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# **Interregional Spillovers and Urban-Rural Disparities in U.S. Employment Growth**

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**Abstract:** Wide disparities in employment growth exist within the United States. To examine the source of such disparities, we estimate a spatial lag model, which assesses the relative contribution of spillover effects and locational characteristics to regional employment growth during 1998-2007. Results confirm significant spatial multiplier effects and an analysis of their constituents shows a large spillover from neighboring urban counties. Moreover, policies aiming to diversify industrial structure and accumulate human capital in urban counties contribute the most to regional employment growth. However, our study also shows that such policies are likely to exacerbate the urban-rural gap in employment growth.

**Keywords:** Employment growth; Spatial econometrics; Spillovers.

**JEL codes:** R11, J21, C21

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## **Interregional Spillovers and Urban-Rural Disparities in U.S. Employment Growth**

### **1. Introduction**

Economic growth, measured by changes in output, wage, employment, and other economic indicators, is highly uneven among regions in the United States (Beeson et al. 2001, Rappaport 2004, 2009, Partridge and Rickman 2008). For instance, figure 1 shows the spatial variation in the average annual employment growth rate at the county level from 1998 to 2007. Moreover, regions with high employment growth rate appear to geographically concentrate in several areas. Classifying counties into urban and rural, according to the U.S. Office of Management and Budget, we find the annual employment growth rate averages 2 percent in the former compared with just 1 percent in rural counties (figure 2).<sup>1</sup> Such large spatial disparities in economic development have been a major concern from academic and policy perspectives both to understand causes and offer remedies.

The emerging new economic geography literature has addressed variations in economic development within and across nations (Fujita et al. 1997, Henderson et al. 2001, Combes et al. 2008). This literature has attributed spatial variations in economic development to four major factors (Henderson et al. 2001): social and economic institutions (e.g. types of governments, legal and property rights systems); natural endowments (e.g. land quality, weather); accumulated human and physical capital (e.g. skilled laborers, road networks); and agglomeration economies (e.g. spatial linkage between economic units).

Empirical tests of the contribution of the above factors to spatial variations in employment or population growth, however, have been mostly carried out in the urban context of developed and developing countries (Glaeser et al. 1992, Glaeser et al. 1995, Henderson 1997, Simon 1998, da Mata et al. 2007).<sup>2</sup> A major finding from the literature is that there is a significant spillover effect, that is, economic activities are interrelated between neighboring urban regions. The spillover effect from urban areas also impacts economic development in

surrounding rural areas. For example, Partridge et al. (2007) found that distance is a key factor underlying employment and population growth in nonmetropolitan counties in the United States; those adjacent to metropolitan areas grew fastest during the 1990s. Similarly, Schmitt and Henry (2000) find that population size and growth in urban regions enhance employment growth in French rural regions. Besides the urban-rural linkage effect, Huang et al. (2002) indicate that diverse industrial structure leads to population growth in the U.S. rural counties but a similar effect is not observed from the provision of public services.

While previous studies have increased our understanding of the potential causes of spatial variations in employment growth, few have evaluated the relative importance of factors causing the observed urban-rural disparity in employment growth. Moreover, the role of neighborhood effects or spatial spillovers, e.g. from urban to rural and vice versa, in employment growth has received limited attention in studies employing regional data (Carlino and Mills 1987, Combes 2000, Beeson et al. 2001, Desmet and Fafchamps 2005). Evaluating the relative importance of factors underlying employment growth and the role of spatial spillovers is critical to designing effective regional development strategies. For example, if spillovers account for a large share of the spatial variation in employment growth, then spatially targeted investments may bring about greater benefits than other developmental strategies.

The main objective of this article is to identify the source of spatial variation in employment growth among U.S counties with emphasis on the politically sensitive urban-rural gap. For this purpose, we apply a spatial-lag model, originally due to Anselin (1988), to data on the U.S. urban and rural counties during 1998-2007. The spatial-lag model allows us to evaluate how much of employment growth in a county is due to (1) the presence of some agglomeration force, (2) the natural advantage of the location, (3) accumulated human capital and (4) local government policies in the own county and in neighboring counties through spillovers.<sup>3</sup> Several articles have employed the spatial-lag model, but the policy implication of spatial spillover effects has received limited attention (López-Bazo et al. 2004, Abreu et al.

2005).

The remainder of this article is organized as follows. A model of regional employment growth is developed in section 2, where a theoretically consistent spatial lag is introduced. We then explain model specification and estimation techniques. Section 3 describes the county level data from 1998-2007. Section 4 presents estimation results, which highlights the role and significance of factors driving employment growth and the disparity between rural and urban regions. The results are also employed to evaluate the effectiveness of alternative policies in promoting employment growth. Section 5 concludes with a summary of results and policy implications.

## 2. Empirical Methodology

### 2.1. Derivation of the Employment Growth Model

To derive the employment growth model, first consider the following labor demand function (da Mata et al. 2007):

$$(1) \quad L_{jc} = L(w_c, k_c, A_{jc}).$$

where  $L_{jc}$  is the demand for labor from industry  $j$  in county  $c$ ; and  $w_c$ ,  $k_c$ , and  $A_{jc}$  denote, respectively, wage rate, capital rental rate, and Hicks-neutral productivity of the industry. Since an increase in productivity enhances the marginal product of labor, the higher the productivity, the larger is the labor demand. Henceforth, capital rental rate is assumed to be the same across counties (da Mata et al. 2007).

Productivity  $A$  is assumed to take the following form:

$$(2) \quad A_{jc} = A(G_{jc}, X_{jc}) \quad \text{with} \quad G_{jc} = \sum_{p \neq c} \delta_{cp} L_{jp},$$

where  $G_{jc}$  measures the productivity enhancement from agglomeration of industry  $j$ , and  $X_{jc}$  denotes all other sources of productivity enhancement. By definition,  $\partial A_{jc} / \partial G_{jc} > 0$  and

$\partial A_{jc} / \partial X_{jc} > 0$ . Since the spillover effects of agglomeration decay with distance, we define  $G_{jc}$  as a weighted sum of employment in surrounding regions, with weight  $\delta_{cp}$  being smaller for counties located farther away (Crozet et al. 2004, Rosenthal and Strange 2003).<sup>4</sup> Our specification of  $G_{jc}$  implies that productivity increases with employment in neighboring regions. In order to implement the spatial econometric model, we need to set a cut-off distance, beyond which spillover effects become zero (Abreu et al. 2005). Earlier studies indicate spillover effects are observed within around 100 miles. For example, Adams and Jaffe (1996) find that R&D spillover effects mostly fade beyond 100 miles. Partridge et al. (2007) also find that population growth in Canadian rural regions is positively affected by cities within a 175 km radius.<sup>5</sup> Hence, we define the weight  $\delta_{cp}$  as follows:

$$(3) \quad \delta_{cp} = \begin{cases} 1/d_{cp} & \text{if } d_{cp} \leq 100 \text{ miles} \\ 0 & \text{otherwise} \end{cases},$$

where  $d_{cp}$  is the great circle distance between county  $c$  and  $p$ , i.e. the shortest distance between regions.

By substituting equation (2) into (1) and differentiating it with respect to time after taking log on both sides, the annual growth rate of labor demand is obtained as follows:<sup>6</sup>

$$(4) \quad \tilde{L}_{jc} = \varepsilon_{LA} \left( \varepsilon_{AG} \sum_{p \neq c} \omega_{jp}^c \tilde{L}_{jp} + \varepsilon_{AX} \tilde{X}_{jc} \right) + \varepsilon_{Lw} \tilde{w}_c,$$

where the tilde represents the annual growth rate and  $\varepsilon_{st}$  is the elasticity of  $s$  with respect to  $t$ ,  $s, t = L, A, G, X, w$ . Since an increase in productivity and a decrease in wage rate raise labor demand,  $\varepsilon_{LA}$  and  $\varepsilon_{Lw}$  take a positive and a negative sign, respectively. Also,  $G_{jc}$  and  $X_{jc}$  are assumed to improve the productivity, and hence,  $\varepsilon_{AG}$  and  $\varepsilon_{AX}$  take a positive sign. Finally,  $\omega_{jp}^c$ , which forms the components of the spatial weight matrix in the estimation, equals:

$$(5) \quad \omega_{jp}^c = \frac{\delta_{cp} L_{jp}}{G_{jc}}.$$

Equation (4) implies that employment growth in a county is positively affected by that in the

surrounding areas.

Now, consider the supply side of the labor market. Suppose  $V(w_c, Q_c)$  is the indirect utility function for an individual working in industry  $j$  and living in county  $c$ , where  $Q_c$  measures the quality of life in county  $c$  (Glaeser et al. 1995, Rappaport 2009). We assume that individuals are free to move, and migration is costless. These assumptions imply that the utility must be equalized across counties in the equilibrium:

$$(6) \quad V(w_c, Q_c) = \underline{V},$$

where  $\underline{V}$  is the equilibrium level of utility (Rappaport 2009). By totally differentiating equation (6), we have:

$$(7) \quad \tilde{\underline{V}} = \varepsilon_{Vw} \tilde{w}_c + \varepsilon_{VQ} \tilde{Q}_c,$$

where  $\tilde{\underline{V}}$  is a growth rate of the equilibrium utility level, which is constant across regions within a country in the equilibrium. Since an increase in both wage rate and quality of life raises the utility level, both  $\varepsilon_{Vw}$  and  $\varepsilon_{VQ}$  take a positive sign. By solving for  $\tilde{w}_c$  from equation (7) and substituting it into equation (4), we have:

$$(8) \quad \tilde{L}_{jc} = \varepsilon_{LA} \varepsilon_{AG} \sum_{p \neq c} \omega_{jp}^c \tilde{L}_{jp} + \varepsilon_{LA} \varepsilon_{AX} \tilde{X}_{jc} - \frac{\varepsilon_{Lw} \varepsilon_{VQ}}{\varepsilon_{Vw}} \tilde{Q}_c + \frac{\varepsilon_{Lw}}{\varepsilon_{Vw}} \tilde{\underline{V}}.$$

Given  $\varepsilon_{Vw} > 0$ ,  $\varepsilon_{VQ} > 0$  and  $\varepsilon_{Lw} < 0$ , the parameter on  $\tilde{Q}_c$  takes a negative sign. In other words, employment in county  $c$  increases with improvements in its quality of life. Let  $W$  be a spatial weighting matrix consisting of  $\omega_{jp}^c$ . With this spatial weighting matrix, equation (8) is expressed in the matrix form as follows:<sup>7</sup>

$$(9) \quad \tilde{L} = \beta_0 i + \beta_1 W \tilde{L} + \beta_2 \tilde{X} + \beta_3 \tilde{Q},$$

where  $i$  is a column vector whose element is one. Matrix  $W$  is expressed as:<sup>8</sup>

$$(10) \quad W = \begin{pmatrix} W_1 & 0 & \cdots & 0 \\ 0 & W_2 & & \vdots \\ \vdots & & \ddots & \vdots \\ 0 & \cdots & \cdots & W_J \end{pmatrix} \text{ with } W_j = \begin{pmatrix} 0 & \omega_{j2}^1 & \cdots & \omega_{jC}^1 \\ \omega_{j1}^2 & 0 & & \vdots \\ \vdots & & \ddots & \vdots \\ \omega_{j1}^C & \cdots & \cdots & 0 \end{pmatrix}.$$

Finally,  $\tilde{X}$  and  $\tilde{Q}$  in equation (9) are assumed to take the following form:

$$(11) \quad \tilde{X}_{jc} = \alpha_1 \ln G_{jc}^0 + \alpha_2 \ln HHI_{jc}^0 + \alpha_3 \ln HC_c^0,$$

$$(12) \quad \tilde{Q}_c = \gamma_1 \ln AM_c^0 + \gamma_2 \ln PTX_c^0,$$

where  $HHI$ ,  $HC$ ,  $AM$  and  $PTX$  respectively denote the Herfindahl-Hirschman index, human capital, natural amenity index and per-capita property tax. Superscript 0 implies that variables are measured at the base year.<sup>9</sup> Based on previous studies (Glaeser et al. 1992, 1995; Henderson 1997), we assume that the initial regional conditions, such as accumulated human capital and regional industrial structure as measured by  $HHI$ , affect productivity growth and quality of life in the following period. For example, previous studies found that agglomeration of an industry increases productivity of the same industry (Henderson, 1997), while diverse regional industrial structure also enhances productivity (Glaeser et al. 1992). Accumulated human capital positively affects productivity through knowledge transfers (Lucas 1988, Rosenthal and Strange 2008). Hence,  $\alpha_1$  and  $\alpha_3$  in equation (11) are expected to take a positive sign while  $\alpha_2$  is expected to take a negative sign. A region's quality of life improves with good natural amenities, but falls with high per-capita property tax. Therefore,  $\gamma_1$  and  $\gamma_2$  are expected to take a positive and a negative sign, respectively.

Substituting equations (11) and (12) into (9), the model to be estimated is derived as:

$$(13) \quad \tilde{L}_{jc} = \beta_0 + \beta_1 \sum_{p \neq c} \omega_{jp}^c \tilde{L}_{jp} + \beta_{21} \ln G_{jc}^0 + \beta_{22} \ln HHI_{jc}^0 + \beta_{23} \ln HC_c^0 + \beta_{31} \ln AM_c^0 \\ + \beta_{32} \ln PTX_c^0 + \beta_4 \ln L_{jc}^0 + d_j + d_s + \eta_{jc},$$

with  $\eta_{jc} = \rho \sum_{p \neq c} \omega_{jp}^c \eta_{jp} + \varepsilon_{jc}$  where  $\varepsilon_{jc}$  is an innovation. The specification in equation (13)

allows for spatial autocorrelation in disturbances. The industry and state fixed effects,



respectively  $d_j$  and  $d_s$ , are expected to capture unobserved industry- and region-specific effects on employment growth. Initial employment level of the industry in the county,  $L_{jc}^0$ , is added to equation (13) to test if the economy exhibits a beta-convergence process (Henderson et al. 1995). That is, if  $\beta_4$  is negative and significant, then the regional employment is in a conditionally convergence process.

We estimate equation (13) by employing data on contiguous U.S. counties described in the next section. In addition, based on the finding that regions with high employment growth rate are geographically concentrated (figure 1), we check if spillover effects are stronger in those regions. For this purpose, we divide the county-level data into two sub-samples, the one consisting of the fast-growing region and the other consisting of its slow-growing counterpart. If the employment growth rate of an industry in a state is greater (smaller) than median employment growth rate of the industry, we consider the state belongs to fast- (slow-) growing region for the industry.<sup>10</sup> If spillovers are an important source of employment growth in the fast-growing region,  $\beta_1$  should be greater for the former sub-sample than the latter.

As long as  $\beta_1 \neq 0$ , shocks on employment growth in county  $c$  is correlated with the spatially lagged employment growth, i.e.  $E\left[\eta_{jc} \sum_{p \neq c} \omega_{jp}^c \tilde{L}_{jp}\right] \neq 0$ . Thus, ordinary least square estimation would yield inconsistent estimates (Anselin 1988). Following Kelejian and Prucha (2009), equation (13) is estimated by generalized spatial two-stage least squares. First, we estimate coefficient  $\beta$ s by two-stage least squares (2SLS). The instruments for the spatial lag of the dependent variable are spatial lags of the exogenous variables,  $X$  and  $QL$ , up to the third order to improve the efficiency (Kelejian and Robinson 1993). Next, the residuals from the 2SLS are used to estimate the spatial autocorrelation parameter  $\rho$  utilizing the generalized moment estimator. If the estimated parameter  $\hat{\rho}$  is statistically significant, then equation (13) is re-estimated by 2SLS after transforming the data using the matrix  $(I_{JC} - \hat{\rho}W)$ , where  $I_{JC}$  is a

$JC \times JC$  identity matrix.

## 2.2. Identification of Spillover Effects

Given the estimation result of equation (13), we can numerically evaluate the contributions of the spillover effects on employment growth in a county. The statistical significance of  $\beta_1$  implies that the employment growth rate in a region depends not only on regional characteristics in the own region but also on those in surrounding regions. In particular, when every region increases its characteristic by one unit, the total effect from a change, also referred to as the spatial multiplier effect, is the same for urban and rural counties and is given by  $1/(1-\beta_1)$  times the estimated coefficient on the characteristic in equation (13) (Anselin 2006). For instance, the spatial multiplier effect of an one unit increase in natural amenities ( $AM$ ) in an average *urban* county can be geographically separated as follows:

$$(14) \quad \frac{\beta_{31}}{1-\beta} = \frac{\beta_{31}}{JN_u} \sum_{c \in u} \sum_{j=1}^J \left( m_{cc}^j + \sum_{q \in u, q \neq c} m_{cq}^j + \sum_{q \in r} m_{cq}^j \right) \\ \equiv \beta_{31} (F_u^o + F_u^u + F_u^r),$$

where  $o$ ,  $u$  and  $r$  indicate the own, urban and rural counties, respectively;  $m_{pq}^j$  is the  $(p, q)$ th element of the matrix  $M_j = (I_C - \beta_1 W_j)^{-1}$  with  $I_C$  as a  $C \times C$  identity matrix;<sup>11</sup> and  $N_u$  denotes the number of urban counties. The first term ( $F_u^o$ ) in the second line of equation (14) reflects the effect from the own county. The second ( $F_u^u$ ) and third ( $F_u^r$ ) terms show the spillover effects from urban and rural counties, respectively. The geographical separation for the average *rural* region, i.e.  $F_r^o$ ,  $F_r^u$  and  $F_r^r$ , can be obtained in a similar manner.

Next, suppose an average urban county increases its regional characteristic by one unit. Since the  $i$ -th column sum of the matrix  $M_j$  measures the total effect from region  $i$  on employment growth in every region, geographical constituents of the total effect from an one

unit increase in natural amenity in an average urban county are obtained as follows:

$$(15) \quad \sum_{i \in \{o, u, r\}} d\tilde{L}_i^u = \frac{\beta_{31}}{JN_u} \sum_{c \in u} \sum_{j=1}^J \left( m_{cc}^j + \sum_{q \in u, q \neq c} m_{qc}^j + \sum_{q \in r} m_{qc}^j \right).$$

where  $d\tilde{L}_i^u$  denotes the effect on the employment growth rate in  $i$ -th type county with  $i = o, u, r$  from an average urban county. The first, second and third terms of the bracket are the effect from an average urban county on its own region, surrounding urban counties and surrounding rural counties, respectively. Equation (15), along with a similar expression for rural counties, shows how much a change in regional characteristics in a county affects employment growth in its own county and surrounding counties through spillovers. The empirical outcomes of equation (15) aid in the evaluation of the effectiveness of alternative development policies.

Finally, using mean values of variables for urban and rural counties, the constituents of the urban-rural variation in employment growth can be derived as follows:

$$(16) \quad \begin{aligned} \bar{\tilde{L}}_u - \bar{\tilde{L}}_r = & \beta_2 \left\{ \left( F_u^o \bar{X}_u + F_u^u \bar{X}_u + F_u^r \bar{X}_u \right) - \left( F_r^o \bar{X}_r + F_r^u \bar{X}_r + F_r^r \bar{X}_r \right) \right\} \\ & + \beta_3 \left\{ \left( F_u^o \bar{Q}_u + F_u^u \bar{Q}_u + F_u^r \bar{Q}_u \right) - \left( F_r^o \bar{Q}_r + F_r^u \bar{Q}_r + F_r^r \bar{Q}_r \right) \right\}, \end{aligned}$$

where  $\bar{X}_u$ ,  $\bar{X}_r$ ,  $\bar{Q}_u$  and  $\bar{Q}_r$  represent the average of  $X$  and  $Q$  in urban and rural regions, respectively. The components of equation (16) show the contribution of county characteristics to the urban-rural gap in employment growth.

### 3. Data and Variables

The *County Business Patterns*, published by the U.S. Census Bureau, is the primary data source for our empirical analysis.<sup>12</sup> These data cover all U.S establishments with paid employees during the week of March 12, including full- and part-time employees, officers and executives from 1998 to 2007. Data for 2-digit industries within manufacturing and service industries (NAICS 31-81) are employed in our estimation.<sup>13</sup> Agglomeration of an industry ( $G$ ) is

constructed based on equation (2) for each industry. Herfindahl-Hirschman index ( $HHI$ ) is computed as  $\sum_{k \neq j} (S_{kc}^0)^2$ , where  $S_{kc}^0$  is the employment share of the 2-digit industry  $k \neq j$  in county  $c$  in the initial period. Human capital ( $HC$ ) is defined as the share of individuals with a bachelor's degree or above to the population of over 25 year-old. The data for calculating the human capital measure come from the 1990 *Census* conducted by the U.S. Census Bureau. The natural amenity index ( $AM$ ) employed in our estimation is developed by the U.S. Department of Agriculture (McGranahan 1999). The index is based on average January temperature, average number of sunny days in January, low winter-summer temperature gap, low average humidity in July, topography scale, and water area proportion of total county area. Finally, data on per-capita property tax ( $PTX$ ) come from the 1997 *Census of Governments* of the U.S. Census Bureau. Summary statistics are reported in table 1. Third and fourth columns of table 1 show that relative to rural counties, urban counties have a higher degree of industrial agglomeration, more diverse industrial structure and more accumulated human capital. On quality of life indicators, urban counties have a higher average natural amenity index and higher average per-capita property tax than rural counties (Rappaport 2007).

Sixth to ninth columns of table 1 show summary statistics in fast- and slow-growing regions. The gap in employment growth between urban and rural counties is still observed in both sub-samples. We find more accumulation of human capital, a higher natural amenity index and a higher per-capita property tax but a lower degree of industrial agglomeration in fast-growing region. The last finding seems to support the idea that regional employment is in a conditionally convergence process. In the next section, we show how the difference between urban and rural counties observed in table 1 leads to a gap in employment growth.

## 4. Estimation Results

### 4.1. Estimation Results of the Employment Growth Model

The results from estimating equation (13) in five alternative versions, using data described in the last section, are presented in table 2. Column labeled (1) is our base model, which is estimated using data from all counties with a cut-off distance for the spatial weighting matrix set at 100 miles. Columns labeled (2) and (3) are estimated using two sub-samples; observations belonging to fast- and slow-growing regions. Columns labeled (4) and (5) differ from column (1) only in that the cut-off distance for  $W$  is set at 50 and 150 miles, respectively.

The coefficient on the spatial lag,  $\beta_1$ , is positive and significant in column (1), confirming that employment growth in a county is positively affected by that in the surrounding counties through spillovers. Hence, any regional characteristic affecting employment growth in a region should influence surrounding regions' employment growth as well. Note that parameters on regional characteristics  $X$  and  $QL$ , which take an expected sign with statistical significance in table 2, only capture the direct effect. Thus, we begin with the qualitative interpretation of each parameter in the following, leaving the discussion on quantitative implications for the next sub-section. On the productivity side,  $\beta_{21}$  is positive and significant, indicating that agglomeration of an industry at the initial period positively contributes to employment growth of the same industry in a county. Diverse industrial structure in a region also leads to fast employment growth as  $\beta_{22}$  is negative. Furthermore, the positive  $\beta_{23}$  implies that accumulation of human capital increases employment growth. With regard to quality of life,  $\beta_{31}$  is positive while  $\beta_{32}$  is negative suggesting that, *ceteris paribus*, employment growth is higher in counties with higher natural amenities and lower per-capita property tax. Finally, the negative  $\beta_4$  confirms a beta-convergence process for employment growth, a finding consistent with other studies (Henderson et al. 1995, Beeson et al. 2001).

To check the robustness of our results, we allow the parameter on explanatory variables to vary between fast- and slow-growing regions. Parameter estimates in column (2) and (3) of table 2 reveal that parameters on regional characteristics for fast- and slow-growing regions are qualitatively and quantitatively similar to those in column (1) except for that on the amenity

index in the slow-growing region. However, the parameter on the spatial lag of the dependent variable shows a stark difference between the two sub-samples. While the parameter for fast-growing region is positive and significant, that for slow-growing region is insignificant, implying that we do not observe spillover effects in the latter region. Next, we check if the estimation results obtained in column (1) depend on the cut-off distance used in constructing the spatial weight matrix in equation (10). A comparison of the results in columns (4) and (5) with those in column (1) indicates that parameter estimates are robust to changes in cut-off distance with the exception of the one on the spatial lag of the dependent variable. The parameter on the spatial lag with a cut-off distance of 50 miles is weakly significant and much lower than that with cut-off distance of 100 miles, suggesting spillovers extend beyond 50 miles.

Finally, table 3 reports the estimates of the base model (13) for individual 2-digit industries. As  $\beta_1$  is positive and significant, the existence of employment-growth spillovers is confirmed in eight of the thirteen 2-digit industries. For example, the financial industry (NAICS 52), known for its knowledge intensity, shows substantial spillovers (Brühlhart and Mathys, 2008). Surprisingly, we do not observe any significant spillover effects in manufacturing industry (NAICS 31). The reason for this unexpected result is the decreasing trend in manufacturing employment during the estimation period, which leads to negative values of the spatial lag variable for more than 95 percent of counties. Spillovers are also observed in several service industries, including retail (NAICS 44) and accommodation and food (NAICS 72), which tend to concentrate in big cities, resulting in geographical concentration of employment growth.<sup>14</sup> With regard to regional characteristics, most parameters take an expected sign with statistical significance. In particular, the parameters on the agglomeration of an industry, the Herfindahl-Hirschman index and the share of human capital are statistically significant for all industries, indicating diverse industrial structure and accumulation of an industry and human capital are important factors for regional employment growth in the U.S. industries.

## **4.2. Sources of Urban-Rural Gap in Employment Growth and Alternative Development Policies**

The first two columns of table 4 show the geographical constituents of the spatial multiplier effect in “average” urban and rural counties in the U.S, respectively; the next two columns show such constituents in average urban and rural counties of the fast-growing region; and the last two columns show the effect in average urban and rural counties of the slow-growing region.<sup>15</sup>

Based on equation (14), we separate the total effect, i.e. spatial multiplier into three components: the effect from the own county, spillover effects from surrounding urban counties, and spillover effects from surrounding rural counties. Table 4 shows the contribution of each of the three effects to the total effect. The results indicate that the own-county or local effect accounts for about 50 percent of the increase in the employment growth rate in both average rural and urban counties. The spillover effects from surrounding urban and rural counties account for 41 and 7 percent of the increase in the employment growth rate in an average urban county and 33 and 16 percent in an average rural county. Although spillovers from rural counties enhance employment growth in rural counties to some extent, spillovers from urban counties are more important sources of employment growth not only in urban counties but also in rural counties. The latter finding is consistent with the results of Partridge et al. (2008) that proximity to cities is an important source of rural population growth. Comparison between fast- and slow-growing regions emphasizes the importance of the spillover effects on employment growth in the former but not in the latter.

After assessing the relative contribution of the spillover effects, we now identify how much of a change in regional characteristics in an average urban or rural county affects employment growth in surrounding regions. By following equation (15), we evaluate in table 5 the effect on employment growth of one standard deviation change in each regional characteristic from the sample mean. Results show that accumulation of human capital has the largest effect on employment growth for the case of full sample. The contributions of regional industrial

structure, agglomeration of an industry ( $G$ ) and per-capita property tax ( $PTX$ ) follow in that order. Compared with an average rural county, an average urban county yields larger spillover effects on employment growth in surrounding urban and rural counties. For example, the employment growth rate in surrounding urban and rural counties increases by 0.6 and 0.9 percentage points, respectively, if  $HC$  increases by one standard deviation in an average urban county. However, corresponding change in an average rural county raises employment growth in surrounding urban and rural counties by only 0.05 and 0.2 percentage points, respectively. Finally, one standard deviation change in a regional characteristic in an average county in the fast-growing region induces employment growth while that effect is not observed in the slow-growing region. The results suggest that a development policy targeted to an urban county, especially in the fast-growing region, is more effective than that in a rural county in generating employment spillovers.<sup>16</sup>

The above discussion points to the important role of spillovers, especially from urban counties, in bringing about regional employment growth. The last question we address in this study is: which regional characteristic contributes most to the urban-rural disparity in employment growth? To answer the question, we examine the difference in the employment growth rate between urban and rural counties by employing equation (16). The predicted difference and its constituents are shown in table 6, which reveals that 45 percent of the urban-rural difference is explained by the level of accumulated human capital ( $HC$ ). Regional industrial structure ( $HHI$ ) and agglomeration of an industry ( $G$ ) explain 33 percent and 24 percent of the gap, respectively. On the other hand, amenities explain only 0.9 percent of the difference in employment growth between rural and urban counties because there is little difference between the average level of amenities in rural and urban counties. Variations in local property tax rate explain about -2.4 percent of the difference in employment growth between rural and urban counties. Results for fast- and slow-growing regions show that accumulation of human capital, regional industrial structure and agglomeration of an industry



explain most of the urban-rural disparity.

To sum up, our results imply that regional characteristics related to productivity enhancement ( $X$ ) are the main factors causing the urban-rural disparity in employment growth. In other words, less attractiveness of rural counties to industries/firms results in a lack of employment demand, which in turn causes the urban-rural disparity in employment growth. These results, while highlighting the classic trade-off between economic growth and development in a regional context, show that policy options vary depending on the weight placed on highest growth versus regional equities in the social welfare function. High localized benefits of a policy might be attractive, but it likely brings about stark regional trends increasing social (national) costs.

## **5. Summary and Conclusions**

A wide gap in employment growth exists between the urban and rural counties in the United States. Although various factors such as agglomeration economies, natural amenity and government policy have been identified as the potential causes of the gap, few studies have examined the relative contribution of these factors to the gap in employment growth between urban and rural counties. The economic activity in one region is likely to be affected by economic activity in the surrounding regions. Hence, when evaluating the contribution of factors to regional employment growth, we must take into account of spillover effects. For this purpose, we derive an employment growth equation including a theoretically consistent spatial-lag of the dependent variable, which explicitly controls for the simultaneous regional economic interactions. Our model linking employment growth to regional characteristics and spillovers is estimated using 1998-2007 data on U.S. counties.

Estimation results reveal strong positive spillover effects in employment growth, i.e. growth in a county affects that in surrounding regions and vice versa, which is robust to changes in model specifications. The evaluation of these neighborhood effects indicates that spillovers,

especially from urban counties, make a relatively large contribution to regional employment growth. Regional industrial structure and the level of accumulated human capital in urban counties, especially those in fast-growing region, are key factors driving economic growth. The main sources of the urban-rural variation in the employment growth rate are factors affecting productivity, including regional industrial structure, accumulated human capital, and the geographical concentration of an industry.

Our results indicate that human capital development and diversification of industrial structure in urban counties can contribute to overall regional employment growth, including both urban and rural regions. Policies to promote the geographical concentration of an industry can also contribute to economic growth. However, as these policies also widen the urban-rural disparity in employment growth, there exists a tradeoff between enhancing overall regional employment growth and shrinking the urban-rural gap, i.e. spatially even economic development. Thus, policy options to generate high regional employment growth may not well serve the objective of regional equity in economic development. Our study evaluates the local and national benefits of alternative policies, which need to be weighed against respective local and national costs prior to choosing a development strategy.

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**Table 1: Summary Statistics**

Variable	Unit	Full sample		Fast-growing region		Slow-growing region	
		Urban	Rural	Urban	Rural	Urban	Rural
Employment growth ( $\tilde{L}$ )	Rate	0.020 (0.043)	0.010 (0.049)	0.027 (0.044)	0.016 (0.052)	0.014 (0.042)	0.005 (0.045)
Agglomeration ( $G^0/1,000$ )	Number	3.259 (4.010)	1.361 (1.785)	2.245 (2.606)	1.006 (1.263)	3.524 (4.083)	1.414 (1.882)
Herfindahl-Hirschman index ( $HHI^0$ )	Index, 0-1	0.141 (0.051)	0.197 (0.079)	0.140 (0.052)	0.196 (0.081)	0.141 (0.051)	0.199 (0.078)
Share of human capital ( $HC^0$ )	Index, 0-1	0.180 (0.079)	0.118 (0.049)	0.182 (0.081)	0.121 (0.050)	0.177 (0.077)	0.114 (0.047)
Natural amenity index ( $AM^0$ )	Index, 1-19	7.648 (2.380)	7.373 (2.238)	8.277 (2.414)	7.987 (2.291)	7.073 (2.194)	6.766 (2.008)
Per-capita property tax ( $PTX^0/1,000$ )	Dollar	0.770 (1.747)	0.665 (0.695)	0.813 (2.194)	0.715 (0.853)	0.730 (1.197)	0.615 (0.487)

Note: Values in parenthesis are standard deviations.

Source: U.S. Census Bureau, County Business Patterns, Various Years.

U.S. Census Bureau, 1997 Census of Governments.

U.S. Census Bureau, Census 1990.

U.S. Department of Agriculture, Agricultural Economic Report No. 781.

**Table 2: Parameter Estimates of the Regional Employment Growth Model**

	(1)	(2)	(3)	(4)	(5)
	Full	Sub-sample		Cut-off distance	
Variable	sample	Fast-growing	Slow-growing	50 miles	150 miles
$\tilde{W}\tilde{L} (\beta_1)$	0.494*** (0.082)	0.570*** (0.118)	-0.010 (0.122)	0.106* (0.055)	0.321*** (0.098)
$\ln G^0 (\beta_{21})$	0.005*** (0.000)	0.005*** (0.000)	0.005*** (0.000)	0.005*** (0.000)	0.007*** (0.000)
$\ln HHI^0 (\beta_{22})$	-0.019*** (0.001)	-0.023*** (0.002)	-0.015*** (0.002)	-0.019*** (0.001)	-0.020*** (0.001)
$\ln HC^0 (\beta_{23})$	0.020*** (0.001)	0.018*** (0.002)	0.022*** (0.001)	0.021*** (0.001)	0.021*** (0.001)
$\ln AM^0 (\beta_{31})$	0.005*** (0.001)	0.009*** (0.002)	0.002 (0.002)	0.006*** (0.002)	0.005*** (0.002)
$\ln PTX^0 (\beta_{32})$	-0.003*** (0.001)	-0.002** (0.001)	-0.005*** (0.001)	-0.004*** (0.001)	-0.003*** (0.001)
$\ln L^0 (\beta_4)$	-0.009*** (0.000)	-0.009*** (0.001)	-0.009*** (0.000)	-0.010*** (0.000)	-0.009*** (0.000)
Constant ( $\beta_0$ )	-0.048*** (0.007)	-0.068*** (0.010)	-0.017* (0.009)	-0.031*** (0.007)	-0.050*** (0.007)
$W\eta (\rho)$	-0.153** (0.070)	-0.225*** (0.090)	0.095 (0.094)	-0.174 (1.891)	0.020 (0.077)
Observations	28012	13188	14811	27083	28067

Note: \*, \*\* and \*\*\* indicate statistical significance at 10%, 5% and 1%, respectively. Values in parenthesis are heteroskedasticity-robust standard errors. Industry and state fixed effects are added in every specification. Only observations belonging to fast- and slow-growing region are used in column (2) and (3), respectively. Cut-off distance is set to 50 miles and 150 miles when constructing spatial weighting matrix  $W$  in column (4) and column (5), respectively.



**Table 3: Parameter Estimates of the Regional Employment Growth Model  
for Individual Industries**

NAICS	Variable								$W\eta$	Observations
	$\tilde{WL}$	$\ln G^0$	$\ln HHI^0$	$\ln HC^0$	$\ln AM^0$	$\ln PTX^0$	$\ln L^0$	Constant		
31	0.219	0.005***	-0.036***	0.014***	-0.007	-0.006*	-0.009***	0.002	-0.125	2216
42	0.727***	0.005***	-0.019***	0.014***	0.000	0.004	-0.007***	-0.125***	-0.321*	2277
44	0.430**	0.003***	-0.006***	0.009***	0.008***	-0.003**	-0.001**	-0.033***	-0.070	2893
48	1.164***	0.011***	-0.023***	0.020***	-0.004	-0.007*	-0.011***	-0.048	-0.489***	2050
51	0.964***	0.002**	-0.029***	0.025***	0.001	0.002	-0.009***	-0.154***	-0.378***	1457
52	0.807***	0.003***	-0.013***	0.019***	0.005	-0.004*	-0.004***	-0.071***	-0.290***	2345
53	0.263	0.005***	-0.031***	0.020***	0.021***	0.005	-0.015***	-0.093***	-0.096	1681
54	0.232	0.006***	-0.024***	0.035***	0.018***	-0.006**	-0.010***	-0.083***	-0.123	2164
56	0.377	0.005*	-0.030***	0.025***	0.012	0.008	-0.020***	-0.101**	-0.133	1706
62	1.217***	0.002***	-0.013***	0.014***	0.002	-0.003	-0.005***	-0.049**	-0.254**	2560
71	0.164	0.006***	-0.026***	0.032***	-0.011	0.002	-0.016***	-0.070**	-0.122	1307
72	0.689***	0.003***	-0.010***	0.013***	0.006*	-0.006***	-0.003***	-0.024	-0.263*	2736
81	0.425**	0.005***	-0.012***	0.017***	0.007**	-0.003*	-0.008***	-0.022	-0.004	2620

Note: \*, \*\* and \*\*\* indicate statistical significance at 10%, 5% and 1%, respectively. State fixed effects are added in every specification.

NAICS codes: 31 Manufacturing, 42 Wholesale, 44 Retail, 48 Transportation and warehousing, 51 Information, 52 Finance and insurance, 53 Real estate and rental and leasing, 54 Professional, scientific and technical services, 56 Administrative and support and waste management and remediation services, 62 Health care and social assistance, 71 Arts, entertainment and recreation, 72 Accommodation and food services, 81 Other services.

**Table 4: Geographical Constituents of the Spatial Multiplier Effect**

Contribution (%)	Full sample		Fast-growing region		Slow-growing region	
	Urban	Rural	Urban	Rural	Urban	Rural
Effect from the own county	52.6	51.1	46.5	43.9	100.0	100.0
Spillover effects <i>from</i> urban counties	40.5	33.4	45.2	38.3	0.0	0.0
Spillover effects <i>from</i> rural counties	6.9	15.6	8.3	17.8	0.0	0.0

Note: The sum of three effects does not add up to precisely 100 percent due to rounding. Contribution shows how much each effect contributes to employment growth, i.e. total effect. Spillover effects are equal to zero in slow-growing region as  $\beta_1$  is not significant in the employment growth estimation (column 3 in table2).

**Table 5: Effects of One Standard Deviation Change in Regional Characteristics  
in a County on Employment Growth**

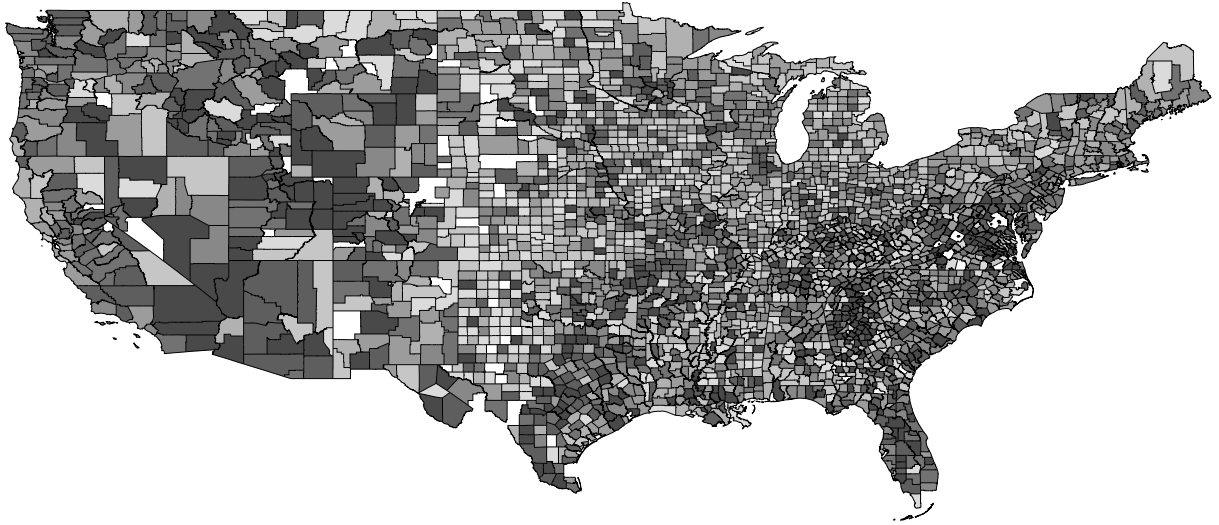
Variable	Full sample		Fast-growing region		Slow-growing region	
	Urban	Rural	Urban	Rural	Urban	Rural
<u>Total effect</u>						
$G^0$	0.0132	0.0061	0.0150	0.0062	0.0036	0.0040
$HHI^0$	-0.0187	-0.0088	-0.0287	-0.0122	-0.0048	-0.0051
$HC^0$	0.0223	0.0098	0.0240	0.0094	0.0080	0.0076
$AM^0$	0.0041	0.0018	0.0084	0.0034	0.0006	0.0006
$PTX^0$	-0.0097	-0.0033	-0.0093	-0.0028	-0.0047	-0.0028
<u>Effect to the own county</u>						
$G^0$	0.0044	0.0045	0.0042	0.0041	0.0036	0.0040
$HHI^0$	-0.0061	-0.0065	-0.0078	-0.0081	-0.0048	-0.0051
$HC^0$	0.0077	0.0071	0.0070	0.0062	0.0080	0.0076
$AM^0$	0.0014	0.0013	0.0024	0.0022	0.0006	0.0006
$PTX^0$	-0.0039	-0.0023	-0.0032	-0.0018	-0.0047	-0.0028
<u>Spillover effects to surrounding urban counties</u>						
$G^0$	0.0034	0.0003	0.0040	0.0004		
$HHI^0$	-0.0047	-0.0004	-0.0076	-0.0007		
$HC^0$	0.0059	0.0005	0.0068	0.0007		
$AM^0$	0.0011	0.0001	0.0023	0.0002		
$PTX^0$	-0.0030	-0.0003	-0.0031	-0.0003		
<u>Spillover effects to surrounding rural counties</u>						
$G^0$	0.0055	0.0014	0.0068	0.0017		
$HHI^0$	-0.0079	-0.0020	-0.0133	-0.0033		
$HC^0$	0.0087	0.0022	0.0102	0.0025		
$AM^0$	0.0016	0.0004	0.0037	0.0009		
$PTX^0$	-0.0028	-0.0007	-0.0030	-0.0007		

Note: The sum of three effects does not add up to the total effect due to rounding. Spillover effects are set to zero in slow-growing region as  $\beta_1$  is not significant in the employment growth estimation (column 3 in table2).

**Table 6: Sources of the Urban-Rural Gap in Employment Growth**

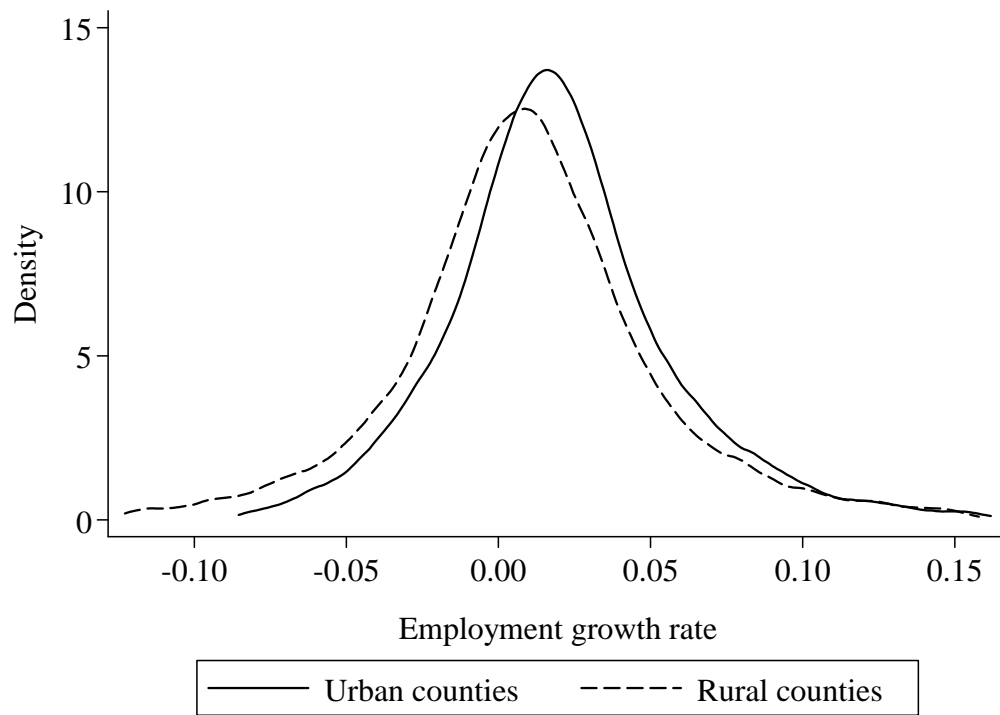
Variable	Full sample	Fast-growing region	Slow-growing region
$G^0$	23.8	21.1	23.1
$HHT^0$	33.1	40.6	28.6
$HC^0$	44.5	38.2	52.3
$AM^0$	0.9	1.6	0.5
$PTX^0$	-2.4	-1.5	-4.5

Note: Contribution of each regional characteristic to predicted urban-rural disparity in the employment growth rate is measured by percentage. The column sum does not add up to precisely 100 percent due to rounding.



**Figure 1: Employment Growth Rate in the United States**

Note: Darker shades indicate higher growth rate. The employment growth rate is averaged across 2-digit industries.



**Figure 2: Kernel Density Estimates for the Employment Growth Rate in Urban and Rural Counties**

## Endnotes

<sup>1</sup> We follow the definition of the U.S. Office of Management and Budget in defining urban and rural counties, i.e. a county is considered as an urban county if it belongs to any metro area based on *Census 1990*.

<sup>2</sup> Some of these studies may suffer from a selection bias. Beeson et al. (2001) and Desmet and Fafchamps (2005) argue that rural regions have not experienced population growth unlike urban regions. Thus, employing urban data alone can lead to a biased sample and the resulting econometric estimates.

<sup>3</sup> Some studies have captured dynamic externalities in economic growth, i.e. agglomeration at the initial period leads to the growth in productivity and employment in the following period (Glaeser et al 1992, Hanson, 2001, Henderson 1997). However, such dynamic-externality frameworks ignore simultaneous regional economic interactions during the estimation period.

<sup>4</sup> A similar specification is widely employed in previous literature, e.g. Head and Mayer (2004).

<sup>5</sup> Bottazzi and Peri (2003) also show that R&D spillovers occur in Europe within a 200 km radius. Employing the U.S. county data, Desmet and Fafchamps (2005) find that the effect of the initial employment level on employment growth in the following period vanishes beyond 100 km.

<sup>6</sup> Capital rental rate is dropped from the expression since it is assumed to be the same across counties.

<sup>7</sup> The equilibrium growth rate of utility level is included in  $\beta_0$  since it is assumed to be constant across regions.

<sup>8</sup> Since  $\sum_p \omega_{jp}^c = 1$  from equation (5), spatial matrix  $W$  is row standardized by construction.

<sup>9</sup> Hanson (2001) argues that the base year value is predetermined and uncorrelated with current shocks on the employment growth rate.

<sup>10</sup> We define fast- and slow-growing regions at the state level by allowing a county to interact

with other counties in the same state. Defining fast- and slow-growing regions at county level implicitly assumes that a county does not interact with neighboring counties if they belong to a different sub-sample, yielding many observations unconnected with other counties and leading to a loss of degrees of freedom.

<sup>11</sup> If  $|\beta_1| < 1$ , then  $M_j$  is expressed as  $M_j = I_C + \sum_{i=1} (\beta_1 W_j)^i$ . Therefore, the row standardization of the matrix  $W$ , i.e. the row standardization of  $W_j$  as  $W$  is a block diagonal matrix (see equation 10), implies that the row sums of the matrix  $M_j$  is  $1 + \sum_{i=1} \beta_1^i = 1/(1 - \beta_1)$ , i.e.  $\sum_q m_{cq}^j = 1/(1 - \beta_1)$ .

<sup>12</sup> Since industry classification system changes from SIC to NAICS in 1998, we avoid using data before 1998. NAICS also changes from NAICS 1997 to NAICS 2002 in 2003 but the effect of that change is negligible at the 2-digit industry level.

<sup>13</sup> We avoid using 3-digit level data because about half of observations are not disclosed due to confidentiality. By the same token, NAICS 22, 55 and 61 are dropped from the sample.

<sup>14</sup> Although the parameter on the spatial lag in transportation (NAICS 48) and health care industries (NAICS 62) exceeds one, the null hypothesis that it is less than one is not statistically rejected at the 10 percent level.

<sup>15</sup> Spillover effects are equal to zero in the last two columns because the parameter on the spatial lag in the slow-growing region is not statistically significant.

<sup>16</sup> The spillover effects from an average rural county to surrounding rural counties are not negligible. Hence, as discussed in da Mata et al. (2007), if cost to increase a regional characteristic by one standard deviation is lower in a small rural county than a big urban county, then it might be cost-effective to invest in rural counties.