retail trade , 1990	County & City Data Book
DFEG	Direct Federal Expenditures and Grants per Capita,, 1992	County & City Data Book
PCTAX	Per Capital Local Tax , 1992	County & City Data Book
PCPTAX	Property Tax per Capita , 1992	County & City Data Book
PCTD	Total Debt Outstanding per capita , 1992	County & City Data Book
LTD	Long-Term Debt, Utility , 1992	County & City Data Book
SCIX	Social Capital Index , 1997	Rupasingha *et al*, 2006
NAIX	Natural Amenities Index 1980, 1990	USDA
HWD	Highway Density , 1990	US Highway Authority
ESBd	Establishment Density , 1990	County Business Pattern
EXPTAX	Personal Income Tax/Local General Expenditure, 1990	Computed

Table 2: Feasible Generalized Spatial Three-Stage Least Squares(FGS3SLS) Estimation Results

	EMPR Equation		**INMR Equation**		**OTMR Equation**		**MHYR Equation**		**GEXR Equation**	
VARIABLE	*Coefficient*	*t-statistic*	*Coefficient*	*t-statistic*	*Coefficient*	*t-statistic*	*Coefficient*	*t-statistic*	*Coefficient*	*t-statistic*
CONSTANT	0.3554	0.6458	-0.5504	-8.2310	0.3060	1.6230	9.1442	9.4644	1.9564	6.0960
EMPR			0.0231	2.3540	-0.2185	-8.0177	0.1381	2.3693	-0.3694	-5.5825
INMR	1.8081	7.4377			0.7928	5.2962	2.4913	9.8457	-3.2780	-9.3664
OTMR	-0.8531	-13.965	0.0783	6.9164			-0.3149	-5.2680	1.9179	3.8501
MHYR	0.0187	0.4811	0.0405	5.2199	-0.1483	-6.6888			0.3250	5.7961
GEXR	-0.2586	-11.534	-0.0323	-7.5391	0.2440	2.4110	0.0375	1.7309		
WEMPR	-1.0443	-9.1809	0.0346	2.4543	0.0215	0.4436	0.0333	0.3569	0.1144	1.0103
WINMR	-2.7225	-8.7347	1.0353	56.110	-0.2817	-1.5762	-2.6358	-9.1565	2.5812	6.3069
WOTMR	1.3404	6.8296	-0.0323	-1.1572	-0.0253	-0.2911	0.2647	1.7087	-0.5485	-2.6833
WMHYR	0.0151	0.1870	-0.0064	-0.6723	-0.0703	-1.9629	0.2501	4.7520	-0.2141	-2.7541
WGEXR	-0.3825	-5.9274	0.0014	0.1812	-0.0519	-1.8335	0.0490	0.9588	0.1994	2.7722
AREA			0.0112	5.7960	0.0153	3.8789				
POPs			0.0339	7.4221	0.0572	7.4926	-0.0896	-0.5674	-0.0506	-3.9516
POP2							0.0037	0.5011		
POP5_17									0.0901	1.7541
POP25_44	0.4502	5.4068								
FHHF	0.0917	2.5126					-0.0039	-0.1285		
POPHD							-0.1899	-2.5590		
POPCD	0.0916	3.8414								
OWHU	-0.3220	-3.0119			0.0106	0.2609				
MCRH			0.0693	6.9536						
UNEMP			-0.0012	-0.3072	-0.0173	-2.2448	0.0424	1.8470		
MANU	0.0024	3.9592					0.0009	1.1803		
WHRT	0.0266	13.2749					-0.0032	-1.0561		
SCRM									0.0052	5.7436
DFEG									0.0644	4.3962
PCTAX									0.1151	7.3746
PCPTAX	-0.0232	-2.3065								
PCTD									-0.0133	-1.8646
LTD									0.0683	4.6108
SCIX							0.0738	7.1384		
NAIX	0.0084	1.7118	0.0011	1.2200	-0.0021	-1.2050				
HWD	0.0775	4.8122								
ESBd	0.0702	3.0330								
EXTAX			0.0026	0.8342	0.0241	3.5259				
EMPt-1	-0.1165	-11.134								
INMt-1			-0.0382	-7.8679						
OTMt-1					-0.0726	-8.8184				
MHYt-1							-0.7604	-13.232		

GEXt-1									-0.2843	-9.7675
RHO	0.8746		-0.2589		0.0507		-0.2177		-0.1531	
SIG	0.0982		0.0031		0.0222		0.0571		0.1832	
$nR^2 \sim \chi^2_{(38,42,42,40,41)}$ [a]	58.7376	0.0169[b]	43.1941	0.4200[b]	28.9533	0.9370[b]	41.1697	0.4192[b]	46.8382	0.2453[b]
Moran I	0.9203	9.3134[c]	-0.0704	-2.3522[c]	0.0175	2.377[c]	-0.0629	-1.7652[c]	-0.0463	-1.7474[c]
ETA (η)	0.1165		0.0382		0.0726		0.7604		0.2843	
n	418		418		418		418		418	

Note: *A coefficient is considered as statistically significant at 10 percent, 5 percent and 1 percent levels, if* $1.65 \leq |\text{t-stat.}| \leq 1.98$, $1.98 < |\text{t-stat.}| \leq 2.58$, and $|\text{t-stat.}| > 2.58$, *respectively.*

[a] *38, 42, 42,40, 41 represent the degree of freedoms which are equal to the over-identifying restrictions in the EMPR, INMR, OTMR, MHYR, GEXR equations, respectively.*

[b] *p-values,*

[c] *Z-values for Moran I*

Table 3: Descriptive Statistics for Appalachia Counties, 1990-2000.

Variable	Description	Mean	Std Dev	Minimum	Maximum
EMPR	Growth Rate of Employment, 1990-2000	0.17672	0.24499	-0.69448	1.7868
INMR	Growth Rate of Gross In-Migration, 1990-2000	0.096241	0.24922	-0.92655	1.08588
OTMR	Growth Rate of Gross Out-Migration, 1990-2000	0.096679	0.22048	-1.09537	0.99832
MHYR	Growth Rate of Median Household Income, 1989-1999	0.47743	0.30826	-0.49426	1.39569
GEXR	Growth Rate of Local Public Expenditures Per Capita, 1992-2002	0.61617	0.44636	-0.54832	4.95896
WEMPR	Spatial Lag of EMPR	0.17629	0.13013	-0.12982	0.84378
WINMR	Spatial Lag of INMGR	0.094796	0.22541	-0.45875	0.80957
WOTMR	Spatial Lag of OTMGR	0.092459	0.15939	-0.33829	0.57753
WMHYR	Spatial Lag of MHYR	0.47791	0.16818	0.076696	1.00418
WGEXR	Spatial Lag of GEXR	0.61467	0.17942	0.1598	1.83703
AREA	Land Area in square miles ,1990	6.00903	0.74824	1.09861	7.27656
POPs	Population ,1990	10.29714	0.94766	7.87664	14.10553
POP2	Population-squared,1990	106.9271	19.95609	62.04143	198.9659
POP5-17	Percent of population between 5 -17 years ,1990	2.92443	0.12003	2.17475	3.22287
POP25-44	Percent of population between 25 -44 years old,1990	3.37993	0.077483	2.78501	3.74479
FHHF	Percent of Female Householder, Family Householder,1990	2.32185	0.20314	1.81143	3.18787
SCRM	Serious crime per 100,000 population ,1990	2284.809	1561.256	0	8487
POPHD	Persons 25 years and over, % high school,1990	4.10041	0.1706	3.56953	4.4682
POPCD	Persons 25 years and over, % bachelor's degree or above,1990	2.26938	0.40654	1.30833	3.7305
OWHU	Owner-Occupied Housing Unit in percent,1990	4.32524	0.076094	3.86703	4.47278
MCRH	Median Contract Rent of Specified Renter-Occupied ,1990	5.64139	0.20586	4.94164	6.35784
UNEMP	Unemployment Rate ,1990	2.15356	0.34816	1.22378	3.24649
MANU	Percent employed in manufacturing ,1990	26.24019	11.29556	2.2	53.6
WHRT	Percent employed in wholesale and retail Trade,1990	18.82775	3.53195	8.7	27.7
DFEG	Direct Federal Expenditures and Grants per Capita,1992	7.98688	0.3758	6.98286	10.1766
PCTAX	Per Capital Local Tax ,1992	5.91452	0.52985	4.50736	7.42253
PCPTAX	Property Tax per Capita ,1992	5.5236	0.61602	3.91202	7.36265
PCTD	Total Debt Outstanding per Capita ,1992	1180.022	2271.215	0	30332
LTD	Long-Term Debt, Utility ,1992	11728.35	71189.12	0	1368142
SCIX	Social Capital Index ,1990	-0.59298	0.95959	-2.5266	5.64457
NAIX	Natural Amenities Index ,1990	0.14333	1.15867	-3.72	3.55
HWD	Highway Density ,1990	0.69039	0.40412	-0.33914	2.63189
ESBs	Establishment Density ,1990	2.92833	0.3351	1.87398	4.09316
EXPTAX	Personal Income Tax/Local General Expenditure,1990	0.8429	0.51449	-0.98373	2.60823
EMPt-1	Employment,1990	8.82649	1.25425	5.42054	13.38131
INMt-1	Gross In-Migration,1990	7.08755	1.00192	4.54329	10.51994
OTMt-1	Gross Out-Migration,1990	7.03768	0.97551	4.49981	10.54952
MHYt-1	Median Household Income,1989	9.9439	0.2261	9.05894	10.68093
GEXt-1	Local Public Expenditures per Capita,1992	7.22576	0.27948	6.49224	8.10832

***Note**: All variables except SCRM, PCTD, LTD, SCIX and NAIX are in log form*