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Natural Amenities and Rural Development: Understanding Spatial and Distributional Attributes

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ABSTRACT Contemporary resource management practice and rural development planning increasingly emphasize the integration of resource extractive industries with non-market-based recreational and amenity values. There is a growing empirical literature which suggests that natural amenities impact regional economies through aggregate measures of economic performance such as population, income, and/or employment growth, and housing development. We maintain that assessing the developmental aspects of amenity-led regional change requires a more thorough focus on alternative measures of economic performance such as income distribution and spatial organization. In the applied research presented here we investigate relationships between amenities and regional economic development indicators. Results suggest mixed and generally insignificant amenity-based associations which highlight the need for appropriate regional economic modeling techniques that account for often dramatic spatial autocorrelation of natural amenity attributes. We conclude that with respect to amenity driven economic growth and development "place in space" matters.

Introduction

Natural resources continue to play an important role in regional economies of the United States and throughout the developed and developing world. They have provided location-specific advantages for many regions at various stages in their economic development. In early stages of development, extractive industries (farming, forestry, mining, and fishing) created plentiful and relatively high-paying job opportunities.

Since the 1960s, several forces have come together to fundamentally alter the manner in which natural resources act as engines of economic growth. With the exception of oil

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production, international competition has led most resource extractive industries in the U.S. to lose their price competitiveness in world commodity markets (Freudenburg 1992; Weber 1995; Pulver 1995; Galston and Baehler 1995). The economic restructuring of the most developed economies toward a service base has significantly tempered the importance of natural raw materials as inputs for production (Bluestone and Harrison 1982; Chevan and Stokes 2000). Finally, environmental awareness and political activism of urban audiences have provided strong criticism of extractive productive practices by emphasizing adverse environmental impacts, threats to bio-diversity and sustainability, and global environmental change (Castle 1993; Buttel 1995).

These regional development issues have forced a reexamination of the uses and management of natural resources; particularly publicly owned land-based resources such as forests and water resources in the American West and the Northeastern Lake States. Since the late 1960s, natural resource management has broadened its focus to embrace non-extractive environmentally sensitive land management practices that reflect broader non-market values (Power 1996; Marcouiller and Deller 1996; Hays 1998). Natural amenity-rich communities have become aware that natural resources provide not only a source of physical raw material commodities but can also serve as a source of recreational use that provides a backdrop for tourism development (Galston and Baehler 1995; Jepson, et al. 1997; Isserman 2000; Green 2001).

Natural amenities are clearly thought to provide an integral component of recreation, tourism, and retirement development (Fredrick 1993; Keith and Fawson 1995; Jakus, Siegel, and White 1995; Keith, Fawson and Chang 1996; Leatherman and Marcouiller 1996; Marcouiller 1997; McDonough et al. 1999). They provide the substantive but latent primary factor input into tourism industry output (Power 1988; Marcouiller 1998). As a quality-of-life factor, they also are believed to play a critical role in human migration and firm location decisions (Graves 1979, 1980, 1983; Gottlieb 1994; Dissart and Deller 2000).

There is a growing empirical literature on the regional economic consequences of amenity-based development. Graves (1979, 1980, 1983) and Knapp and Graves (1989) found that location-specific amenities such as climate were significant in explaining population migration. Porell (1982) showed that both economic and amenity factors were important determinants of migration. Roback (1982, 1988) found that while improving quality of life, amenity variables might lower wages and increase housing rents. Hoehn, Berger, and Blomquist (1987) found statistical differences in housing prices and wages due to location-specific amenities. Deller and Tsai (1999), building on the work of Blanchflower and Oswald (1996) argued that amenity variables can influence levels of local unemployment. Specifically, people may be willing to accept higher probabilities of unemployment to live in high amenity areas. These early studies, however, typically employed simple measures of climate, crime, or congestion, and lacked a focus on specific natural amenities that can be influenced by regional public policy.

Recent studies have paid attention to the effects of natural amenities on migration and economic conditions. Rudzitis and Johansen (1991) were among the first to suggest that the presence of wilderness and large expanses of open space were an important reason why people moved to or lived in remote rural counties. Natural amenities have been shown to influence individual rural migration decisions (Nord and Cromartie 1997; Beale and Johnson 1998; Rudzitis 1999). Deller et al. (2001) found that different types of amenities can influence growth in population, employment and per capita income in subtle and unique ways.

Not all studies, however, support the notion that natural amenities have strong effects on economic growth and development. Keith and Fawson (1995) examined the economic effects of wilderness on local economic characteristics in Utah and found that the economic contribution of wilderness to local economic activity was not likely to be significant. Duffy-Deno (1997) analyzed the local economic impact of state parks in the eight intermountain west states and found a relatively weak effect on population and employment growth. In a related study, Duffy-Deno (1998) also failed to find an association between the existence of federally owned wilderness areas and population and employment growth between 1980 and 1990. Lewis et al. (2002) found that access to public conservation lands had no effect on migration or employment growth in the northern forested region of the U.S. In a complementary study Lewis, Hunt, and Plantinga (2003) found that alternative public land management policies did not appear to influence local wage growth.

Although much work remains and significant debate continues, it is fair to identify the fact that from an empirical perspective, natural amenity-based economic development appears to be an important determinant in population, employment, and income growth (McGranahan 1999; English, Marcouiller, and Cordell 2000).

Aggregate measures of regional economic growth, however, mask key developmental aspects that are important when assessing amenity-based development strategies such as tourism and retirement migration. For instance, there are concerns about the quality of returns to amenity-led development (tourism and recreation-related jobs) and its distributional implications. Some argue that tourism and recreation-related jobs are dead-end, low-skilled, low-paying, and seasonal (Frederick 1993; Lewis, Hunt, and Plantinga 2003; Marcouiller et al. 2004). Others suggest that tourism and recreation development may lead to the general exploitation of the poor by the rich (Smith 1989; Ashworth 1992; Marcouiller 1997; Marcouiller and Green 2000). In short, most of the available studies linking amenities and the economy focus on traditional notions of growth while few emphasize notions of economic development.

A limited number of studies have evaluated the distributional effects of alternative rural development strategies including resource-based commodity production, amenity-based tourism, and recreation development (Marcouiller, Shreiner, and Lewis 1995; Wagner 1997; Leatherman and Marcouiller 1996, 1999) showing mixed results while clearly identifying critical developmental linkages. Simply stated, the effects of natural amenities on the distribution of economic activity across households are important yet remain largely uncharted and provide a wide opportunity set for future research.

Given a general lack of theoretical basis, the significance of natural amenities on regional production and supply components are not yet well-understood. A fundamental reason for this lack of understanding is that natural amenities, as latent primary inputs to the production process of tourism and recreation, evade standardized accounting procedures and are typically non-marketed and often publicly owned (Power 1988, 1996; Marcouiller and Deller 1996; Marcouiller 1998). Nor is there as yet a systematic method for measuring natural amenity attributes (Jepson et al. 1997; English, Marcouiller, and Cordell 2000; Deller et al. 2001) or incorporating their characteristics into production analysis.

Furthermore, previous empirical studies tend to ignore the spatial characteristics of natural amenities. Different natural amenity attributes can have different growth and distributional impacts on regional economies (Beale and Johnson 1998). Different regions have unique types of natural amenities and their spatial distribution patterns are distinct but highly correlated within close neighborhood proximity due to regional differences in climate, topography, geology, and ecotype.[1] These spatial characteristics of natural amenities have important implications to regional natural amenity research. The clustering patterns of natural amenities suggest that attribute characteristics are interdependent over geographic space. This spatial dependency of natural amenities becomes problematic with conventional modeling approaches.

Thus, the goals of our work reported here involve extending previous amenity related regional research into the distributional realm while explicitly incorporating an assessment of spatial dependency. Our thematic developmental interest involves an evaluation of the role natural amenities play in both income generation (growth) and its distribution among regional households. In essence, we expand the existing literature by explicitly introducing notions of economic development above and beyond simply growth.

This study is organized into three additional sections. First, we outline both the manner in which amenities and economic development attributes are defined and suggest an empirical model that accounts for spatial dependencies. Next, we discuss the spatial nature of amenity results and outline key elements that can be drawn out of our empirical development models. Finally, we summarize the results, identify further research needs, and provide implications for public policies that address rural resource management and amenity-driven development.

Modeling the Distributional Effect of Natural Amenities

The methods used to sort out distributional impacts of natural amenities continue to evolve. In our applied research, we empirically addressed the complexities associated with measuring the regional incidence of natural amenities using an aggregate factor score approach. We also corrected for spatial autocorrelation using a spatial error modeling approach. These two modeling issues are now, in-turn, more fully described.

Measuring Amenity Attributes. Two approaches are evolving in measuring natural amenity attributes: a summary index approach and an aggregate factor score approach. The summary index approach is an effort to define natural amenities as a single index of different natural amenity attributes. Two recent empirical studies employed the summary index approach to evaluating the effects of natural amenities. Nord and Cromartie (1997) produced the summary index to represent natural amenities in rural counties. The summary index consisted of mild sunny winters, moderate summers with low humidity, varied topography, mountains, and the abundance of water. McGranahan (1999) generated a single index with six amenity measures: average January temperature, average January days of sun, low winter-summer temperature gap, low average July humidity, topographic variation, and water areas.

The summary index approach is not free from criticism. First of all, using a single summary index to represent the heterogeneous nature of natural amenity distributions is problematic. Second, decisions about which amenity attributes should be incorporated to develop a single summary index are quite subjective. Finally, there is no strong theoretical rationale for producing a single summary index.

The aggregate factor score approach is an effort to reduce a wide array of natural amenity attributes into multiple but similar groups. Principal component analysis is one approach that can be employed to produce smaller sets of factors (or principal components) that can be used in subsequent modeling such as regression analysis. Several recent studies have evaluated the economic impacts of natural amenity attributes using the aggregate factor score approach. Henry, Barkley, and Bao (1997) used a factor analysis to produce two aggregated amenity sets out of twelve local amenities. English, Marcouiller, and Cordell (2000) used a principal component analysis to create four sets of amenity variables: urban, land, winter and water resources. Using a principal component analysis, Deller et al. (2001) examined the economic effects of five amenity measures: climate, urban facilities, land, water, and winter amenity attributes. Finally, Marcouiller et al. (2004) reduced about fifty key natural amenity and recreation site variables into five distinct categories unique to the lake states of Minnesota, Wisconsin, and Michigan that included two types of water (river and lake), land, and two seasonal-specific recreational attributes (summer and winter).

The aggregate factor score approach is less subjective than the single index approach, but the final measures (factor scores or principal component scores) may not be easy to interpret. The use of aggregate factor scores, however, can allow researchers to examine multidimensional aspects of natural amenity attributes (English, Marcouiller, and Cordell 2000; Deller et al. 2001; Marcouiller et al. 2004). Similar to the summary index approach, however, the aggregate factor scores compresses the heterogeneous nature of natural amenity distributions into a scalar index and there is no strong theoretical rationale for producing a single summary index. Despite these limitations this study employed principal component analysis (PCA) to condense a set of related amenity attributes into a smaller set of amenity scores.

Natural Amenities and Spatial Dependence. The presence of natural amenity attributes exhibit spatial clustering, thus the question of their treatment as random variables in classical statistical models comes into question.[2] In resolving this empirical dilemma, our modeling approach follows the earlier work of Doreian (1980, 1981), Loftin and Ward (1983), LeSage (1997), and Anselin and Bera (1998) by suggesting a spatial error model (SEM) to incorporate this issue through the error term.

In the work reported here, spatial autocorrelation was treated as a missing variable represented by the unobserved error terms (Miron 1984). The spatial error model was fitted using a maximum likelihood estimation procedure (Kaluzny et al. 1998). The SEM was formulated in matrix notation as follows:

$$y = X\beta + u \quad (1)$$

$$u = \rho W u + \varepsilon \quad (2)$$

where the $(n \times 1)$ vector y contains cross-sectional observations on the dependent variable, the $(n \times p)$ matrix X contains observations on a set of $(p - 1)$ explanatory variables β, u is a $(n \times 1)$ vector of error terms that are spatially correlated, ε is the uncorrelated $(n \times 1)$ error vector with $N(0, \sigma^2 I)$, and the scalar ρ is the $(n \times 1)$ vector of the spatial autoregressive coefficient to be estimated.

The SEM includes a $(n \times n)$ positive and symmetric spatial weights matrix W. W is often expressed as a first-order spatial contiguity matrix for incorporating the values of variables in adjacent geographic areas. The elements w_{ij} of W are 1 when county i and j are defined as neighbors and 0 when they are not neighbors.[3]

When errors are spatially correlated the problem with using ordinary least squares (OLS) is that the usual standard estimator tends to underestimate the true standard error. The inefficient variance estimators affect levels of statistical significance and lead to incorrect policy implications (Griffith 1996; Anselin and Bera 1998; Rey and Montouri 1999). An SEM controlling for spatial autocorrelation in the error term produces more efficient estimators than an OLS method does.

We hypothesize that natural amenities not only have positive impacts on regional economic development profiles but also have an equalizing effect on income distribution. To test this hypothesis, we develop an empirical model of regional economic development that is a function of demographic characteristics, education (human capital), socioeconomic characteristics, industrial composition, taxes, and amenities (eq. 3).

The research region of this study is the 242 counties of Michigan, Minnesota, and Wisconsin. The northern counties of this region provide ample natural amenities and thus, tourism and recreational opportunities for regional households, especially those who reside in metropolitan counties found in the southern portion of this region. Our selection of the US Lake States was driven by the uniqueness of natural amenities attributes in this region, the contemporary public policy debate in the region that focuses attention to the efficacy of tourism development as a regional strategy for economic growth, and the relatively homogeneous conditions of key industrial sectors that are reliant on natural resource utilization (e.g., wood using industries, real estate, and tourism).

Our central focus is to examine how amenities, once controlled for a range of socio-demographic and new growth variables, affect changing levels of economic development. To do this we estimate a relatively straightforward dynamic economic development model over the period 1980-1990:[4]

$$\Delta EcoDev_i = f(Demo_i, Edu_i, SocioEcon_i, IndusCompo_i, Tax, Amenity_i) + u_i \quad (3)$$

The error structure of this model takes the form as outlined in equation (2).

Data. The dependent variables included profiles of regional economic development measured by change rates of population, retail and service employment, per capita income, and distributional profiles from 1980 to 1990. The distribution profile was measured using Gini coefficients of family income between 1979 and 1989 (Kuenne 1993). The data were collected from the Bureau of Economic Analysis, Regional Economic Information System (BEA-REIS) and from the Census of Population of Housing data for 1980 and 1990. The descriptive statistics of all variables employed in the analysis are provided in Table 1.

Demographic variables (*Demo*) included population density and the growth of female-headed families, both of which are needed to control for urbanization and account for the importance of recent household trends (Morris and Western 1999). Educational attainment (*Edu*) was measured using data on adult high school graduates (persons 25 years old and over with a high school diploma). This provides a proxy for the quality of human capital in a region which represents an important new (or endogenous) growth indicator (Ehrlich 1990) and a key factor involved in wage inequality. Socioeconomic characteristics (*SocioEcon*) of regional economic development included the Gini Coefficient of family income and the female labor participation rate, again needed to control for recent trends (Harrison and Bluestone 1988). Industry composition (*IndusCompo*) was represented by retail and service employment in 1980 to reflect economic restructuring to the service sector thought to be an important control (Chevan and Stokes 2000). A tax variable (*Tax*) based on property tax per capita in 1980 served as a proxy for general investment activities of local governments thought to be important in determining regional productivity and subsequent rates of change (Aschauer 1989; 1990, Keeler and Ying 1988; Krol 1995; Andrews and Swanson 1995; Morrison and Schwartz 1996; Boarnet 1998; Chandra and Thompson 2000).

For the amenity variables, this study employed principal component analysis (PCA) to condense a set of related amenity attributes into a smaller set of amenity scores. This approach allowed measuring and evaluating multiple natural amenities into five distinct groupings. These groupings included land-based, river-based, lake-based, warm weather-based, and cold weather-based amenities. These five amenity groups were incorporated to produce county-level amenity indices (1st principal component scores as identified in Table 2).[5] The specified model included state and urban/rural dummy variables used to capture possible spatial processes that remained after accounting for the specified characteristics above.

Empirical Results and Discussion

The Spatial Relationships of Natural Amenities. An exploratory spatial data analysis (ESDA) was conducted to highlight particular spatial features and to allow detection of spatial patterns. The ESDA included mappings of the five amenity indices, global Moran's I statistic for spatial correlation, Moran scatterplots, and local indicators of spatial association (LISA) for land-based natural amenity variables.

The mapping of the principal component scores allowed spatial interpretation and confirmation of natural amenity incidence. Overall, the maps of the five amenity groups

TABLE 1. DESCRIPTIVE STATISTICS AND SPATIAL AUTOCORRELATION.

Variable	Variable Definition	Mean	St. Dev.	Spatial autocorrelation Moran's I	p-value
	Dependent Variables				
POP_PC1	Total population change, 1980-1990	1.997	10.246	0.513	0.000
RSV_SPC1	Percent change of retail & service employment, 1980-1990	6.414	8.901	0.102	0.000
CAPI_PC1	Percent change of per capita personal income, 1980-1990	83.165	13.598	0.288	0.000
GINI8715	Net change of Gini index change, 1979-1989	26.487	8.883	0.485	0.000
	Independent Variables				
POPDEN80	Population density per square mile, 1980	138.72	434.45	0.230	0.000
FEMHH80	Percent of female-headed households, 1980	6.813	1.810	0.445	0.000
EDUMID80	Percent of high school graduates, 1980	39.96	3.463	0.336	0.000
GINI715	Gini index of family income, 1979	22.535	6.213	0.521	0.000
FEMLAB80	Percent of female labor participation, 1980	21.938	3.593	0.599	0.000
RSVC80	Percent of retail & service employment, 1980	49.77	8.139	0.220	0.000
P_TAX82	Percent of property tax per capita, 1982	0.133	0.340	0.545	0.000

D_MI	Dummy for Michigan state = 1, otherwise = 0	83*			
D_MN	Dummy for Minnesota state = 1, otherwise = 0	87*			
D_Metro	Dummy for metro county = 1, otherwise = 0	63*			
D_Rural	Dummy for rural county = 1, otherwise = 0	92*			
PC_LAND	1st principal component score of land-based amenity	0	1.000	0.732	0.000
PC_RIVER	1st principal component score of river-based amenity	0	1.000	0.428	0.000
PC_LAKE	1st principal component score of lake-based amenity	0	1.000	0.249	0.000
PC_WARM	1st principal component score of warm weather-based amenity	0	1.000	0.158	0.000
PC_COLD	1st principal component score of cold weather-based amenity	0	1.000	0.313	0.000

Note: * indicates the number of counties with a dummy variable of 1.

TABLE 2. FIVE NATURAL AMENITY ATTRIBUTES FOR PRINCIPAL COMPONENT ANALYSIS.

Amenity Variables	Variable Description	Eigenvectors
Land-based	**Cumulative variance explained**	**0.2598**
PVTAGAC	Acres of crop/pasture/range land (%)	–0.5548
FSACRE	USDA-FS Forest & Grassland acres (%)	0.4235
NRIFORAC	NRI non-federal forest acres (%)	0.5121
WildLand	NRI non-federal wildlife-reserved land acres in the county (%)	–0.1010
NPL_LAND	Rural land open to public for outdoor recreation	0.1895
RTCTRTM	RTC total rail-trail miles (%)	0.2577
STPARKS	State park acres (%)	0.1235
PKLOC	Local or county parks per 1Kpop	0.2355
ABIPARK	State parks per 1Kpop	0.2562
ISTEA	ISTEA funded greenway trails per 1Kpop	0.0417
River-based	**Cumulative variance explained**	**0.3536**
ABICANO2	Canoe/raft outfit/trip firms per 1Kpop	0.1805
AWAWHITE	AWA white-water river miles per 1K acres	0.3404
WSRIVER	Wild & scenic river miles per 1K acres	0.0549
RUNWATER	River & stream acres (%)	–0.0192
RIVERML	NRI river miles, outstanding value (per 1K acres)	0.5996
RIVRECML	NRI river miles eligible for recreation status (per 1K acres)	0.3555
RIVRVALU	NRI river miles w/recreation + scenic + wildlife value (per 1K acres)	0.6019
Lake-based	**Cumulative variance explained**	**0.3806**
ABIMARIN	Marinas per 1Kpop	0.3797
ABIFISH2	Fish camps/lakes/piers/ponds per 1Kpop	0.2934
OthWATER	Other water acres of reservoir + bay/gulf + estuary per (%)	–0.0302
LAKEBIG	NRI acres of lake >= 40 in size (%)	0.6085
WATERSML	SUM of small streams and water bodies (%)	0.2008
RECWATER	NRI acres devoted to water-based recreation (%)	0.5986
Warm Weather-based	**Cumulative variance explained**	**0.2116**
ABIPARKD	Parks and recreation departments per 1Kpop	–0.0830
ABITOUR	Tour & sightseeing operators per 1Kpop	0.3843
ABIPLAY2	Playgrounds & recreation centers per 1Kpop	–0.0804
ABISWIM2	Private & public swim pools per 1Kpop	0.0850
ABITEN2	Private & public tennis courts per 1Kpop	–0.1031
CAMPS	Organized camps per 1Kpop	0.4871
ABIGOLF2	Private & public golf courses per 1Kpop	0.3312
AMUSE	Amusement places per 1Kpop	0.3202
FAIR	Fairgrounds per 1Kpop	–0.0284
CAMPsite	WOODALLS private + public campground sites per 1Kpop	0.4821
ABITATT2	Tourist attractions/historic places per 1Kpop	0.3721

TABLE 2. (CONTINUED)

Amenity Variables	Variable Description	Eigenvectors
Cold Weather-based	**Cumulative variance explained**	**0.3944**
CCSFIRM2	XC ski firms and public centers (#/1Kpop)	0.4148
ISSSACRE	ISS skiable acreage (%)	0.2146
SNOWLAND	Federal acres in county w/ > 24 in snow (%)	0.3229
SNOWAG	Agricultural acres in county w/ > 24 in snow (%)	–0.3386
SNOWFOR	Forest acres in county w/ > 24 snow (%)	0.2664
SKIINFRA	ABI # skiing centers/resorts + tours + rentals per 1Kpop	0.4577
DOWNSKI	ISS # downhill skiing areas per 1Kpop	0.4186
WINTRAIL	Rail line miles converted to trails for winter recreation (%)	0.0988
SNOWMOBL	NPS # units + state park # w/ snowmobiling available per 1Kpop	0.3123

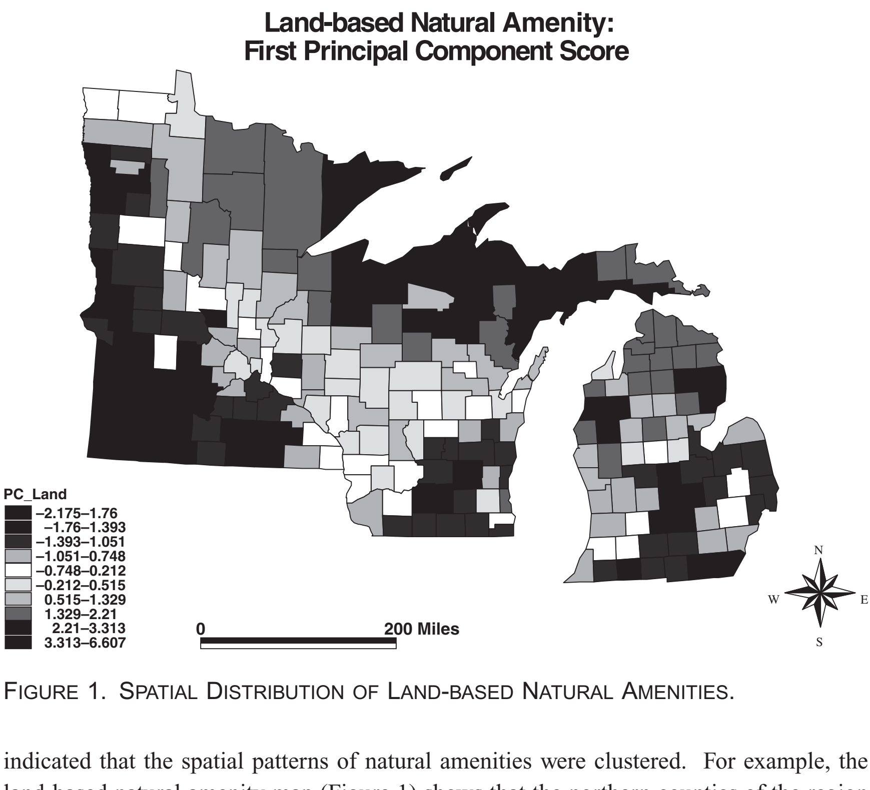

FIGURE 1. SPATIAL DISTRIBUTION OF LAND-BASED NATURAL AMENITIES.

indicated that the spatial patterns of natural amenities were clustered. For example, the land-based natural amenity map (Figure 1) shows that the northern counties of the region have higher principal component scores while the southern counties have lower scores.

Mapping the scores, however, is only visually descriptive. Quantitatively, the most common statistic for spatial clustering patterns is the Moran's I for spatial autocorrelation.[6] Moran's I is based on a comparison of the values of neighboring spatial units. This study measured Moran's I statistics of demographic, socioeconomic, and natural amenity variables (Table 1). Most demographic, socioeconomic, and natural amenity variables had positive spatial autocorrelations. Like the mapping of the principal component scores, this finding also shows statistically that natural amenities are clustered into spatial patterns within the study region.

A Moran scatter plot is a graphical presentation of the global Moran's I statistic.[7] The Moran scatterplot of a land-based natural amenity group appears in Figure 2. This Moran scatterplot of the amenity groups shows the positive spatial correlations that are reflected by the coefficients of the ***Wx***'s corresponding to the Moran's I statistics which are driven by the majority of the counties falling in quadrants I and III.[8]

The LISA is another way to detect spatial correlation (Getis and Ord 1996; Anselin 1995; Lee and Wong 2001).[9] A LISA is derived from spatial correlation between a spatial unit and its immediate neighbors. A high value of the local Moran's I statistic indicates a clustering of similar values (either high-high or low-low) and a low value of the statistic shows a clustering of dissimilar values (either high-low or low-high).

The LISA of the land-based natural amenity group, a local Moran's I statistic in this study, is presented in Figure 3. This map shows that the northern band of the region had

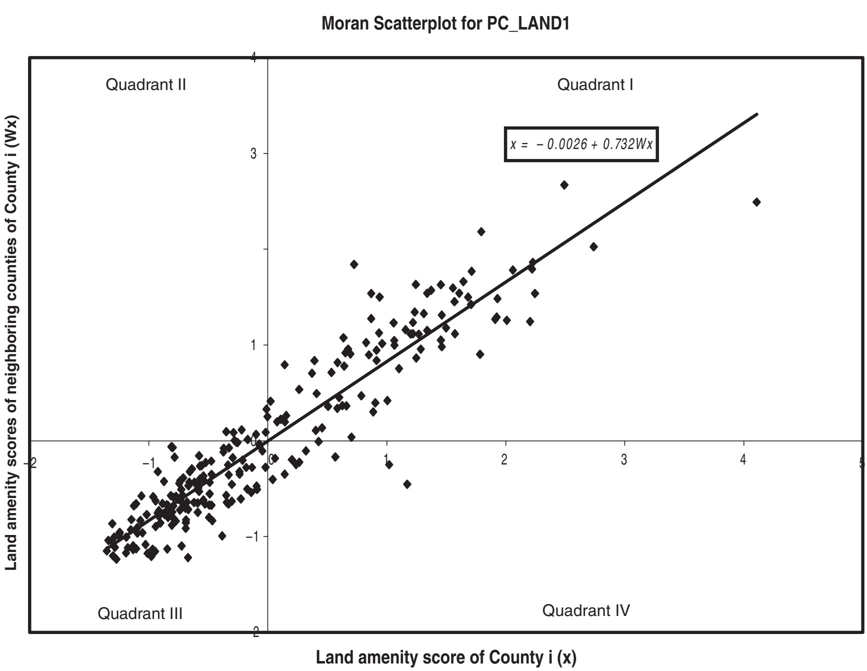

FIGURE 2. MORAN SCATTERPLOTS OF LAND-BASED NATURAL AMENITIES.

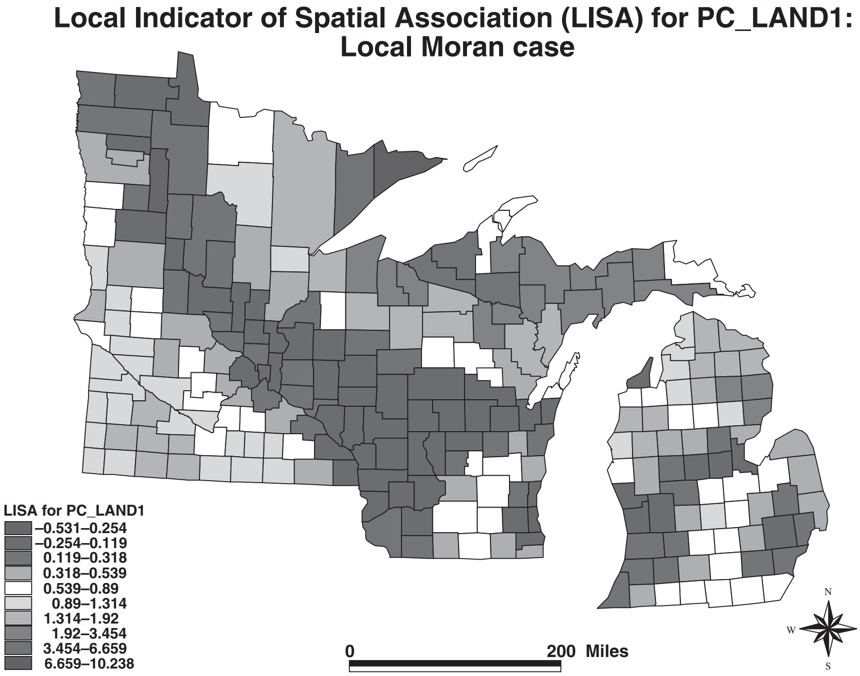

FIGURE 3. LOCAL INDICATORS OF SPATIAL ASSOCIATION (LISA) OF LAND-BASED NATURAL AMENITIES.

very similar land-based amenity values, while the northwest band had dissimilar values. Thus, the northern counties were 'hot pockets' of land-based natural amenities. The LISA maps indicated that the spatial patterns of natural amenities were clustered.

In sum, the ESDA analysis showed that demographic, socioeconomic, and natural amenity attributes were spatially associated. The spatial patterns of both human activities and natural amenities may be taken to validate the suggested spatial econometric model used in this study.

The Moran's I statistics of the error terms of the four empirical models were not significant (Table 3). The SEM specification, thus, successfully controlled for the spatial correlation of the error terms of the population growth model, the retail and service employment model, the per capita income growth model, and the Gini index change model. The 1980 population density variable (POPDEN80) did not have statistical associations with the four dependent variables. Results suggest that urban areas with higher population density in 1980 did not have different growth and income distributional profiles as compared to the rest of this research region during the 1980-1990 period.

Results of Modeling Amenity-led Development. The female-headed households variable in 1980 (FEMHH80) was associated with the growth and distributional profile in the

TABLE 3. ESTIMATION RESULT OF THE SPATIAL ERROR MODEL (SEM).

Model	Population Growth		Retail and Service Job Growth		Per Capita Income Growth		Gini Change	
Variables	$\hat{\beta}$	p-value	$\hat{\beta}$	p-value	$\hat{\beta}$	p-value	$\hat{\beta}$	p-value
Intercept	–44.01	**0.000**	–5.208	0.658	97.247	0.000	–1.133	0.850
POPDEN80	–0.002	0.180	–0.001	0.695	–0.001	0.722	0.000	0.815
FEMHH80	–1.100	**0.013**	1.548	**0.004**	–1.834	**0.011**	–0.585	**0.024**
EDUMID80	0.345	**0.034**	0.194	0.285	–1.022	**0.000**	0.290	**0.002**
GINI80	0.138	0.208	0.121	0.310	0.413	**0.011**	–0.795	**0.000**
FEMLAB80	1.340	**0.000**	–0.040	0.867	0.572	**0.080**	1.765	**0.000**
RSVC80	0.101	0.103	–0.265	**0.001**	0.119	0.250	–0.104	**0.005**
P_TAX82	–9.646	0.100	6.106	0.372	7.066	0.447	5.385	0.113
D_MI	6.046	**0.025**	–0.211	0.912	8.757	**0.001**	5.287	**0.000**
D_MN	–2.736	0.292	5.556	**0.003**	12.390	**0.000**	1.563	0.154

D_Metro	3.034	**0.049**	2.232	0.248	3.333	0.202	4.407	**0.000**
D_Rural	0.739	0.608	0.142	0.920	1.648	0.393	–2.603	**0.001**
PC_LAND	0.348	0.629	–0.162	0.816	0.626	0.511	–0.432	0.244
PC_RIVER	0.107	0.782	–0.542	0.218	–0.493	0.410	–0.089	0.687
PC_LAKE	0.196	0.583	0.706	**0.089**	0.882	0.118	–0.205	0.319
PC_WARM	0.373	0.313	0.348	0.448	0.492	0.428	–0.023	0.918
PC_COLD	–0.022	0.958	0.306	0.534	0.248	0.710	0.153	0.523
R^2[a]	0.392		0.235		0.400		0.813	
F-value[a]	9.032	**0.000**	4.310	**0.000**	9.327	**0.000**	60.76	**0.000**
Moran's I[b]	–0.089	0.970	0.000	0.915	–0.001	0.938	–0.008	0.927

[a] These statistics are based on the OLS estimations as a reference because the statistics are not available from the spatial econometric approach.

[b] Moran's I statistics were based on the residuals from the SEM estimations.

Note: Bold characters indicates significant at the $p < 0.1$ level.

region. Results suggest that during the 1980s, counties with a higher proportion of female-headed households in 1980 had slower growth rates of population and income, faster growth in the retail and service sectors, and negative association with the Gini income inequality index. A plausible interpretation could be related to the relatively higher proportion of females in retail and service sector tourism jobs which are generally of lower wage. The dampening effect on income inequality provides an obvious caveat and stresses the need for a closer examination of distributional structure.

Results of the models suggest a relationship between educational attainment and economic development. In our models, the high school education variable (EDUMID80) had a statistical association with the dependent variables of population density growth, per capita income growth, and Gini index change. Counties with higher proportions of high school graduates in 1980 tended to experience faster population growth, slower per capita income growth, and higher income inequality in the region. Thus, the high school educational premium, while significant, may not be a sufficient mechanism for income growth in the research region.

The Gini index variable (GINI80) had a statistical relationship only with the per capita income growth variable and the Gini index change variable. Our results suggest that counties with higher income inequality were those experiencing faster growth in per capita income. This somewhat contradictory set of findings suggests that inequality (or distributional) structure is a critical aspect of income inequality. Namely these results suggest that counties with higher income inequality had higher income growth but this growth was strongly skewed toward the upper-income classes up to and beyond the scaled upper-limit thus confirming the "hollowing out" conclusion of previous research (Leatherman and Marcouiller 1996, 1999; Marcouiller et al. 2004). In addition, counties experiencing growth in the proportion of female labor participation (FEMLAB80) experienced higher population growth, higher income growth, and faster change in income inequality during the study period.

The dummy variables showed the global spatial characteristics of aggregate growth and distributional profiles in the region. Metropolitan regions tended to have faster population growth than suburban regions. The jobs in the retail and service sector in Minnesota grew faster than those in Wisconsin during the 1980s. Both Michigan and Minnesota increased their per capita income faster than did Wisconsin. Change in income inequality was more rapid in Michigan than in Wisconsin. Metropolitan counties experienced faster change in income inequality than suburban counties, while rural counties saw relatively slower change in the distribution of income than suburban counties.

A key interest of this study dealt with the effects of natural amenity attributes on growth and distribution profiles within this regional economy. Results of our modeling suggest that the five natural amenity attributes were not significantly related with aggregate growth measures and had no significant associations with income distribution.

Unlike previous studies (McGranahan 1999; Deller et al. 2001) that showed strong positive effects of natural amenities on population growth, this study found that the five natural amenity attributes had no statistical association with population growth in the region during the 1980-90 period for the Great Lakes states of Minnesota, Wisconsin, and Michigan. While earlier OLS model results (not shown here) suggested significant land and cold site amenity variables, these statistical associations were not evident in the SEM specification. This reinforces the need for correcting spatially autocorrelated error structures when conducting regional economic analyses. Overall, our spatial modeling results suggest that natural amenities in this region did not induce population change during the 1980s.

During the 1980s, the retail and service sector in this region and the U.S. overall grew rapidly. As discussed at length above, natural amenities have been hypothesized to serve as latent factor inputs into the retail and service sector, especially recreational and tourism industries. Among the five natural amenity groups, only lake-related amenities had marginally significant positive association with employment growth in the retail and service sector during the 1980s. It is important to note that the research region has extensive lake-based natural amenities. Recreational use of lakes across this region may provide opportunities for retail and service sector job growth. This positive association with lake-based amenities is consistent with the findings of McGranahan (1999).

Natural amenities are usually discovered and distributed in regions where household income is relatively lower and more equally distributed. Thus, the potential relationship of natural amenities with income distribution may just be a spatial process resulting from earlier patterns of agglomeration, not an economic process as measured through employment or income growth. This study suggests that the dynamics of the natural amenity-driven distributional effects are complex and not necessarily linked through traditional metrics of regional economic structure.

Summary and Policy Implications

Our intent with this study was to develop a better understanding of the effects of natural amenities on economic growth and development. This was done within the context of natural amenities as a new growth engine appropriate to regions where traditional extractive industries have been in decline. Previous research suggests that natural amenities do indeed have significant effects on population, employment, and income growth.

Past research, however, has not addressed two important aspects of natural amenity research: the distributional effects on income and the spatial distribution of natural amenities. This study examined the distributional effects of natural amenities, along with their growth effects. In short, we expand the literature by explicitly introducing notions of economic development and move beyond simply examining economic growth. Spatial distribution of natural amenities was modeled into the empirical specification using a spatial error model.

We measured natural amenities using principal components analysis that produced five natural amenity groups. The exploratory spatial data analysis (ESDA) suggested that the spatial distributions of natural amenities were not random but were indeed spatially correlated. We then argued that research on natural amenities should take into account inherent spatial characteristics of natural amenities and should employ relevant analytical methods.

This study provided several important implications. Unlike previous studies that found positive growth effects of natural amenities, we did not find that natural amenities had strong associations with population, employment, and income growth. Only one amenity attribute—lakes—was positively related with retail and service sector employment. The other amenities were found to be insignificant at the county level.

This finding implies that natural amenities can vary significantly with respect to their ability to serve as new growth engines. Given the extensive presence of lake-related natural amenities in this region, there may be a certain level of quantity and quality of natural amenities that can affect aggregate economic growth of a regional economy. Unlike the findings of the previous studies that showed positive associations of natural amenities with aggregate economic growth measures, lake-related natural amenities in this research were only associated a with specific economic sector—the retail and service sector. This finding implies that different types of natural amenities have different effects on regional economic development.

Future studies on the effects of natural amenities on regional economic characteristics should search for and develop region-specific amenity measures that can reflect unique regional competitive advantages rather than across-the-board support for amenity-driven management action. This is particularly true for multi-functional (or multiple use) landscapes such as those which exist within rural forested regions that are dotted with lakes, ponds and streams. The manner in which rural lands are managed for jointly produced outputs (e.g., recreation and timber) requires objectivity when considering the set of alternative uses that have forward-linked impacts on regional value-added sectors (e.g., tourism and wood products manufacturing). Linkages between the environment and the economy are indeed better thought of as complex empirical questions than preconceived notions.

This research did not suggest the presence of robust evidence on the association of natural amenities with regional economic profiles. That is, we did not identify causal elements that linked natural amenity attributes with economic growth and income distribution. We found that economic growth variables were not strongly associated with natural amenities, indicating that the distributional effects of natural amenities might not be channeled through economic growth but may be a spatial process represented within spatial patterns of income distribution in a region.

Certainly, results of this modeling effort should be viewed as an incremental advance in our understanding of natural amenities and regional economic change. Ample opportunity for further research exists. We employed one of a variety of spatial econometric modeling approaches. Future research will employ alternative spatial econometric model specifications that could indeed provide different results. Our work employed one of a variety of empirical approaches to measuring natural amenity attributes. Our approach is not free from the empirical issues of subjectivity. Systematic and scientific measurement methods with more sound theoretical foundations can enhance our understanding of the effects of natural amenities and, again, provide ample opportunity for future research efforts.

One must also keep in mind that our analysis was limited to the upper Great Lake states of Michigan, Minnesota and Wisconsin. While there is significant heterogeneity in amenities across the region, it is predominantly a forested area with numerous lakes. A replication of this study to the mountain west or other regions in the U.S. may find different patterns in the relationship between amenities and economic growth and development.

Rural resource dependent regions are often found to lag behind their urban counterparts in both economic and socio-demographic metrics of community vitality. As the American economy continues to grow and develop the role of tourism and amenity-driven development appears to be a potential alternative to resource extraction and manufacturing. In the end the notion that "place in space" matters is driven home by considering amenities in rural economic growth and development. But this latter conclusion opens another important line of research that needs to be considered. Specifically, if place in space matters how do we formally model space? With our framework this would focus on the structure of the spatial weight matrix. Alternative approaches might be to explore the notion of travel cost modeling with respect to amenities.

Tourism offers hope of economic diversification while maintaining a general perception as being environmentally "friendly" or "benign." Many questions remain about the efficacy of tourism development as an economic strategy for rural resource dependent regions. Does the promotion of natural resource based recreational development result in the best jobs being described as "burger-flippers" or "chamber-maids"? Indeed, these questions of efficacy, equity, and community impact represent complex empirical questions that will increasingly demand creativity and innovation with respect to academically rigorous policy analysis.

NOTES

1. Another methodological problem with amenities is that their spatial patterns are usually independent of political or administration jurisdiction such as states, counties, or census tracts, the units which data are commonly reported. A possible mismatch between the geographical units and the spatial distribution of natural amenities being studied may result in misspecification problems and misleading policy implications (Doreian 1980, 1981; LeSage 1997; Anselin 1988; Anselin and Bera 1998). Spatial dependency and spatial mismatch of natural amenities require alternative methods to take into account the distinct spatial characteristics of natural amenities and provide ample opportunity for further research.
2. Regional clustering patterns are not limited to variables representing natural amenities attributes. According to Doreian (1980, 1981), most socioeconomic and demographic variables also tend to have positive spatial autocorrelation. We confirm this simple fact in our models (see the last two columns of Table 1 that show spatial autocorrelation of other socioeconomic variables.) Thus, spatial autocorrelation from variables employed in an empirical model should be controlled by either an implicit or explicit manner (see Anselin and Bera 1999).
3. For a discussion of an alternative weights matrix, see Cliff and Ord (1973), Bailey and Gatrell (1995, pp. 261-262), LeSage (1997), and Anselin and Bera (1998, pp. 243-245).
4. It is important to note a couple of empirical issues associated with the temporal specification of this model. First, to avoid a potential endogeneity problem, this model employed the beginning

period values of the RHS variables, while $\Delta EcoDev_i$ indicates the percent changes of the dependent variables between 1980 and 1990. Second, we use change estimates for variables with the exception of natural amenities assuming that natural amenity attributes have not changed over time because of a key natural amenity characteristic referred to as non-productibility (Green 2001). In other words, it is infeasible to produce or redevelop natural amenities in the short term.

5. The natural amenity data are from the 1997 National Outdoor Recreational Supply Information System (NORSIS) data set developed and maintained by the USDA Forest Service's Wilderness Assessment Units, Southern Research Station at Athens, Georgia.
6. Moran's I can be expressed as $I = \frac{n\sum\sum w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{w\sum(x_i - \bar{x})^2}$ where w_{ij}, an element of spatial weights matrix $\boldsymbol{W}$, is 1 if spatial units i and j share a border and 0 otherwise; $\boldsymbol{x_i}$ is the value of a spatial unit i and $\bar{\boldsymbol{x}}$ is the mean of the variable $\boldsymbol{x}$;, and N is the number of observations. If neighboring spatial units have similar values over the entire study region, then Moran's I indicates a strong positive spatial autocorrelation. If neighboring spatial units have very dissimilar values, Moran's I should show a strong negative spatial autocorrelation (Anselin 1988; Lee and Wong 2001).
7. The Moran scatterplot is based on a regression framework because Moran's I statistic can be interpreted as the degree of linear association between a value of a variable x in spatial unit i and a spatially weighted average of the neighboring values of the variable x, or spatial lag, $\boldsymbol{W}x$. Thus, the linear association between x and $\boldsymbol{W}x$ in the form of a bivariate scatterplot of $\boldsymbol{W}x$ against x is a Moran scatterplot (Anselin 1995, 1996).
8. The Moran scatterplot can be divided into the four quadrants to indicate different types of spatial association between the values of a location (x) and its spatial lag ($\boldsymbol{W}x$). Quadrants I and III represent positive spatial association because high-high and low-low values are associated, respectively. Quadrants II and IV indicate negative spatial association because low-high and high-low values are associated, respectively.
9. Anselin (1995, p.2) suggests that "a local indicator of spatial association (LISA) is any statistic that satisfies two requirements that include (a) the LISA for each observation gives an indication of the extent of significant spatial clustering of similar values around that observation and (b) the sum of LISAs for all observations is proportional to a global indicator of spatial association." A LISA, thus, can identify the existence of pockets or 'hot spots.'

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