The Effect of Innovative Behavior and Technological Spillovers on Employment Growth in the US Midwest

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Abstract

This study uses an overlapping generations (OLG) model with two labor types and two employment regions to examine factors driving labor migration. Specifically, we examine the effect of innovative behavior on employment growth. Using an OLG model, we test this hypothesis in the Midwestern States of Iowa, Minnesota, Missouri, Kansas, Nebraska, South Dakota, and North Dakota for eight sectors of employment. We find innovative behavior as measured by patents has a positive effect on employment growth in all sectors studied for the growth period 1969-99.

Introduction

Most of the rural United States experienced a decline in activity in the early part of the 20th Century. This decline was marked by both a relative decline in economic activity and a large out migration of population from rural regions to urban and metropolitan centers. Rural areas have traditionally been focused on production and distribution of agricultural products. However, with the development of labor saving technologies, labor once employed in primary agriculture has moved away from these rural areas to larger urban centers offering a wider spectrum of employment opportunities. For those continuing to remain in rural areas, employment opportunities were generally more limited.

The realization that primary agriculture is no longer a driving force in most rural regions has prompted consideration of the factors underlying rural economic growth. To understand rural economic growth we need to understand the underlying causes of economic growth. What is the impact of investment in technology within the firm? How do spillovers between firms and industries impact growth? What is the relationship between rural and neighboring urban areas? What are the inter-relationships of the above?

This paper proposes to examine factors affecting employment in the US Midwest with special attention to the role of innovative behavior and technology spillovers. In this paper we adopt a two period overlapping generations model (OLG) with two production regions in an endogenous growth framework. Within the framework of the model we inspect the factors driving employment migration from one sector to another. We then use data from the US Midwestern States of Minnesota, Iowa, Missouri, Kansas, Nebraska, South Dakota, and North Dakota to empirically estimate industry employment growth at the county level. Included in our analysis is a measure, patent filings by county, to proxy innovative behavior. The growth period for this study spans the years 1969-99.

In light of the introductory comments, it is interesting to make a slight diversion and review Figure 1. In the opening paragraph we indicate that demands for labor in urban centers encourages out-migration from rural areas, and that the rural focus on agriculture would slow, or possibly turn negative. Figure 1 indicates that population growth was indeed negative during our study period in most rural counties except those having opportunities to develop tourism, while employment growth was positive in many rural counties.

Conceptual Framework

When considering economic growth it is important to consider the effects of technological spillovers. Romer (1996) and Lucas (1988) argue that externalities, especially knowledge, are important determinants of growth. Lucas is primarily concerned with economic development across countries over time. Knowledge spillovers have been modeled by Loury (1979) and Dasgupta and Stiglitz (1980). Griliches (1979) surveys empirical literature on the role of knowledge spillovers. Jacobs (1969) and Bairoch (1988) argue that innovations are made in cities due to larger interaction with people. Without the opportunity to learn from others and improve ones self there would be no reason for people to pay large rents to work in a city (Glaeser, et al. 1992). Glaeser, et al. (1992) suggests that the relatively easy flow of ideas may explain how cities survive despite high costs of living.

Two relatively polar ideas of market structure concerning knowledge spillovers and economic growth are present and both have merits. The first MAR, as called by Glaeser et al. (1992) and is based on the works or Marshall, Arrow, and Paul Romer, suggests concentration of an industry in an area helps knowledge spillovers and thus positively influences growth of that industry. Arthur (1989) used Silicon Valley as an example of such a phenomenon. MAR also predicts that local monopoly is better for growth than local competition. This prediction is similar to that made by Schumpeter (1942).

On the other hand, Porter (1990) believes that spillovers also come from within the industry but that growth is fostered by competition and not monopoly. He gives the example of the Italian ceramics and gold jewelry industries. Jacobs (1969) believes that the most important spillovers come from between industries rather than within the industry. She concludes that industry diversity and not industry specialization promotes growth. Jacobs also argues that local competition rather than local monopoly as a market environment for stimulating growth. The Glaeser et al. (1992) empirical analysis lends support to Jacobs' theory.

Much of the macroeconomic economic growth literature has developed using infinite horizon models. However, some recent growth literature has been developed in an overlapping generations (OLG) framework. One such model is that of Bencivenga and

Smith (1997) who use a two period multi-region OLG model to examine rural to urban migration. The model is characterized by rural-urban migration and urban unemployment arising from an adverse selection problem in the labor market. Production in rural areas is via a single input production function, using only labor to produce an agricultural good. Urban production produces a manufactured good via a technology employing capital and skilled labor. Such a specification follows that used by Drazen (1982), Drazen and Eckstein (1988), Ranis (1988) and Rauch (1993).

Model With Endogenous Growth

The following is an OLG model with two economic regions. The model follows Bencivenga and Smith (1997) (BS 97) except there is no adverse selection problem and endogenous growth is introduced in the form of a production spillover. The two regions in the model are a primary region where only an agricultural good is produced and an advanced or developed region where a manufactured good is produced.

Model Preliminaries:

At t n^t new people appear in the economy and n^{t-1} dies, hence the population growth rate is n. There are 2 types of young agents: denoted by θ_i for i=1,2, where 1 and 2 index the low and high skill proportion of the entering population respectively. Also $\theta_1 + \theta_2 = 1$. There are two goods produced in this economy, an agricultural good and a manufactured good. The agricultural good is produced in the primary region and uses only labor as an input. Each unit of labor employed in agriculture is able to produce π_i units of the agricultural good. We assume high skill labor is more productive in production of the agricultural good so $\pi_2 > \pi_1 > 0$. The manufactured good is produced in the developed region that uses both labor and capital to produce output. However, only high skilled labor is used in production of the manufactured good since the production mix of capital and labor requires skilled labor. As in BS 97 it is assumed low skill labor is completely unproductive in manufacturing, and as a result a firm will only employ skilled labor. Unlike in BS 97 there is no adverse selection problem since firms are assumed to observe the type of agent working and will thus have full employment. From this assumption we will have all low skill agents working in the primary region and high skill workers will make a choice where to work, primary or developed region.

In the model that follows, endogenous growth behavior arises due to the presence of a production spillover. The production function is of the form $F\left(K_t, L_t; \bar{k}_t\right)$ where K and L are total capital and labor respectively and $\bar{k}_t$ is average per-capita capital production externality. It is this last term that embodies endogenous growth. The production function is assumed to exhibit constant returns to scale from the point of view of firms, i.e. $F\left(lK_t, lL_t; \bar{k}_t\right) = lF\left(K_t, L_t; \bar{k}_t\right)$, since K and L are the only choice variables they perceive. This type of externality is eluded to in Shell (1966) and introduced explicitly by Romer (1986). In most cases this type of externality is introduced into a Cobb-Douglas production technology. For this treatment, however, this spillover effect is introduced in the following manner into a CES production technology.

$$F\left(K_t, L_t; \bar{k}_t \right) = \left(a\bar{k}_t^{d}\ K_t^{r} + bL_t^{r} \right)^{\frac{1}{r}}$$

or, in intensive form:

$$f\left(k_t; \bar{k}_t \right) = \left(a\bar{k}_t^{d}\ k_t^{r} + b \right)^{\frac{1}{r}}.$$

Where δ is the type and strength of the spillover. If we assume ρ <0, as is the case in BS 97 corresponding to conventional thinking, then δ<0 (δ>0) will correspond to a positive (negative) spillover effect since $\frac{\partial f(.)}{\partial \bar{k}_t} = \frac{1}{r} d \left(a\bar{k}_t^{d}\ k_t^{r} + b \right)^{\frac{1-r}{r}} a\bar{k}_t^{d-1} k_t^{r}$. Thus the sign of δ will determine the sign of this derivative depending on the type of the spillover effect.

<u>Firms Profit Maximization Problem</u>

Firms are assumed to be competitive and pursue the objective of profit maximization. Setting up the firm profit maximization problem and optimizing gives the following two first order conditions for a maximum where both inputs are used in strictly positive quantities:

$$r_t = f^{/}\left(k_t;\bar{k}_t\right) = \left(a\bar{k}_t^{d}\, k_t^{r} + b\right)^{\frac{1-r}{r}} a\bar{k}_t^{d}\, k_t^{r-1} = a^{\frac{1}{r}}\bar{k}_t^{d}\, k_t^{\frac{1}{r}}\left[1+\left(\frac{b}{a}\right)\bar{k}_t^{-d}\, k_t^{-r}\right]^{\frac{1-r}{r}}$$

$$w_t = f\left(k_t;\bar{k}_t\right) - k_t f^{/}\left(k_t;\bar{k}_t\right) = \left(a\bar{k}_t^{d}\, k_t^{r} + b\right)^{\frac{1}{r}} - k_t\left(a\bar{k}_t^{d}\, k_t^{r} + b\right)^{\frac{1-r}{r}} a\bar{k}_t^{d}\, k_t^{r-1} = b^{\frac{1}{r}}\left[\left(\frac{a}{b}\right)\bar{k}_t^{d}\, k_t^{r} + 1\right]^{\frac{1-r}{r}}$$

The above two equations represent the marginal returns to the factors of production.

L_t is the total labor force in formal manufacturing and can be written as $L_t = q_2 f_t n^t$. Per worker capital is written as $k_t \equiv \frac{K_t}{L_t} = \frac{K_t}{q_2 f_t n^t}$. The storage technology is straightforward here as one unit of the manufactured good at t becomes one unit of capital at t+1. Complete or 100% depreciation is assumed so capital depreciates completely from one period to the next. The manufactured good is the numeraire at each date so p_t is the (relative) price of the agricultural good i.e. $p_t \equiv \frac{price\ \ of\ \ the\ \ agricultural\ \ good}{price\ \ of\ \ the\ \ manufactured\ \ good}$.

<u>Consumers:</u>

All young agents are endowed with only one unit of labor when young. There are no other endowments or transfers. Agents utility is such they care only about second period consumption so they save all of their labor income when young and exhaust all income on either the agricultural or manufactured good in the second period. The only vehicle for saving in this economy is capital. Agents are risk neutral and have constant aggregate expenditures for both goods. The agents utility function is described by:

$$U(c_{mt}, c_{at}; y) = y c_{mt} + (1 - y) c_{at}$$

where y is identically and independently distributed with the following probability function:

$$y = \begin{cases} 0 & with \quad probability \quad g \\ 1 & with \quad probability \quad (1-g) \end{cases}$$

and c_{mt} and c_{at} are the amounts consumed of the manufactured and agricultural good respectively.

An agent of type i working in the agricultural sector receives a wage of $p_t p_i$. The fraction of type 2 agents seeking employment in the developed region is f_t where $f_t \in (0,1]$. Full employment is assumed throughout. If $f_{t+1} > f_t$ ($f_{t+1} < f_t$) then there is net migration to (away from) manufacturing in the developed region.

<u>Agents Behavior:</u>

Type 1 – The income for low skilled labor will be derived exclusively from agricultural production in the primary sector since they are not qualified to work in the developed sector. They will have a period one income of $p_t p_1$ which will become $r_{t+1} p_t p_1$ in the next period where r_{t+1} is the rate of return on savings. With this income, type 1 agents will spend a fraction $(1-g)$ of these savings on the manufactured good and a fraction g on the agricultural good. The agent then has expected utility of:

$$\left[(1-g)+\frac{g}{p_{t+1}}\right]r_{t+1}p_t p_1$$

Type 2 – High skilled labor earns income of $p_t p_2$ if they choose to work in production of agricultural products and this will result in next period utility of:

$$\left[(1-g)+\frac{g}{p_{t+1}}\right]r_{t+1}p_t p_2$$

If however high skill labor chooses to work in the developed sector in manufacturing they will earn a wage of w_t and thus have expected utility of:

$$\left[(1-g)+\frac{g}{p_{t+1}}\right]r_{t+1}w_t\,.$$

If in equilibrium we require $f_t \in (0,1)$, i.e. some high skill workers are employed in manufacturing and the rest are employed in the primary region, then we need the expected utility for high skilled labor to be the same in both sectors. This will require $p_t p_2 = w_t$, or high skill types are indifferent between where they choose to work.

General Equilibrium

An equilibrium consists of a sequence of prices, capital-labor ratios, and migration behavior for all time periods i.e. $\{p_t\},\{k_t\},\{f_t\}$ for t=0,1,2,… such that 1) agents maximize their utility, 2) firms maximize profits, 3) all factor and goods markets clear.

In the credit market we need total savings to equal capital next period. Noting here utility maximization implies all income from period one is saved we have:

$$K_{t+1} = n^t\left[q_1 p_t p_1 + q_2(1 - f_t)p_t p_2 + q_2 f_t w_t\right]$$

and since $p_t p_2 = w_t$ the above equation can be written as:

$$k_{t+1} q_2 f_{t+1} n^{t+1} = n^t\left[q_1 \frac{p_1}{p_2} + q_2\right]w_t$$ where we use the relationship $k_t q_2 f_t n^t = K_t$.

Agricultural goods market clearing requires the value of agricultural goods produced equals the fraction of aggregate income spent on agricultural goods:

$$n^t\left[q_1 p_1 + q_2(1 - f_t)p_2\right]p_t = g r_t K_t^t$$

The above may be used to solve for f_t:

$$f_t = \frac{\left(\frac{q_1}{q_2}\frac{p_1}{p_2}+1\right)}{\left(g\,\frac{r_t k_t}{w_t}+1\right)}$$

for f_t <1 requires $g\,\frac{r_t k_t}{w_t} > \frac{q_1 p_1}{q_2 p_2}$.

For our specific CES form of the production function and using the profit maximizing conditions for factor inputs we can write $\frac{r(k;\bar{k})k}{w(k;\bar{k})} = \left(\frac{a}{b}\right)\bar{k}_t^{d}\,k_t^{r}$ which will give the following ratio representing the fraction of total population working in the advanced production region:

$$f_t = \frac{\left(\frac{q_1}{q_2}\frac{p_1}{p_2}+1\right)}{\left(g\left(\frac{a}{b}\right)\bar{k}_t^{d}\,k_t^{r}+1\right)}$$

We have assumed ρ>0 to coincide with the usual case so then $\frac{\partial f_t}{\partial k_t} > 0$, and since $w^{/}(k) > 0$ what we have is as the wage in manufacturing increases, more high skill workers choose to work in manufacturing as would be expected. Looking at the term technological spillovers, $\bar{k}$, it is easily verified that migration to the advanced region is positive (negative) if the spillover has a positive (negative) impact. That is, if we maintain the assumption $\rho<0$, then $\delta<0$ ($\delta>0$) will correspond to a positive (negative) effect on migration.

We have used the variable $\bar{k}$ to represent technological spillovers but have not given an intuition to this variable. Technological spillovers arise from a number of different factors and market conditions. Some of these factors include innovative behavior, between and within industry spillovers, and market conditions. Formally, we can write $\bar{k} = f\left(innovative\ behavior, industry\ spillovers,\ market\ environment\right)$. Using this functional form, we test some of the growth hypothesis evaluated by Glaeser et al. (1992) in the context of US cities for US counties in addition to testing the Lucas and Romer hypothesis of innovative behavior.

Data and Estimation

The region of study includes the Midwestern States of Iowa, Minnesota, Missouri, Kansas, Nebraska, North Dakota, and South Dakota. This region comprises some 618 counties. Industry output and employment figures for a number of industries are available from Bureau of economic Analysis (BEA). Data available also include total sector earnings used to calculate wages. Data are available from 1969-99, but observations are missing for some counties to protact confidentiality or because particular industrial activities are non-existent. We collected industry data for construction, manufacturing, transportation and utilities, wholesale, finance insurance and real estate (FIRE), retail, services, and government.

To proxy technology and innovative behavior we use patents filed at the county level. The use of patents to proxy knowledge output has been used by Jaff (1989), and replicated by Acs, Audretsch, and Feldman (1992). The measure we use in this paper to capture innovative behavior is per-capita patents filed by county for the years 1990-99. While the data available only coincide with the last ten years of the analysis, Kydland and Prescott (1982) discuss how time-to-build delays in capital formation helps to explain the lag between research and development and the application for the patent.

To capture market environment and competitive behavior we employ the use of both county-specific and industry-county-specific variables. Employment concentration provides a county-specific indicator of the market environment. This measure is an indicator of diversity within a county. It is computed in a manner similar to that of the Herfindahl-Hirschman Index, however, for our analysis we use shares rather than percentages. Specifically this variable is calculated as:

$$h_{j,t} = \sum_{i \in S} \frac{emp_{i,j,t}}{emp_{j,t}} \qquad \forall j = 1,2,\ldots,n$$

Where j is the county, S is the set of all employment sectors of interest, and t is the year of interest. Here the sectors or industries of interest are S = manufacturing, construction, transportation and utilities, wholesale, retail, government, finance insurance and real estate (FIRE), and services. For any county $h_{j,t} \in (0,1]$ where a value of one corresponds to complete domination by one industry, and the further to the left on the real number line the more diverse is the labor force in terms of sector employment. This variable gives insight into the relationship of local specialization vs. local diversity. Jacobs (1969) argues that the greatest growth comes from diversity rather than specialization.

The industry-county-specific indicator we use is employment share in the county of a given sector relative to the employment share in that same sector for the entire region. It is calculated as:

$$rs_{i,j,t} = \frac{\left(\dfrac{emp_{i,j,t}}{\sum_{i \in S} emp_{i,j,t}} \right)}{\left(\dfrac{\sum_{j=1,2,...,n} emp_{i,j,t}}{\sum_{i \in S} \sum_{j=1,2,...,n} emp_{i,j,t}} \right)} \quad j = 1,2,...,n \, , i \in S$$

A value of rs greater (less) than one is an indication of higher (lower) concentration of a given industry within a given county relative to the entire region or state. The measure of concentration is used to evaluate the Schumpetarian hypothesis that regional monopoly stimulates economic growth. This hypothesis is in contrast to Jacobs' theory that concentration is not beneficial to growth. Glaeser et al. (1992) empirical findings supports the Jacobs.

Here as in Glaeser et al, (1992), several initial conditions are specified. Initial conditions consist of average county distance to the nearest Metropolitan Statistical Area (MSA), a zero-one dummy variable for the presence of an interstate in the county, and the initial wage - for industries this is sector earnings within a county divided by sector employment and for total employment within a county this is total county sector earnings divided by total employment.

The sector employment growth equations that we estimate are represented by:

$$\ln\left[\frac{emp_{i,j,t+K}}{emp_{i,j,t}}\right] = b_0 + b_1 wage_{i,t} + b_2 h_{j,t} + b_3 rs_{i,j,t} + b_4 dist\ \ MSA + b_5 \operatorname{int} dum \\ + b_6 patents\ \ per\ \ capita_{j,t} + e$$

where k is the length of the growth period and ε is the error term. The signs of betas for the employment concentration and relative share variables (i.e. b_2 and b_3) will indicate to the nature of the market externality. That is, if the sign of the parameter estimate is positive (negative), corresponding to a negative (positive) delta (δ) in our equilibrium migration equation, then the variable has a positive (negative) impact on employment growth. Similarly, the sign of b_6 is indicative of the relationship between employment growth and innovative behavior. The above equations are estimated using Zellner's seemingly unrelated regression (SUR) technique to account for the probable relationship among the error terms. While it is true there is no cost in terms of efficiency or bias from using the SUR method if ordinary least squares (OLS) is also valid, in our estimation we loose in the number of degrees of freedom due to missing data in some sectors. The total employment equation is estimated using OLS.

Results

We explored the employment growth equation described in the previous section over four growth periods: 1969-99, 1969-79, 1979-89, and 1989-99. We have separated the thirty-year growth period into three ten-year intervals to visually inspect for any structural adjustments that may have occurred, such as the recession of the 1980's. The results of the SUR and OLS estimations for the thirty-year and the three ten-year periods are presented in tables 1-4.

The growth impact of innovative behavior, represented by patents filed per capita by county, is positive and significantly different from zero in most cases. In fact, this important impact on growth persists in all of the growth periods with only one negative parameter estimate for construction employment (1989-99), but not significantly different from zero. These positive results support the theory of Lucas and Romer, who suggest knowledge spillovers are important determinants of growth. While it is true that the patent variable was based only on data for 1990-99, the exploratory power of this parameter, coupled with typical delays between research and filling of patents, make these results worthy of further consideration.

The variable indicating strength of the local industry labor force relative to the entire region also performed quite well. The significance and negative persistence of this variable is also robust to all periods of the study. This result tends to add support to the Jacobs school of thought promoting regional diversity as a driver of growth.

However, Jacobs' hypothesis on the importance of local diversity is rejected given the parameter estimates of the employment concentration variable. In general, this parameter estimate is positive and significant or not significantly different from zero. This results lends support for the hypothesis of Marshall, Arrow, Romer, and Schumpeter, who argue that local specialization in an industry is a means to facilitate spillovers between firms.

The initial conditions as measured by proximity to a MSA and presence of an interstate within the county all performed as would be expected. Presence of an interstate in a county positively influences employment growth and greater county distances from the nearest MSA tends to hinder employment growth. However, as shown in the last growth period, 1989-99, the interstate variable is no longer significantly different from zero. The wage variable as an initial condition demonstrates somewhat conflicting results, depending on the time interval examined.

For the 1970's the wage variable tended to be positive and significant with the exception of manufacturing, which was negative but not significantly different from zero. However, in the 1980's, this variable is negative for wholesale, and significantly less than zero for construction, manufacturing, and government. The late 1970's and 1980's were characterized by a prolonged recession and by industry efforts to secure more flexible and more favorable arrangements with organized labor. Many of these efforts were successful in part because labors bargaining power was weakened by the recession. Major structural changes were occurring in production arrangements with out-sourcing of production components, new production facilities located in lower wage areas, and substitution of technology and robotics for labor. In the 1990's this initial wage variable is not significantly different from zero except for transport and wholesale sectors.

Also, note the inability of the models to explain employment growth for the later time periods. This is evident upon examination of the R-squares for tables 2 and 4. This would suggest that there may be other variables providing incentives for employment growth in more recent periods.

Conclusions

Theorists such as Lucas and Romer have long hypothesized the importance of innovative behavior and technological spillovers in promoting economic growth. In this paper we explore this notion further for the US Midwest and find, using patent filings per capita per county as a proxy, innovate behavior and technology spillovers are indeed important. This result seems robust for all growth periods studied in this paper. In addition we find relative diversity between industries in counties and regions is beneficial to employment growth.

The results also seem to suggest initial conditions such as physical infrastructure and proximity to large centers of economic activity are important determinants of employment growth. However, physical infrastructure such as presence of an interstate does not seem to be as important to growth in later years as compared to earlier growth periods. This may be due to the fact that once infrastructure is in place for a prolonged period, such infrastructure may no longer stimulate local growth. The wage variable is sensitive to the growth period under consideration and may have changed due to weakened bargaining positions of organized labor, out-sourcing of production in non-unionized plants, relocation of production to non-unionized plants in the other regions of the US, and the 1980's recession. These results indicate the importance of structural adjustments in employment growth modeling and the importance of careful analysis of the time-series empirical results. Fortunately our result regarding the growth impacts of technology spillovers and innovative behavior persist during all employment growth periods considered in this analysis.

References

Acs, Zoltan J., David B. Audretsch, and Mayann P. Feldman. “Real Effects of Academic Research: Comment.” The American Economic Review, Vol. 82, No. 1 March pp. 363-367, 1992.

Arrow, Kenneth J. “The Economic Implications of Learning by Doing.” Review of Economic Studies 29, (June) pp. 155-73, 1962

Castle, Emery N., Editor, with a foreword by Clifton Wharton Jr.; The Changing American Countryside: Rural People and Places. Lawrence, KS: The University Press of Kansas, 1995.

Bencivenga, Valerie, and Bruce D. Smith. " Unemployment, Migration, and Growth." The Journal of Political Economy 105, Issue 3, pp. 582-608, 1997.

Drazen, Allan. "Unemployment in LCDs: Worker Heterogeneity, Screening, and Quantity Constraints." World Development 10. December, pp. 1039-1047, 1982.

Drazen, Allan, and Zvi Eckstein. "On the Organization of Rural Markets and the Process of Economic Development." American Economic Review 78, June, pp. 431-443, 1988.

Glaeser, Edwardl., Heidi D. Kallal, Jose A. Scheinkman, and Andrei Schleifer. "Growth in Cities." Journal of Political Economy 100, 6 (Dec.), pp. 1126-1152, 1992.

Glaeser, Edward L., Jose Scheinkman, and Andrei Cheifer. "Economic Growth in a Cross-Section of Cities." Journal of Monetary Economics 36, pp. 117-143, 1995.

Griliches, Zvi. “Issues in Assessing the Contribution of Research and Development to Productivity Growth.” Bell Journal of Economics. 10 (Spring). pp. 92-116, 1979.

Jacobs, Jane. The Economy of Cities. New York: Vintage, 1969.

Jaffe, Adam B. “Real Effects of Adademic Research.” The American Economic Review. Vol. 79, No. 5, December, pp. 957-970, 1989.

Kydland, Finn E., and Edward C. Prescott. “Time to Build and Aggregate Fluctuations.” Econometrica 50 (Nov.), pp. 1345-13701, 1982.

Loury, Glenn C. “Market Structure and Innovation.” Quarterly Journal of Economics. 93 (Aug.), pp. 395-410. 1979.

Lucas, Robert E., Jr. “On the Mechanics of Economic Development.” Journal of Monetary Economics 22 (July), pp. 3-42, 1988.

Porter, Michael E. The Competitive Advantage of Nations. New York: Free Press, 1990.

Ranis, Gustav. "Analytics of Development:Dualism." In Handbook of Development Economics, vol. 1, edited by Hollis Chenery and T.N. Srinivasan. New York: Elsevier Sci., 1988.

Rauch, James E. "Economic Development, Urban Underemployment, and Income Inequality." Canadian Journal of Economics 26, November, pp. 901-918, 1993.

Romer, Paul. “Increasing returns and Long-Run Growth.” The Journal of Political Economy 94, 5 (Oct.), pp. 1002-1037, 1986.

Schumpeter, Joseph A. Capitalism, Socialism, and Democracy. New York: Harper, 1942.

Shell, Karl. “Toward a Theory of Inventive Activity and Capital Accumulation.” American Economic Review, Vol. 56, No. 1/2. Mar., pp. 62-68. 1966.

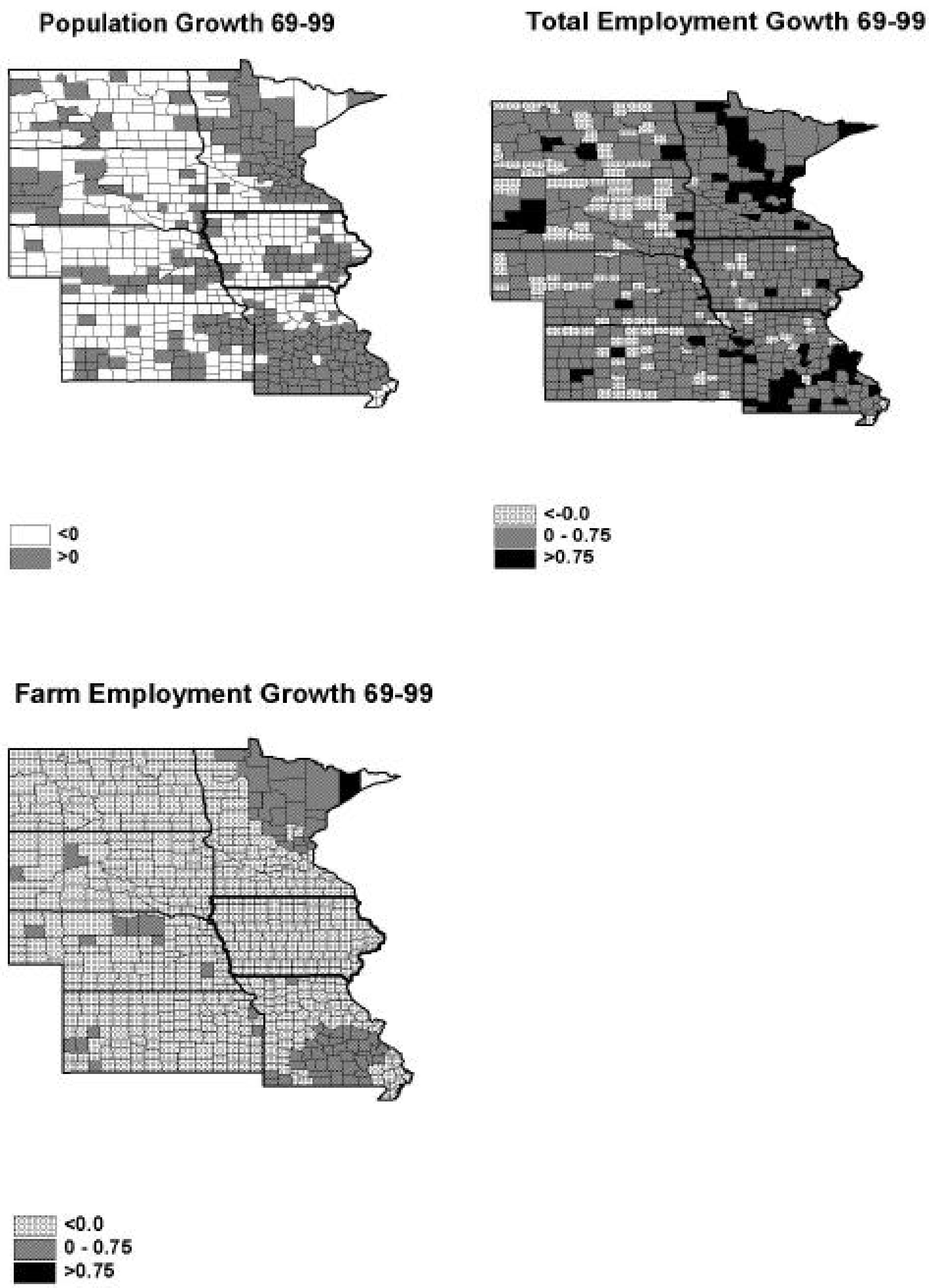

Figure 1 – Population, Total Employment, and Farm Employment Growth Trends 1969-1999

Table 1 – Total and Sector Employment Growth 69-99

	Total	Construction	Manufacturing	Transportation	Wholesale	Retail	FIRE	Services	Government
Coefficient									
Wage 69	***0.0806	0.0090	***-0.07967	***0.05220	***0.03392	**0.04472	***0.08529	***0.07340	-0.0103
Employment Concentration 69	0.0838	0.4600	-0.4006	**1.1924	-0.6621	***1.5721	**0.93319	**0.78461	**0.8016
Relative Employment Share 69		***-0.67095	***-0.46272	***-0.46243	***-0.88113	**-0.1786	***-0.50483	***-0.48845	***-0.26162
Distance to a MSA	***-0.0010	***-0.0018	-0.0007	0.0000	-0.0003	**-0.00099	**-0.00095	**-0.0009	**-0.00079
Interstate Dummy	**0.07252	*0.10442	0.1027	**0.16755	*0.11526	***0.17418	**0.11957	***0.1524	0.0319
Patents filed per capita	***63.463	***52.472	***93.946	***71.066	***75.398	***84.651	***86.008	***79.608	***44.118
Intercept	0.1123	***1.2288	***1.4020	0.0955	***1.189	0.1652	***0.44001	***0.88248	***0.55291
R-square	0.288	0.222	0.203	0.209	0.406	0.277	0.200	0.305	0.141
n	514	329	329	329	329	329	329	329	329

Probability of rejecting the hypothesis the coefficient is equal to zero:*** - 99%, ** - 95%, *- 90%

Table 2 – Total and Industry Employment Growth 69-79

	Total	Construction	Manufacturing	Transportation	Wholesale	Retail	FIRE	Services	Government
Coefficient									
Wage 69	***0.05213	*0.01368	-0.01995	***0.01942	***0.03498	***0.08316	***0.0800	***0.04617	***0.06003
Employment Concentration 69	**-0.3773	-0.05779	-0.36955	***1.2911	***-1.9649	***0.93340	***0.88608	***0.4940	***0.62280
Relative Employment Share 69		***-0.61420	***-0.30929	***-0.16023	***-0.83640	***-0.25946	***-0.40051	***-0.3601	***-0.16475
Distance to a MSA	-0.00015	0.00006	-0.00047	0.00018	**0.00076	-0.00016	***-0.0007	0.00003	***-0.00043
Interstate Dummy	**0.0305	**0.07402	0.08173	0.04090	0.02869	***0.09779	**0.0657	***0.08819	-0.00374
Patents filed per capita	***23.066	*24.435	**39.856	*19.176	*24.79113	***37.657	***34.496	***27.434	7.13256
Intercept	0.03547	***0.79350	***0.73820	-0.04817	***1.2157	*-0.1394	**0.16249	***0.31906	-0.07423
R-square	0.201	0.265	0.105	0.112	0.439	0.266	0.266	0.206	0.201
n	515	493	493	493	493	493	493	493	493

Probability of rejecting the hypothesis the coefficient is equal to zero:*** - 99%, ** - 95%, * - 90%

Table 3 – Total and Industry Employment Growth 79-89

	Total	**Construction**	**Manufacturing**	**Transportation**	**Wholesale**	**Retail**	**FIRE**	**Services**	**Government**
Coefficient									
Wage 69	-0.00432	***-0.01225	***-0.0218	0.00600	-0.00255	***0.02724	***0.06117	***0.03487	**-0.00848
Employment Concentration 69	***0.8648	***1.5514	-0.20964	*0.65446	***0.87884	***1.6320	***1.0835	***0.84463	***0.68988
Relative Employment Share 69		***-0.37780	-0.05854	***-0.22663	***-0.18833	-0.03443	***-0.30425	***-0.3135	***-0.06527
Distance to a MSA	***-0.00049	***-0.00174	***-0.00092	-0.00023	***-0.00070	***-0.00069	-0.00012	***-0.00065	***-0.00031
Interstate Dummy	**0.03186	0.03643	0.05190	**0.07863	*0.05776	**0.0446	**0.05890	0.02686	0.01239
Patents filed per capita	***24.161	**29.089	18.54173	**24.551	17.53504	***22.341	***42.080	***29.33	**10.146
Intercept	-0.02206	***0.31323	***0.44290	0.00771	0.08103	***-0.31315	***-0.43538	***0.17030	***0.16778
R-square	0.255	0.21	0.047	0.115	0.176	0.302	0.25	0.3	0.107
n	540	518	518	518	518	518	518	518	518

Probability of rejecting the hypothesis the coefficient is equal to zero:*** - 99%, ** - 95%, * - 90%

Table 4 – Total and Industry Employment Growth 89-99

	Total	**Construction**	**Manufacturing**	**Transportation**	**Wholesale**	**Retail**	**FIRE**	**Services**	**Government**
Coefficient									
Wage 69	-0.00161	-0.00254	0.00022	***0.00768	***0.01361	-0.00248	0.00308	0.00292	-0.00390
Employment Concentration 69	***0.692	0.14757	0.17757	0.29622	-0.26842	***0.60795	0.30125	**0.52521	0.07602
Relative Employment Share 69		***-0.14093	***-0.13251	***-0.22646	***-0.31552	**-0.0808	***-0.3296	**-0.10969	***-0.04737
Distance to a MSA	***-0.00038	***-0.00075	0.00006	-0.00039	-0.00022	***-0.00039	***-0.00077	***-0.00045	**-0.00034
Interstate Dummy	0.01269	0.00996	-0.01270	-0.01568	0.01427	0.00304	-0.01348	0.00557	0.00599
Patents filed per capita	***19.57369	-0.34567	19.95290	17.05098	*20.1632	***16.1952	9.65857	***16.212	***16.461
Intercept	***0.09593	***0.64176	***0.26529	*0.14164	0.11860	***0.23717	***0.5027	***0.29453	***0.23977
R-square	0.208	0.011	0.043	0.14	0.239	0.083	0.122	0.098	0.093
n	555	344	344	344	344	344	344	344	344

Probability of rejecting the hypothesis the coefficient is equal to zero:*** - 99%, ** - 95%, * - 90%