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By

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Abstract: Competition for local economic development has increased dramatically in the past 20 years. This competition is in many cases extremely costly to states and communities, while the benefits are uncertain. If regions whose economic fortunes are complementary could work with instead of against one another, costs of competition could be eliminated, while returns to economic development investments could be enhanced. This paper presents a method by which the underlying spatial economic relationships among areas within a region can be identified. Economic development policy can then be guided by the identification of the competitive or complementary links that exist among areas. The Dendrinos-Sonis (DS) model of relative social spatial dynamics is used to determine these relationships, in aggregate and on an industry-by-industry basis, in the Cincinnati metropolitan region. Sets of competitive and complementary region pairs are identified.

I. Introduction

Relationships among local public and private sectors in the United States have changed as the pursuit of local economic growth among regions has intensified (Watson, 1995; Fisher & Peters, 1998). The majority of state-level economic development agencies have been established over the last twenty years (Watson, 1995), and local officials have become increasingly proactive in their quest to promote economic development. Relocating and new plants in the United States commonly receive incentive packages from various combinations of federal, state and local sources.

A common result of this competition for economic growth is a bidding war among regions like the competition among the Southern US states of Alabama, Georgia, Tennessee, Mississippi and North and South Carolina for a new Mercedes Benz facility in the mid-1990's (Watson, 1995). The major objectives of this type of competition are direct job and income growth for local workers and increased economic activity in production and consumption-linked industries. While suppliers of the new major facilities may locate in the same general area of the new facility, the new facility also can develop relationships with existing local suppliers. Income along with subsequent consumption expenditures will increase accordingly, further stimulating demand for local industry output. The cycle continues until the spin-off effects have played out completely.

Nunn (1995) examined economic development incentives and their differential implementation among sub-regions of the Indianapolis MSA. The wide range and mix of incentives used has created distinctly different development environments within the larger region. Within these different environments, competition for economic development is evidenced in a number of ways. The overall effect of this localized but interregional competition, however, is unknown. Might these sub-regions benefit from cooperative rather than competitive relationships? Benefits of similar cooperative efforts can be seen in Lindstrom's (1998) study of six counties in the northeastern Chicago area that have joined forces in designing development incentives. Lindstrom describes this as "functional regionalism", emphasizing cooperation and collaboration in transportation planning, solid waste management, regulatory standardization, and intergovernmental agreement. Do regions benefit from this cooperation?

This paper presents and applies a method by which underlying spatial economic relationships can be identified. Although few studies of this type have been carried out, competition between regions at the state or national level has been the more common focus of this type of analysis (Hewings et al, 1996; Sonis and Hewings, 2001). Given the explosive growth in competition between localities, however, a localized MSA scale of analysis is warranted (Martin and Sunley, 1996; Van Hagen and Hammond, 1994). Local governments are promising millions of dollars to corporations in exchange for the location of these facilities in their regions. If regions understand that they can share in the benefits of growth in other regions, poor decisions regarding incentives might be averted and regions can work with instead of against one another.

II. Problem Statement

Do areas within a region compete with or compliment each other in terms of economic development? Can these types of regional interactions coexist in a regional economy? If so, are there neighborhood or close spatial association effects? Is localized growth in one area beneficial to the region as a whole? Or does it benefit only particular and specific subregions? If complimentary interregional relationships do exist, what sectors of the economy are responsible for these linkages? Do some areas see themselves as competitors with other regions, when in fact they complement each other in their economic development?

The goal of this study is to determine the types and degree of spatial economic relationships among the counties of the Cincinnati, Ohio Consolidated Metropolitan Statistical Area. This region is of particular interest because it includes areas of three states: Ohio, Kentucky and Indiana. Do these three states play against each other in attracting economic opportunities, and if so, should they? Do counties within this region compete for economic development, or do some pairs of counties complement each other in terms of development? Is development in one state adversely affecting economic growth in a neighboring state? Might tax money used to promote growth in one area also spur growth in another region?

If the relationships between region pairs can be identified as either competitive or complementary, this information can be extremely important in regional economic development planning. If complementarity can be established, regions can work together in pursuit of economic development. Local governments would no longer have to bid against one another, but could instead join forces to attract development and growth, and would be able to save millions of dollars instead of spending it competitively in the name of local economic development. If competitive relationships are identified, regions can be aware of the effects of certain types of development underway in other area sub-regions.

Hewings et al (1996) and Sonis and Hewings (2001) have suggested that each sector of the economy and its linkages be examined. By identifying the particular industries that are responsible for these relationships, regions can develop formal ties with other regions that will benefit from their growth and coordinate development policies. The relationship among interindustry linkages differs across counties. One or two counties may compete in one industry for development and complement each other in another industry. This study applies a method that can identify these relationships to the 13-county Cincinnati CMSA. Understanding these types of spatial economic relationships and linkages could dramatically guide planning policy and objectives.

The competitive or complementary spatial economic relationships will be determined using the Dendrinos-Sonis model of relative social spatial dynamics (Dendrinos and Sonis, 1990). By identifying spatial economic relationships among the sub regions, economic development policy can be guided by the existence or nonexistence of these linkages.

III. Precursors

White and Hewings (1982) attempted to model and forecast employment at the county level by assuming that growth in employment in a sector in a county was some linear, exponential, or share function of employment growth in other counties. Building upon Chalmers and Beckhelm (1976), they incorporate industrial and spatial interdependence into their modeling effort. White and Hewings used seemingly unrelated least squares in their interindustry, interregional model, but did not pursue the distinction between complementarity and competition.

Prastocos and Brady (1985) designed and implemented a structural model in which a regional input-output model is used to evaluate the relative strengths of potential sectoral linkages in the San Francisco Bay Region. Linkage assessments were then used in the a priori restriction of coefficients. Equations in the County Employment Forecasting System (CEFS) were specified to account for intersectoral feedback and for the fact that employment in each sector is tied to employment level in other sectors. Spatial interactions within the region also were taken into account by linking basic economic activity in industrial sectors with economic activity in the larger region. Local service sectors were linked at the county level. The result of these efforts is a regional economic and demographic forecasting system designed to predict output, employment, population and migration, and labor force. While their model has proven useful, it has not been used to explore directly interindustry and interregional impacts.

Lesage and Magura (1986) analyzed regional labor markets and proposed a simple procedure for determining statistically significant dynamic employment linkages. Kraybill and Dorfman (1992) recognized the importance of temporal and sectoral dimensions of regional growth. They used a combination of structural economic and time series methodologies to model the dynamics of regional growth in Georgia. Fawson and Criddle (1994) provided a comparative study of time series approaches to modeling intersectoral and intercounty employment linkages. They evaluated the performance of four model specification criteria and confirmed that "regional analysis is sensitive to the specification of linkage diversity both within regions and industrial and market stratifications". Researchers have increasingly become interested in the understanding and importance of the underlying linkages within a region, and have begun to investigate ways in which these underlying relationships could be identified. One area that has begun to drawn attention in this context is nonlinear dynamics.

IV. Non-linear Dynamics

Non-linear dynamics is an important area of study that has gained momentum in recent years. Non-linear dynamics can trace its origins to the natural sciences. Developments in the social sciences such as economics, geography, sociology and others have been affected by recent discoveries in mathematics and the natural sciences. With the emergence of these discoveries and their combination with the social sciences a new area of study has emerged, socio-spatial dynamics. New concepts and theories abound in relation to the abrupt growth and decline of spatially distributed socio-economic stocks, disequilibrium dynamics, cycles, periodic movement, turbulence and chaos (Dendrinos and Sonis, 1990).

Socioeconomic transitions and bifurcation are a result of dynamic feedback processes among stocks that are distributed spatially as well as temporally. Socio-spatial dynamics rely upon the assumption that even though individual behavior is complex and multi-faceted, the aggregate behavior of socio-economic stocks can be captured in simple spatio-temporal models. Socio-spatial dynamics recognizes that both time and space are heterogeneous: every location and every period of time is different. Therefore this work differs from traditional geographical work in which space is only looked upon as an impedance of generally universal force, as in transportation rates, and is considered to be homogenous otherwise.

May (1974) states that as the dimensionality, strength, or degree of interconnectiveness of the variables increase, the likelihood that the system will exhibit dynamically stable behavior diminishes. Therefore, simple deterministic processes that behave in ways that create turbulent and chaotic fluctuations challenge our perception of socioeconomic systems as stable and calm. Realistically, one should be surprised if a social system shows stability and calmness. The advantage of using non-linear dynamic models is their ability to better capture economic behavior that is non-regular (Creedy and Martin, 1994).

Some of the early work in nonlinear dynamics in economics includes Dynamic Econometric Modeling, a volume edited by Barnett, Bernhelt and White (1988) and Richard Day's (1981) paper, "Emergence of Chaos from Neoclassical Growth." There also has been some pioneering research in geography. One of the early geographic applications dealt with population interactions in the United States (Dendrinos and Sonis, 1988). Sonis and Dendrinos (1987a, 1987b), Dendrinos and Sonis (1987) and Reiner, Munz, Haag and Weidlich (1986) have contributed to the small but growing body of literature in socio-spatial dynamics. Casti (1984) and Nijkamp (1985, 1986) analyzed cyclical behavior in the socioeconomic sciences. Nijkamp and Reggiani (1995) provide an overview of recent developments in non-linear dynamic modeling and its parallel with recent advances in dynamic ecological modeling.

From Nonlinear Dynamics to the Dendrinos-Sonis Model

The Dendrinos-Sonis model of relative socio-spatial dynamics is capable of generating results for the structure of spatio-temporal correlation. This nonlinear dynamic model and the statistical analysis of the parameters provide a useful alternative to the conventional methods of incorporating exogenous changes in regional models. This model can help determine whether there exists a pattern of regional interaction within a specified framework. It identifies how these sectoral interactions play out in economic competition or complementarity. By determining the nature of the linkages and interaction among areas within a region, a regional planner can determine the effects of a regional policy on all areas within a region. These relationships can also help in the development of policy in the sense that economic development programs that have the greatest region-wide benefit can be targeted.

All socioeconomic stocks are distributed over a spatially heterogeneous horizon. This spatial horizon can be considered finite, acting as a closed system, and is the theater on which a multitude of forces play out. Locational stocks are characterized by differential access to other locational stocks. This differential access, and thus spatial heterogeneity, is a result of historical and geographic factors and topographical differences between locations.

The bundle of elements behind spatial heterogeneity makes up the composite locational advantages at any given point in space and time. When these individual locational advantages are compared, composite comparative advantages can be obtained. These comparative advantages are interrelated with the distribution of socioeconomic stocks, as the advantages are a function of these distributions, as the distributions are functions of the comparative advantages. One does not exist without the other, therefore cause and effect relationships disappear within this relationship.

Socio-spatial dynamics can be viewed through four lenses (Dendrinos and Sonis, 1990). Two are the absolute and relative lenses and the others are discrete and continuous. Through the absolute lens, the observer considers an unbounded environment within which open and locally interconnected systems interact. With a relative lens, the observer is forced to consider a closed system within which local systems interact. Absolute dynamics are appropriate for open systems where boundaries are not well defined. Relative dynamics are used for examining closed systems where the environment is well defined – the environment being the area over which one normalizes the various stocks' size (Dendrinos with Mullally, 1985). The work here utilizes relative discrete dynamics over space and time. The Dendrinos Sonis (DS) model presented is one that can be used to analyze relative change in the environment of a zero-sum game.

Applications of the DS model

Sonis and Hewings (2001) used the DS Model to assess the interplay between the regional composite comparative advantages and disadvantages in a seven-region US regional system, which in turn revealed regional competition and complementarity. Hewings et al (1996) utilized the DS model for analyzing the pattern of competition and complementarity among US census regions. They also used the model to forecast regional shares of gross regional product. Magalhaes, Sonis and Hewings (1999) performed a comparative study between the Northeast region of Brazil and the Great Lakes region of the US using Gross Regional Product as the socioeconomic stock of interest. Their results suggest a stronger degree of interaction among the states of the Midwest US than the states of Northeast Brazil. Within the Midwest, Michigan and Indiana were the states with the strongest influence on others. In Northeast Brazil, the dynamics were mostly concentrated in the smaller states. Both regions tended to a steady state quickly when the model was used for forecasting. The model did predict a shift in the relative distribution of GRP in the Northeast states of Brazil, whereas no change was predicted in the Midwest US states. Most recently, Jackson and Sonis (2001) used the model to analyze subregional shares of socioeconomic stocks in the Columbus MSA. They further extended the DS model to include a stochastic error term in the forecasting segment of the model. Using this stochastic application, they were able to compare historical patterns of data with a deterministic forecast as well as a simulation forecast with the stochastic error term.

V. Mathematical Explanation of DS model

Let Γ_{ST} be an economy defined over space and time and define S to be a finite number of regions in the economy and T to be the time horizon. An S-dimensional vector represents regional economy activity within a region: $Y'_t = (Y_{1t}, Y_{2t}, \ldots Y_{st})$ [0< Y_{st}<; s=1,…,S; t=1,…,T].

Now consider a set of arbitrary positive real-valued functions, $F_{jt} = (F_{1t}, F_{2t}\ldots, F_{St})$, such that each F_{jt} is defined at each time period t by a subset of Y_{st}. The general discrete nonlinear process can then be defined as:

$$Y_{st+1} = \frac{F_{st}}{\sum_j F_{jt}} \qquad [j=1,2,3,\ldots S] \qquad (1)$$

If the first region is to be taken as the numeraire region, i.e., if the following relation is used:

$$F_{ojt} = \frac{F_{jt}}{F_1} \qquad [j=1,2,3,\ldots S]$$

Then the process defined in (1) can also be represented by

$$Y_{1t+1} = \frac{1}{1+\sum_j F_{ojt}} \qquad [j= 2,3,\ldots S]$$

$$Y_{st+1} = \frac{F_{ost}}{1+\sum_j F_{ojt}} \qquad [j= 2,3,\ldots S]$$

where $\sum_s Y_{st} = 1$ [s=1,2,…S]

and $\frac{Y_{st+1}}{Y_{1t+1}} = F_{ost}$ [s=2,3,…S]

This makes it possible to generate the results in relative terms i.e., the function F_{ojt} represents the temporal "comparative advantages" enjoyed by location s in reference to a numeraire location (Dendrinos and Sonis, 1990).

A log linear specification of the function F_{ost} suggested by Dendrinos and Sonis (1988) is adopted and given by

$$F_{ost} = A_s \prod_k Y_{kt} a_{sk} \qquad [F_{st}>0;\ s=2,\ldots,S; k=1,\ldots S]$$

where $A_s > 0$ represents the locational advantages of all state $s \in S$, and

$$a_{sk} = \frac{\partial \ln F_{ost}}{\partial \ln Y_{kt}} \qquad [s=2,3,\ldots S;\ k=1,2,\ldots S]$$

are the regional growth elasticities, with $-\infty < a_{sk} < \infty$.

Using the log-linear form we can rewrite the process as:

$$\ln Y_{st+1} - \ln Y_{1t+1} = \ln A_s + \sum_{k=1}^{s} a_{sk} \ln Y_{kt} \qquad [s=2,\ldots S;\ t=1,\ldots T]$$

Regional interaction at this level is assumed to involve a competition whereby each region attempts to increase its share of socio-economic stock, which is attained by improving its comparative advantages. However this behavior will depend on the rest of the states' behavior that is reflected in the sign and magnitude of the elasticities (a_{sk}). A negative sign for a_{sk} indicates the existence of a competitive relation between regions s and k, i.e., if the socio-economic stock share of region s increases, the share of region k will decrease and vice-versa. A positive coefficient indicates a complementary relationship between s and k. The elasticities will be estimated utilizing ordinary least squares regression (Magalhaes et al., 1999).

VI. <u>Problem Context</u>

In 1788, settlers from the East started to congregate in an area that is known today as the city of Cincinnati. Fort Washington was built in 1789 in what is now downtown Cincinnati as a base against Indian attacks. Cincinnati was chartered as a village in 1802 and was incorporated as a city in 1819. As upriver travel became possible with the invention of the steamboat, the lives of Cincinnatians and their city changed forever. A major industry during this time period was the pork industry. By 1835, the city became the nation's chief pork-packaging center. Small companies sprang up to process the pork by-products. Lard was turned into soap and candles. One of these companies, started in 1837, was Proctor & Gamble. The Industrial Revolution also played a large part in the economic development of Cincinnati. Many businesses that form the core of the local economy today were started during this time. Some of the notables are Fifth Third Bank in 1858, the Cincinnati Reds in 1869, Kroger Co. in 1883, Cincinnati Milacron in 1884, and Western and Southern Life in 1888. As time progressed, Cincinnati became a major player in the beer industry. At one time, 32 breweries operated in Cincinnati. When prohibition was instituted in the 1920's, it effectively tore down one of the cornerstones of Cincinnati's foundation. Cincinnati helped itself during the Great Depression with the construction of many buildings in the downtown area, many of which are still there today. Cincinnati continued to grow and expand through the middle part of the 20th century and into the latter half as well. Today the Cincinnati area is a thriving metropolis with a diversified economy that encourages opportunity for many different types of industries.

The Cincinnati CMSA includes the following counties: Hamilton, Warren, Clermont, Butler and Brown counties in Ohio; Boone, Campbell, Gallatin, Grant, Kenton and Pendleton counties in Kentucky; and Dearborn and Ohio counties in Indiana. The Cincinnati area can be broken down into seven geographic areas: the city, central suburbs, East Side, West Side, Northern Suburbs, Northern Kentucky and Southeastern Indiana. Each different area brings a different connotation to the mind and a different type of lifestyle as well. Cincinnati is as very diverse area in its population. Although 87 percent of the population is white, different cultures comprise this 87 percent from such diverse areas as the rural backgrounds of Kentucky to the white aristocratic ways of Indian Hills.

The economy of Cincinnati is as diverse as its population. No business holds more than 3 percent of the area's workforce. Greater Cincinnati is the headquarters for six Fortune 500 companies and home to 11 other companies on Fortune's list of the country's 500 largest service companies. Cincinnati's CMSA population in 2000, 1,979,202, ranks the area in the top 30 of US metro areas. The Greater Cincinnati area has 25,720 working scientists and engineers, which is more than Research Triangle in North Carolina. There are 20 local colleges and universities in the Cincinnati area.

VII. Analysis

Data

The data used in this work were downloaded from the Regional Economic Information System website hosted by the University of Virginia (fisher.lib.virginia.edu/reis/). Employment data were compiled for the major sectors of the economy for each county in the Cincinnati CMSA. Results will be generated for each major sector of the economy at the county level. Data will then be aggregated to the state level to determine what relationships exist between Ohio, Kentucky and Indiana. Using the DS model, qualitative analysis of the sign of the coefficients of the parameters of the model will lend insight in the nature of the economic relationship between the counties.

Survey questionnaires were distributed to the local economic development officials in the 13 counties of the Cincinnati CMSA. These surveys were designed to gauge the perception of the counties as to who were their main competitors for economic development in the area, and to determine whom each county felt they worked with to attract economic development. The answers from these surveys were then compared with the results from the DS model.

Results: Quantitative[1]

Table 1 presents the results of the estimation of the 3-region DS model for total employment in the region. The table can be interpreted in the following fashion.

Reading down the columns indicates that a positive shock to total employment in the Indiana sub-region will decrease the relative shares of total employment in Ohio and Kentucky, while a positive shock in total employment in Ohio would cause an increase in the relative shares in Ohio and Kentucky. A positive shock to Kentucky would result in an increase in the relative shares of total employment for Kentucky and Ohio as well. Reading across the rows of the table, the interpretation would be as follows: for Ohio, a positive shock to total employment in Ohio or Kentucky would have a positive impact on the total employment of Ohio. All results in Table 2 are significant at the 5% level.

Table 2 presents the results of the estimation of the 13-region DS model using the county breakdown of the Cincinnati CMSA. Once again total employment is the socio-economic stock being analyzed. This table can be read in the same way. A positive shock to Clermont, Dearborn, Kenton or Pendleton counties all result in increases in the relative shares of total employment for all counties in the region. While not all parameters are significant at the 5% level, some basic direction of interaction can be ascertained. Dearborn County, however, does have a significant positive relationship with 8 other counties in the region beside itself. These counties include Hamilton, Warren, Butler, Boone, Campbell, Gallatin, Grant, Kenton, and Pendleton. Kenton County has a significant positive relationship with Boone County, as well as with itself. A positive shock to the following counties will result in a relative decrease in total employment for all of the counties in the region: Hamilton, Warren, Butler, Ohio, Gallatin, and Grant. Butler County's negative impact is significant at the 5% level with all counties in the region. Hamilton County has a significant negative relationship with Warren, Boone, Campbell, Gallatin, and Grant counties. While all parameters are not significant at the

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[1] For an analysis of results for all industrial sectors in the Cincinnati CMSA refer to Healy, 2001.

5% level, a basic understanding of the relationships is revealed. In Table 2, the qualitative interpretations of the results can be seen. The relationships between the regions have been reduced to the sign of the parameters only. By reading across the rows, Dearborn and Kenton have 7 complementary relationships with other counties, while the other counties have either 5 or 6 complementary relationships. As has been suggested in the literature (Hewings et al, 1996; Sonis and Hewings, 2001), it is important to analyze each sector of the economy to determine which economic sectors are responsible for the underlying competitive or complementary relationships.

Results for service, FIRE, government, wholesale and manufacturing employment can be seen in tables 4, 5, 6, 7 and 8. These results will be analyzed in the policy implication section below.

Results: Surveys

Ten of the 13 counties in the Cincinnati CMSA responded to the surveys that were distributed. The following section will discuss the results of these surveys along with the results from the DS model in regards to total employment. Clermont County feels as if it is competing with Hamilton, Boone and Warren counties. Boone County actually displays a complementary relationship with Clermont County, but the Hamilton and Warren relationships from the model are competitive. Clermont also feels as if it works with Hamilton, Boone and Dearborn counties in attracting economic development. As stated before, Clermont has a competitive relationship with Hamilton per the DS model. However, both relationships with Boone and Dearborn are complementary. Brown County reveals Clermont as the main county it works with and competes with. Per the DS model, Brown and Clermont are complementary and should be working together. Hamilton County feels its main competitors are Butler, Boone and Kenton counties. Hamilton County actually should be working together with Boone and Kenton, as they have complementary relationships per the DS model. Hamilton and Butler do have a competitive relationship. Hamilton works with Clermont, Warren and Butler counties to attract economic development. Warren and Butler counties have competitive relationships with Hamilton County, while Clermont has a complimentary one. Butler County lists its main competitors for economic growth and development as Boone, Kenton and Warren counties. While Boone and Warren do have competitive relationships with Butler County per the DS model, Kenton has a complementary relationship. Butler works with Hamilton, Clermont and Warren. Hamilton and Warren are competitors according to the DS model, and Clermont and Butler should work together. Many of the other results from the surveys are of the same form (Table 3). Counties are competing and working with counties that perhaps they should not be. Many times inter-county competition is perceived when in fact economic growth in one county will benefit both counties, and potentially all the counties in the CMSA. These common misconceptions can be corrected and guided with the DS model.

VIII. Implications

Policy Implications

From a policy standpoint, analysis will be restricted to total, FIRE, government, manufacturing, service and wholesale employment. First looking at total employment, in the aggregate, increases in the states of Ohio and Kentucky are beneficial to the region. An increase in the relative share for Indiana will result in a relative decrease in Ohio and Kentucky. Therefore, Ohio and Kentucky have complimentary relationships between each other and Indiana has a competitive relationship with Ohio and Kentucky. Positive increases in the relative share of total employment in the following counties will benefit all counties in the region: Clermont, Dearborn, Kenton and Pendleton. Therefore, it would be instructive to look at these counties as possible locations to concentrate growth in total employment, as it will then have beneficial effects for the rest of the counties in the region. The 13-region model also identifies counties in which an increase would be detrimental to the rest of the counties in the region. Hamilton, Warren, Butler, Ohio, Gallatin and Grant counties all have competitive relationships with the rest of the region. An increase in the relative share of total employment in any of these counties will result in a decrease in the relative share for the rest of the counties in the region. Policy makers may therefore want to steer clear of these counties for initial stimulus in total employment growth. Each of these counties will benefit from growth in other counties but may hinder growth in the rest of the region with growth in their county.

The 3-region model for manufacturing (Table 4) suggests that increases in Indiana may be detrimental to the rest of the region, while a relative increase in Ohio and Kentucky is beneficial. From a county-level viewpoint, a relative increase in manufacturing employment in Boone County will result in a relative increase in the rest of the counties in the region. Increases in Clermont, Gallatin, and Pendleton also have positive impacts for a majority of counties in the area. Counties such as Warren, Ohio, Grant and Dearborn should steer clear of initial increases in manufacturing employment as this will result in relative decreases in the rest of the region. However these counties will see relative increases in manufacturing employment with initial increases in other counties. Policymakers and economic development strategists might be advised to concentrate initial manufacturing locations in counties such as Boone, Clermont, Gallatin and Pendleton. This will have positive manufacturing employment results for all the counties in the Cincinnati CMSA.

Initial increases in wholesale employment (Table 5) should be concentrated in Brown and Gallatin counties. An increase in the relative share of wholesale employment in either of these counties has positive results for the rest of the counties in the region. Counties in which development strategists should be wary include Ohio, Boone, Campbell, Clermont, Hamilton, Dearborn, and Butler. Once again, each of these counties will experience a relative increase in wholesale employment, with a positive stimulus in other counties. For example, Clermont County can expect an increase with an initial stimulus in Brown, Warren, or Gallatin counties. Unfortunately, the model suggests that an initial increase in Clermont County wholesale employment may be detrimental to the region as a whole.

Service employment (Table 6) also reveals some appealing insights. Ohio, Grant, and Pendleton counties will be good places for strategists to look at increasing service employment, because it would be beneficial to all counties in the region. Many counties in the region have competitive relationships with a majority of the counties. Relative increases in Brown, Clermont, Hamilton, Butler, Boone, Campbell and Gallatin all will have a negative impact on many counties. Developers may be inclined to concentrate efforts in the service sector of those counties mentioned before, because that will have a positive and complementary impact on the rest of the region.

Government employment (Table 7) in the Cincinnati CMSA seems to be a very complementary sector. Increases in Clermont, Hamilton, Butler, Dearborn, Boone, and Kenton counties all have positive impacts on the rest of the counties. Only an increase in Ohio County will result in a relative decrease in the rest of the region. Development strategists may want to steer clear of Indiana for government increases since the 3-region model suggests a relative increase in Indiana government employment has a negative effect on Ohio and Kentucky.

A positive relative increase in FIRE employment (Table 8) in six counties in the region will be beneficial for all counties. These counties include Brown, Hamilton, Butler, Boone, Grant, and Kenton counties. Ohio, Campbell and Gallatin should not be targeted for initial growth in FIRE employment, as this could mean a relative decrease for the rest of the region.

Overall, the following six counties may want to be targeted for growth in the following sectors. They display the highest number of positive impacts in the each economic sector: Brown County in wholesale, government, and FIRE; Clermont County in government, FIRE, and manufacturing; Boone County in government, FIRE, and manufacturing; Grant County in wholesale, service, and FIRE; Kenton County in government, FIRE, and manufacturing; and Pendleton County in service, government, FIRE, and manufacturing.

It is interesting to note that the two largest counties in the area, Hamilton and Butler, do not seem to posses a great deal of complementary relationships with the other counties. This would seem to suggest that initial development or relative increases in employment in these counties is not good for the region as a whole. The only sectors in which growth in either of these counties helps every county in the region are government and FIRE. However, these two counties will benefit from growth in other counties in the region. In manufacturing, both Hamilton and Butler have complementary relationships with 6 other counties in regards to initial impact. In other words, Hamilton and Butler counties will experience increases in their relative share of manufacturing employment, with positive initial impacts in 6 other counties. In wholesale employment, Hamilton and Butler have complementary relationships with 3 other counties. In FIRE employment, there are 8 and 9 complementary relationships respectively. Hamilton County has 11 complementary relationships, while Butler has 10 in government employment. In service, both counties benefit from increases in 3 other counties.

Theoretical Implications

This type of study also has theoretical implications as it relates to cumulative causation theory posited by Myrdal (1957). Myrdal writes of spread and backwash effects. Myrdal calls the positive effect of a prosperous region on a lagging region a spread effect. This occurs when a prosperous region provides a market for raw or processed products of a lagging region. The negative influence is called the backwash effect. This occurs when labor and capital leave a lagging region and migrate to a prosperous region. This can also be thought of in terms of the central counties of an MSA as the prosperous counties and the fringe counties as the lagging regions. By using Hamilton and Butler counties as the central counties for the Cincinnati CMSA, this study would seem to enforce the idea of backwash effects. When looking at the results from total employment, construction, wholesale, service, transportation, retail and manufacturing employment, it can be seen that an increase in these two main counties in any of these employment sectors will have a negative impact on the relative shares in the majority or all of the fringe counties.

Growth pole theory as relayed by Perroux (1950) and followed up by Hansen (1967) can also be addressed through the results of this study. Growth pole theory states that the government or institutions should manage the economy and decide where to concentrate industries to drive growth. According to growth pole theory, economic growth will trickle down to other regions if it is concentrated in one area. This can be refuted by the results of this study. Once again, initial stimulus in one of the two larger counties, Hamilton and Butler, has actually a negative impact on most of the rest of the region. So instead of economic growth trickling out down to the other regions, it is actually pulled out of the fringe regions into the larger regions as suggested by Krugman (1991, 1995, 1996).

Limitations

One obvious limitation of the DS model is the idea that inter-industry linkages cannot be identified. The model identifies the relationships between counties in specific sectors but not across sectors. For instance, the model conveys how service sector employment shares are affected in one county by an increase in service sector employment share in another county; however the model does not explain how service sector employment in one county may affect manufacturing employment in another. Another limitation with the model is that an increase in one sector may not necessarily be good for the economy as a whole. An increase in service sector employment may all be concentrated in low wage jobs. This may not be the kind of growth that economic development officials may desire. A further disaggregation of economic sectors would help this problem. This is not meant to be an exhaustive list of the limitations of the model, just two of the more prevalent ones.

IX. Conclusion

Regional competition for economic development is very much a factor in today's development agencies. Many times regions will give away millions of dollars in the hope of luring new industries and growth to a region. Unfortunately, many times regions should actually be working together instead of against each other, when it comes to attracting economic development. Regions and areas may actually benefit from economic growth in other regions. It is important to understand these underlying relationships that exist between regions.

This paper has presented a method by which the relationships that exist between regions experiencing economic growth and development may be identified. The Dendrinos-Sonis model of relative social spatial dynamics can help to determine whether there exists a pattern of regional interaction within a region. This method identifies how these sectoral interactions play out in economic competition and complementarity. This type of study, using nonlinear dynamics, is of tremendous importance to regional economic planners. The model presented here can be a practical tool for analysis of a region. This model can help to suggest which sectors of a local economy should be targeted for stimulus. By determining the nature of the linkages and interaction among areas within a region, a regional planner can determine the effects of a regional policy on all areas within a region. These relationships can also help in the development of policy in the sense that areas that benefit the most regions can be targeted for growth.

This work also contributes from a theoretical standpoint. The results from this work seem to support the notion of cumulative causation as explained by Myrdal (1957) and Kaldor (1970) and even some of Krugman's (1991, 1995, 1996) work. The results from the DS model for the Cincinnati CMSA suggest that development efforts may be best if concentrated in the smaller outlying counties, rather than in the central and larger counties. The central counties will benefit from the growth in the outlying counties. However, if growth is stimulated in the central counties, resources from the outlying counties are pulled into the central counties.

Further work using the DS model can also be approached. The model can be extended to forecast relative shares of each socio-economic stock in the future. By utilizing these forecasts a regional planner would be able to gauge if there would be any structural changes in the regional economy. The results from the DS model can also be compared to results from other regional economic models. By comparing these results, a development official can analyze if different modeling techniques suggest the same workings of the regional economy being studied. Perhaps an even greater disaggregation by economic sector would yield greater insight into the underlying spatial economic relationships within the region.

Nonlinear dynamic modeling has only begun to be utilized in the social sciences. This type of methodology, however, begins to present social scientists with a way of understanding dynamic and complex human systems. There are many advantages to be gained by analyzing social and economic processes and relationships within this framework. Linear modeling has shown to have shortcomings in its representation of these phenomena. Social reality is not just a series of random occurring events; on the contrary, it is events and processes that do conform to some sort of order and logic. Modeling these systems serves as an abstract representation of a process. Through this representation, we hope not to replicate a process, but to help understand a complex social or economic process.

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Table 1 - Total Employment

Results for 3 region model
Indiana Numeraire

Total Employment								
	Ohio	Indiana	Kentucky			Ohio	Indiana	Kentucky
Ohio	**17.3451**	**-0.8047**	**2.3734**		Ohio	+	__	+
Kentucky	**12.1304**	**-1.1454**	**2.6217**		Kentucky	+	__	+

Table 2 - Total Employment

Ohio County IN Numeraire
Total Employment
13 - Region

	Brown OH	Clermont OH	Hamilton OH	Warren OH	Butler OH	Dearborn IN	Ohio IN	Boone KY	Campbell KY	Gallatin KY	Grant KY	KentonKY	Pendleton KY
Brown OH	-0.0685	0.3223	-12.7435	-2.9142	**-5.1843**	2.4367	-0.2066	0.1831	0.1674	-0.4447	-1.0445	1.5551	0.2365
Clermont OH	-0.1529	**1.3005**	-12.9898	-2.5938	**-5.8567**	2.4343	-0.2968	0.0544	-0.2234	-0.4659	-1.1594	1.4393	0.272
Hamilton OH	-0.2195	0.3994	-11.2809	-2.6903	**-5.2626**	**2.7261**	-0.2112	0.1417	0.1451	-0.4181	-1.0626	1.9456	0.0908
Warren OH	0.2639	0.3586	**-18.2737**	-2.6591	**-6.5958**	**2.7577**	-0.2978	-0.0426	-0.2506	-0.478	-1.3295	2.1014	0.0343
Butler OH	0.1292	0.4322	-16.1685	-2.9622	**-5.9942**	**2.8195**	-0.2087	-0.0701	0.0284	-0.5045	-1.2674	1.5936	0.3362
Dearborn IN	0.374	0.1926	-14.9365	-2.8929	**-5.2708**	**2.8872**	-0.2547	0.091	0.2461	-0.5057	-1.1174	1.9294	0.2752
Boone KY	-0.5033	0.7117	**-18.7164**	-3.2537	**-6.1767**	**3.4755**	-0.0773	0.4708	-0.4191	-0.9799	-1.4695	**2.6301**	0.1971
Campbell KY	0.6252	0.2966	**-17.6728**	-3.3511	**-6.4349**	2.2028	-0.3906	-0.0619	-0.0599	-0.3857	-1.4822	2.3615	0.1879
Gallatin KY	1.0485	0.479	**-17.2047**	-1.9773	**-6.4426**	**3.5971**	-0.388	-0.6759	-0.4087	-0.2994	-0.6542	0.3949	0.1124
Grant KY	0.0261	0.5898	**-18.4953**	**-3.5299**	**-6.7106**	**2.5543**	-0.1963	-0.1012	0.1275	-0.4522	-0.8744	1.5146	0.1087
KentonKY	0.0909	0.4138	-12.653	-2.5504	**-5.8908**	**2.5502**	-0.2348	0.0612	0.1381	-0.3181	-1.0986	**2.3197**	0.0018
Pendleton KY	-0.1742	0.4581	-9.021	-2.3676	**-5.8768**	**3.505**	-0.3517	0.3346	0.8526	-0.2198	-1.1826	1.5328	0.4007

Qualitative Analysis															
	Brown OH	Clermont OH	Hamilton OH	Warren OH	Butler OH	Dearborn IN	Ohio IN	Boone KY	Campbell KY	Gallatin KY	Grant KY	KentonKY	Pendleton KY	Pos	Neg
Brown OH	-	+	-	-	-	+	-	+	+	-	-	+	+	6	7
Clermont OH	-	+	-	-	-	+	-	+	-	-	-	+	+	5	8
Hamilton OH	-	+	-	-	-	+	-	+	+	-	-	+	+	6	7
Warren OH	+	+	-	-	-	+	-	-	-	-	-	+	+	5	8
Butler OH	+	+	-	-	-	+	-	-	+	-	-	+	+	6	7
Dearborn IN	+	+	-	-	-	+	-	+	+	-	-	+	+	7	6
Boone KY	-	+	-	-	-	+	-	+	-	-	-	+	+	5	8
Campbell KY	+	+	-	-	-	+	-	-	-	-	-	+	+	5	8
Gallatin KY	+	+	-	-	-	+	-	-	-	-	-	+	+	5	8
Grant KY	+	+	-	-	-	+	-	-	+	-	-	+	+	6	7
KentonKY	+	+	-	-	-	+	-	+	+	-	-	+	+	7	6
Pendleton KY	-	+	-	-	-	+	-	+	+	-	-	+	+	6	7

Bold Indicates Significance at 5%

Table 3

Survey Results	DS Results		DS Results	Survey Results	DS Results		DS Results
Boone County				**Hamilton County**			
Competes with		Works with		Competes with		Works with	
Warren	+	Kenton	+	Butler	-	Clermont	+
Butler	+	Campbell	-	Boone	+	Warren	-
Clermont	+	Grant	-	Kenton	+	Butler	-
Campbell County				**Butler County**			
Competes with		Works with		Competes with		Works with	
Clermont	+	Kenton	+	Boone	-	Hamilton	-
Hamilton	-	Boone	-	Kenton	+	Clermont	+
Butler	-	Grant	-	Warren	-	Warren	-
Kenton County				**Warren County**			
Competes with		Works with		Competes with		Works with	
Hamilton	-	Boone	+	Boone	-	Butler	-
Butler	-	Campbell	+	Campbell	-	Hamilton	-
Warren	-	Grant	-	Butler	-	Clermont	+
Clermont County				**Dearborn County**			
Competes with		Works with		Competes with		Works with	
Hamilton	-	Hamilton	-	Kenton	+	Hamilton	-
Boone	+	Boone	+	Hamilton	-	Kenton	+
Warren	-	Dearborn	+	Butler	-	Butler	-
Gallatin County				**Brown County**			
Competes with		Works with		Competes with		Works with	
Grant	-	Grant	-	Clermont	+	Clermont	+
Boone	-	Boone	-				
Kenton	+	Kenton	+				

Table 4 - Manufacturing

Results for 3 region model
Indiana Numeraire

Manufacturing								
	Ohio	Indiana	Kentucky			Ohio	Indiana	Kentucky
Ohio	**9.1298**	**-0.559**	**0.9625**		Ohio	**+**	__	**+**
Kentucky	3.4312	**-0.8827**	**1.3846**		Kentucky	+	__	**+**

Ohio County IN Numeraire
Manufacturing Employment
13 - Region

	Brown OH	Clermont OH	Hamilton OH	Warren OH	Butler OH	Dearborn IN	Ohio IN	Boone KY	Campbell KY	Gallatin KY	Grant KY	KentonKY	Pendleton KY
Brown OH	-0.902	0.2094	-1.8058	-1.2093	-1.3081	-1.908	-0.3833	1.7665	-1.8839	0.1207	-0.2819	1.4268	0.482
Clermont OH	-1.0172	1.1242	2.5956	-0.8983	-2.0885	-0.5682	-0.451	1.7115	-0.8876	0.1709	-0.243	0.5764	0.367
Hamilton OH	-1.3199	0.7691	2.3698	-1.0162	-0.2232	-1.2922	-0.4085	1.194	-0.9068	0.2319	-0.388	1.0876	0.4714
Warren OH	-1.5704	0.5981	0.8489	-0.7132	1.3291	-2.5525	-0.3984	1.8322	-0.7883	0.2398	-0.346	1.7815	0.2036
Butler OH	-1.2996	0.7042	-0.2402	-1.1008	0.1162	-1.3962	-0.4046	1.1423	-0.9359	0.1734	-0.3793	0.8483	0.4712
Dearborn IN	-1.2487	0.73	-1.1551	-1.3386	0.498	-1.6198	-0.3479	1.0792	-0.699	0.1419	-0.4052	0.4687	0.4486
Boone KY	-1.5033	0.6854	4.7476	-0.9337	3.2325	-3.3186	-0.351	2.3309	-0.4012	0.2006	-0.3143	0.8355	0.3515
Campbell KY	-1.2946	0.658	-4.8341	-1.4617	-3.0705	-1.841	-0.2522	1.1052	-0.6641	0.1911	-0.5622	0.5137	0.4603
Gallatin KY	0.75	-1.2158	-35.6832	-3.105	-4.0716	-1.8834	-0.3224	1.568	-2.1102	0.3418	-0.7933	1.6431	0.0777
Grant KY	0.0848	1.171	-4.4929	-1.939	-3.0902	-1.1609	-0.376	1.4356	-0.6029	-0.0169	-0.2783	-2.2767	-0.1449
KentonKY	-1.26	0.8104	0.0267	-0.9203	-2.5888	-0.6093	-0.3469	1.0379	-1.1566	0.2181	-0.4173	1.0712	0.5009
Pendleton KY	-0.7188	0.7962	12.0998	-0.2931	1.5487	-0.3855	-0.1981	2.032	0.274	0.2135	-0.5797	-0.3091	**0.9683**

Qualitative Analysis

	Brown OH	Clermont OH	Hamilton OH	Warren OH	Butler OH	Dearborn IN	Ohio IN	Boone KY	Campbell KY	Gallatin KY	Grant KY	KentonKY	Pendleton KY		Pos	Neg
Brown OH	-	+	-	-	-	-	-	+	-	+	-	+	+		5	8
Clermont OH	-	+	+	-	-	-	-	+	-	+	-	+	+		6	7
Hamilton OH	-	+	+	-	-	-	-	+	-	+	-	+	+		6	7
Warren OH	-	+	+	-	+	-	-	+	-	+	-	+	+		7	6
Butler OH	-	+	-	-	+	-	-	+	-	+	-	+	+		6	7
Dearborn IN	-	+	-	-	+	-	-	+	-	+	-	+	+		6	7
Boone KY	-	+	+	-	+	-	-	+	-	+	-	+	+		7	6
Campbell KY	-	+	-	-	-	-	-	+	-	+	-	+	+		5	8
Gallatin KY	+	-	-	-	-	-	-	+	-	+	-	+	+		5	8
Grant KY	+	+	-	-	-	-	-	+	-	-	-	-	-		3	10
KentonKY	-	+	+	-	-	-	-	+	-	+	-	+	+		6	7
Pendleton KY	-	+	+	-	+	-	-	+	+	+	-	-	+		7	6

Bold Indicates Significance at 5%

Table 5 - Wholesale

Results for 3 region model
Indiana Numeraire

Wholesale	Ohio	Indiana	Kentucky			Ohio	Indiana	Kentucky
Ohio	**20.5036**	**-0.6634**	**2.2898**		Ohio	**+**	__	**+**
Kentucky	7.6132	**-0.9892**	1.6903		Kentucky	+	__	+

Ohio County IN Numeraire
Wholesale Employment
13 - Region

	Brown OH	Clermont OH	Hamilton OH	Warren OH	Butler OH	Dearborn IN	Ohio IN	Boone KY	Campbell KY	Gallatin KY	Grant KY	KentonKY	Pendleton KY
Brown OH	0.8565	-0.6001	**-27.2098**	0.1794	**-6.7186**	**-3.6494**	-0.2751	**-1.9637**	-1.8045	0.0529	-0.0044	-1.0607	-0.6656
Clermont OH	0.7522	-0.2648	**-32.5157**	0.018	-5.4935	**-4.2188**	-0.2391	**-2.0879**	-1.4753	0.0414	-0.0606	-1.1015	-0.6177
Hamilton OH	0.6385	-0.419	**-30.358**	-0.0731	**-7.8942**	**-3.8072**	-0.2746	**-2.055**	-0.963	0.045	0.0179	-0.4338	-0.9221
Warren OH	0.9381	-0.6721	**-37.8395**	0.2697	**-7.49**	**-4.2101**	-0.1957	**-2.0109**	-1.5134	0.0596	-0.0295	-0.9911	-0.8004
Butler OH	0.7028	-0.4188	**-33.1948**	0.0884	**-7.6208**	**-3.9043**	-0.2199	**-2.2292**	-1.0226	0.0412	-0.0163	-0.7916	-0.8567
Dearborn IN	0.7147	-0.5292	**-32.6115**	-0.1247	**-7.917**	**-3.1374**	**-0.3073**	**-2.0203**	-1.3177	0.0378	-0.0175	-0.8991	-0.8918
Boone KY	0.6834	-0.0836	**-34.1053**	-0.4561	**-7.519**	**-3.8538**	-0.3313	**-1.9891**	-1.0998	0.0249	0.0182	-0.4336	-0.8241
Campbell KY	0.6051	-0.612	**-33.5785**	0.1221	**-8.2386**	**-4.6844**	-0.2049	**-2.312**	-0.876	0.064	0.0045	-0.8985	-0.6042
Gallatin KY	0.2055	1.4962	24.8028	-0.5197	3.1703	-0.4033	-0.7143	-0.6959	-0.5404	**0.7559**	0.0044	6.6492	0.2917
Grant KY	**8.9969**	-0.6005	-44.2912	-2.1867	5.03	0.6417	-0.1646	-2.7685	-4.6145	0.0602	0.054	0.0156	1.1614
KentonKY	0.633	-0.2279	**-32.4422**	-0.3632	**-8.4276**	**-3.7341**	**-0.276**	**-1.8105**	-0.8159	0.0356	0.0057	-0.5011	-1.0188
Pendleton KY	0.9412	-0.1861	**-23.5992**	-0.1449	**-7.2631**	**-3.6836**	**-0.4955**	-1.4216	-0.6545	**0.1571**	0.0782	-0.5432	-0.9367

Qualitative Analysis

	Brown OH	Clermont OH	Hamilton OH	Warren OH	Butler OH	Dearborn IN	Ohio IN	Boone KY	Campbell KY	Gallatin KY	Grant KY	KentonKY	Pendleton KY		Pos	Neg
Brown OH	+	-	-	+	-	-	-	-	-	+	-	-	-		3	10
Clermont OH	+	-	-	+	-	-	-	-	-	+	-	-	-		3	10
Hamilton OH	+	-	-	-	-	-	-	-	-	+	+	-	-		3	10
Warren OH	+	-	-	+	-	-	-	-	-	+	-	-	-		3	10
Butler OH	+	-	-	+	-	-	-	-	-	+	-	-	-		3	10
Dearborn IN	+	-	-	-	-	-	-	-	-	+	-	-	-		2	11
Boone KY	+	-	-	-	-	-	-	-	-	+	+	-	-		3	10
Campbell KY	+	-	-	+	-	-	-	-	-	+	+	-	-		4	9
Gallatin KY	+	+	+	-	+	-	-	-	-	+	+	+	+		8	5
Grant KY	+	-	-	-	+	+	-	-	-	+	+	+	+		7	6
KentonKY	+	-	-	-	-	-	-	-	-	+	+	-	-		3	10
Pendleton KY	+	-	-	-	-	-	-	-	-	+	+	-	-		3	10

Bold Indicates Significance at 5%

Table 6 - Service

Results for 3 region model
Indiana Numeraire

Service								
	Ohio	Indiana	Kentucky			Ohio	Indiana	Kentucky
Ohio	42.9304	0.2291	4.9857		Ohio	+	+	+
Kentucky	38.4325	0.3	5.3012		Kentucky	+	+	+

Ohio County IN Numeraire
Service employment
13 - Region

	Brown OH	Clermont OH	Hamilton OH	Warren OH	Butler OH	Dearborn IN	Ohio IN	Boone KY	Campbell KY	Gallatin KY	Grant KY	KentonKY	Pendleton KY
Brown OH	**-3.0818**	**-3.4099**	**-63.7994**	-1.025	**-8.6819**	-0.083	0.0733	**-1.2457**	**-5.6983**	**-0.9877**	0.4301	-3.454	**3.7432**
Clermont OH	**-3.5738**	**-2.2738**	**-49.4636**	-0.7254	-6.9994	-0.4874	0.0911	-0.7558	**-4.7591**	**-0.9884**	0.375	-1.8857	2.7396
Hamilton OH	**-3.6844**	**-3.3756**	**-58.8171**	-0.8131	**-7.9948**	-0.1858	0.1719	-0.9421	**-5.355**	**-0.9923**	0.5318	-2.7857	**3.6964**
Warren OH	-2.5399	**-3.1718**	**-51.5969**	-0.3915	-6.6383	0.2784	-0.0247	-0.6578	**-5.3988**	**-0.9836**	0.2686	-2.99	2.9758
Butler OH	**-3.526**	**-3.2271**	**-54.7036**	-0.7982	**-7.2261**	-0.0699	0.0978	-0.9527	**-5.1079**	**-0.9837**	0.4164	-2.3501	3.0948
Dearborn IN	**-4.3344**	**-4.4201**	**-76.3909**	-1.1915	**-10.7927**	-0.4325	0.3627	**-1.0535**	**-5.7549**	**-1.0059**	0.4267	-3.9331	**4.1358**
Boone KY	-2.6525	-1.8544	-29.73	0.6078	-3.9377	0.5248	0.461	0.205	-3.5845	**-0.9972**	0.781	1.2097	2.4185
Campbell KY	**-4.2696**	**-3.8486**	**-70.9274**	-1.2563	**-10.0464**	-0.0391	-0.0588	**-1.0516**	**-6.2374**	**-0.9911**	0.5862	-3.9583	**4.6315**
Gallatin KY	1.2182	13.6995	183.6087	13.7541	19.0594	2.9157	0.8982	-1.4881	8.1	0.2589	5.2715	18.8713	-1.6308
Grant KY	**-3.0692**	**-3.7762**	**-69.4127**	-0.6063	**-9.9221**	0.2189	0.1636	**-1.426**	**-5.4492**	**-1**	0.7462	-4.2448	**3.7208**
KentonKY	**-3.7633**	**-3.3032**	**-58.4407**	-0.7723	-7.7449	-0.1512	0.0864	**-1.0593**	**-5.5767**	**-0.9926**	0.6075	-2.2382	3.5737
Pendleton KY	**-3.9296**	**-3.5357**	**-60.8803**	-0.863	**-8.4667**	-0.1451	0.0904	**-1.0765**	**-5.6195**	**-0.9855**	0.4375	-2.8847	**4.5412**

Qualitative Analysis

	Brown OH	Clermont OH	Hamilton OH	Warren OH	Butler OH	Dearborn IN	Ohio IN	Boone KY	Campbell KY	Gallatin KY	Grant KY	KentonKY	Pendleton KY		Pos	Neg
Brown OH	-	-	-	-	-	-	+	-	-	-	+	-	+		3	10
Clermont OH	-	-	-	-	-	-	+	-	-	-	+	-	+		3	10
Hamilton OH	-	-	-	-	-	-	+	-	-	-	+	-	+		3	10
Warren OH	-	-	-	-	-	+	-	-	-	-	+	-	+		3	10
Butler OH	-	-	-	-	-	-	+	-	-	-	+	-	+		3	10
Dearborn IN	-	-	-	-	-	-	+	-	-	-	+	-	+		3	10
Boone KY	-	-	-	+	-	+	+	+	-	-	+	+	+		7	6
Campbell KY	-	-	-	-	-	-	-	-	-	-	+	-	+		2	11
Gallatin KY	+	+	+	+	+	+	+	-	+	+	+	+	-		11	2
Grant KY	-	-	-	-	-	+	+	-	-	-	+	-	+		4	9
KentonKY	-	-	-	-	-	-	+	-	-	-	+	-	+		3	10
Pendleton KY	-	-	-	-	-	-	+	-	-	-	+	-	+		3	10

Bold Indicates Significance at 5%

Table 7 - Government

Results for 3 region model
Indiana Numeraire

Government	Ohio	Indiana	Kentucky			Ohio	Indiana	Kentucky
Ohio	26.3923	-0.0321	4.8025		Ohio	+	-	+
Kentucky	25.7764	-0.228	5.8446		Kentucky	+	-	+

Ohio County IN Numeraire
Government Employment
13 - Region

	Brown OH	Clermont OH	Hamilton OH	Warren OH	Butler OH	Dearborn IN	Ohio IN	Boone KY	Campbell KY	Gallatin KY	Grant KY	KentonKY	Pendleton KY
Brown OH	**1.3404**	**1.4309**	**18.7534**	0.8303	**6.0923**	0.8537	-0.2815	**1.0864**	-0.0598	0.0073	-0.1739	**2.3809**	0.3747
Clermont OH	0.6607	**1.6669**	**17.8257**	0.8296	**5.8218**	0.6491	**-0.6931**	**1.1131**	0.1369	-0.2159	-0.1028	**2.2486**	**0.727**
Hamilton OH	**1.041**	**1.6307**	**25.4737**	1.2195	**8.3564**	0.6503	-0.085	**1.444**	0.7425	-0.1582	0.0087	**3.2759**	0.3397
Warren OH	0.947	**1.5157**	**19.3442**	1.3632	**6.3508**	0.6266	-0.2405	**1.2126**	-0.0114	-0.0208	0.0527	**2.5361**	0.2626
Butler OH	**0.8236**	**1.5294**	**22.2984**	**1.1622**	**7.3643**	**0.8697**	-0.255	**1.3372**	0.3504	-0.0343	-0.0958	**2.7524**	0.4361
Dearborn IN	0.1579	**1.5267**	**18.1878**	0.9807	**5.6237**	**1.0191**	-0.0257	**1.0669**	-0.0539	0.1068	-0.257	**2.1657**	0.1208
Boone KY	-0.3335	**1.584**	15.706	1.1091	3.4959	0.1708	-0.6125	**1.4645**	0.8777	-0.2199	0.5576	2.427	0.3639
Campbell KY	0.8561	**1.3947**	**20.3988**	1.0168	**6.3487**	0.7341	**-0.5361**	**1.1844**	0.5055	-0.0147	-0.1231	**2.6449**	0.3927
Gallatin KY	**1.1797**	0.8363	**16.716**	**2.4608**	**6.1264**	0.6442	-0.433	**1.2495**	0.3545	-0.0438	-0.6656	1.7148	0.3951
Grant KY	0.6791	**1.9793**	**17.9633**	**1.5794**	**4.6422**	**1.1731**	-0.0509	**1.161**	-0.0876	0.1486	-0.3456	**1.7283**	-0.0874
KentonKY	**1.4244**	**1.4882**	**21.5451**	0.134	**7.616**	0.5029	-0.4068	**1.3914**	1.1319	-0.1245	-0.2778	**3.1453**	**0.9211**
Pendleton KY	1.1187	0.5005	8.3171	-0.4263	3.2771	0.2977	**-0.6944**	0.919	-0.3492	-0.4627	-0.3459	0.601	**1.1689**

Qualitative Analysis

	Brown OH	Clermont OH	Hamilton OH	Warren OH	Butler OH	Dearborn IN	Ohio IN	Boone KY	Campbell KY	Gallatin KY	Grant KY	KentonKY	Pendleton KY	Pos	Neg
Brown OH	+	+	+	+	+	+	-	+	-	+	-	+	+	10	3
Clermont OH	+	+	+	+	+	+	-	+	+	-	-	+	+	10	3
Hamilton OH	+	+	+	+	+	+	-	+	+	-	+	+	+	11	2
Warren OH	+	+	+	+	+	+	-	+	-	-	+	+	+	10	3
Butler OH	+	+	+	+	+	+	-	+	+	-	-	+	+	10	3
Dearborn IN	+	+	+	+	+	+	-	+	-	+	-	+	+	10	3
Boone KY	-	+	+	+	+	+	-	+	+	-	+	+	+	10	3
Campbell KY	+	+	+	+	+	+	-	+	+	-	-	+	+	10	3
Gallatin KY	+	+	+	+	+	+	-	+	+	-	-	+	+	10	3
Grant KY	+	+	+	+	+	+	-	+	-	+	-	+	-	9	4
KentonKY	+	+	+	+	+	+	-	+	+	-	-	+	+	10	3
Pendleton KY	+	+	+	-	+	+	-	+	-	-	-	+	+	8	5

Bold Indicates Significance at 5%

Table 8 - Fire

Results for 3 region model
Indiana Numeraire

FIRE	Ohio	Indiana	Kentucky			Ohio	Indiana	Kentucky
Ohio	-61.1057	-1.7492	-6.7834		Ohio	-	-	-
Kentucky	-37.7643	-1.3286	-3.4414		Kentucky	-	-	-

Ohio County IN Numeraire
FIRE Employment
13 – Region

	Brown OH	Clermont OH	Hamilton OH	Warren OH	Butler OH	Dearborn IN	Ohio IN	Boone KY	Campbell KY	Gallatin KY	Grant KY	KentonKY	Pendleton KY
Brown OH	2.3217	-0.6295	29.828	-1.0943	6.1582	0.5493	**-1.3577**	1.7253	-2.2398	**-1.0822**	0.1659	3.8799	0.1266
Clermont OH	**2.8278**	**2.1192**	**59.7578**	-0.7717	**9.9606**	0.1937	**-1.143**	**3.158**	-2.3427	**-0.8161**	0.7971	**6.6534**	0.246
Hamilton OH	1.9117	0.6176	36.5002	-1.35	**6.4798**	-0.261	-0.8078	**2.4061**	-2.0338	-0.5435	0.6604	4.1858	0.1041
Warren OH	**2.3663**	0.6072	**39.2433**	-1.061	**7.8161**	0.1107	**-1.2358**	**2.4844**	-2.3373	**-1.0466**	0.5602	**5.0319**	0.081
Butler OH	1.979	0.4516	35.7905	-1.3804	**7.6199**	0.0512	**-1.037**	**2.1874**	-2.0289	**-0.8319**	0.4906	**4.7219**	0.0705
Dearborn IN	0.4657	0.6695	29.6856	-2.1276	6.3283	0.4657	**-1.1367**	2.0312	-2.1922	-0.5978	0.3699	3.7113	0.1297
Boone KY	1.9226	1.6848	**42.2255**	0.0191	**8.1326**	-0.0722	-0.8117	**2.7599**	-0.789	**-0.9284**	0.7556	3.9337	0.1853
Campbell KY	2.4665	0.7753	48.8625	-1.1734	**8.805**	-0.0602	-0.8475	**2.8995**	-1.5665	-0.6527	0.769	4.8174	-0.0585
Gallatin KY	1.7021	0.6162	34.0647	-0.7375	8.8318	-0.5964	-0.6765	1.9679	-0.1496	-0.8529	0.1793	3.007	0.4701
Grant KY	2.2346	0.563	31.9896	-2.6328	5.835	-0.0517	**-1.1946**	**2.2499**	-2.3332	-0.5536	0.6988	4.6442	-0.2542
KentonKY	4.5627	1.0392	40.5673	-0.9918	**7.2292**	-0.0333	-0.6853	**2.4315**	-1.5235	-0.6973	0.5717	4.5627	-0.0041
Pendleton KY	0.9674	-0.3262	12.5687	-1.8533	2.7946	-0.3696	-0.5832	1.6453	-1.3704	-0.3903	0.8677	1.2053	0.2869

Qualitative Analysis

	Brown OH	Clermont OH	Hamilton OH	Warren OH	Butler OH	Dearborn IN	Ohio IN	Boone KY	Campbell KY	Gallatin KY	Grant KY	KentonKY	Pendleton KY		Pos	Neg
Brown OH	+	-	+	-	+	+	-	+	-	-	+	+	+		8	5
Clermont OH	+	+	+	-	+	+	-	+	-	-	+	+	+		9	4
Hamilton OH	+	+	+	-	+	-	-	+	-	-	+	+	+		8	5
Warren OH	+	+	+	-	+	+	-	+	-	-	+	+	+		9	4
Butler OH	+	+	+	-	+	+	-	+	-	-	+	+	+		9	4
Dearborn IN	+	+	+	-	+	+	-	+	-	-	+	+	+		9	4
Boone KY	+	+	+	+	+	-	-	+	-	-	+	+	+		9	4
Campbell KY	+	+	+	-	+	-	-	+	-	-	+	+	-		7	6
Gallatin KY	+	+	+	-	+	-	-	+	-	-	+	+	+		8	5
Grant KY	+	+	+	-	+	-	-	+	-	-	+	+	-		7	6
KentonKY	+	+	+	-	+	-	-	+	-	-	+	+	-		7	6
Pendleton KY	+	-	+	-	+	-	-	+	-	-	+	+	+		7	6

Bold Indicates Significance at 5%