Land Use Policy 100 (2021) 104883

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

The role of public lands in local economies of the US Lake States: A spatial simultaneous equation approach

Danya Kim[a,*], David W. Marcouiller[b]

[a] Department of Urban Design Information Engineering, Sungkyul University, Sungkyul-gwan 103, Sungkyul University-ro 53, Manan-gu, Anyang-si, Gyeonggi-do, Republic of Korea

[b] Natural Resources Institute, University of Wisconsin-Madison, 925 Bascom Mall, Madison, WI 53706, United States

ARTICLE INFO

Keywords:
Public Lands
Local economic growth
Spatial simultaneous equations model

ABSTRACT

Public lands in the United States are managed to conserve environmental resources. Serving as regional natural, historic, and/or cultural amenity endowments, these lands produce recreational opportunities for residents and exist as important regional attractants for visitors and residents thus serving as important stimuli for local retail and service sector firms. In this study, we examined associations between the presence of 13 different types of public lands with population and employment growth using a spatial simultaneous equations model for data covering 6,019 MCDs in the US Lake States region of Minnesota, Wisconsin, and Michigan. Results suggest that certain types of public lands were important determinants of local economic growth although these effects varied by time period. Among the thirteen types of public lands, national parks, national wildlife refuges, national recreation areas, state parks, and local parks were significant explanatory elements behind local economic growth. However, such public lands have differing and mixed effects on population and employment growth rates between the time periods 1990 – 2000 and 2000 – 2010.

1. Introduction

Public lands in the U.S. provide natural amenities and recreational opportunities for residents and visitors. These lands also provide environmental benefits through the conservation of wildlife and their habitats, clean water, biodiversity, and general ecosystem function (Cline et al., 2011; Lewis et al., 2003). With rising concern over environmental issues, policies to conserve and sustainably manage public lands have increased in the United States over the past three decades. For example, the Bureau of Land Management (BLM) and the U.S. Forest Service (USFS) adopted the Northwest Forest Plan (NWFP) in 1994 to restrict commodity production on public lands, and the USFS attempted to ban new road construction and commercial development on national forest land by establishing the 'Roadless Rule for National Forests' in 2001 (Lewis et al., 2003; Lorah and Southwick, 2003; Eichman et al., 2010).

Such policies have led to debates over whether increasing protections for public lands entail a tradeoff between jobs and the environment (Dobbs and Ober, 1995; Goodstein, 1999). Opponents of additional protections have argued that a reduction in the use of public lands for commodities would adversely and directly impact local economies by replacing high-wage jobs in resource-based industries with low wage jobs in the retail and service sectors (Patric and Harbin, 1998; Phillips, 2006) and consequently decrease earning power and the generation of local tax revenue. However, proponents of these policies have emphasized that increasing protections for public lands may improve local economies by providing access to natural amenities and recreational opportunities that attract new residents and tourists thus stimulating retail and service sector jobs, income growth, and economic diversification (Lorah and Southwick, 2003; Power, 1991, 1996; Power, 1991; Rasker, 1993; Rasker and Hackman, 1996; Niemi et al., 1999; Power and Barrett, 2001; Charnley, 2006). Also, proponents of increased regulation have argued that the overall effects of increased protection could be sufficient to offset negative effects of reduced job creation in manufacturing, logging, mining, and agriculture.

Although these issues have been vigorously debated for years, only recently have efforts been made to empirically explore the role of public lands in local and regional economic growth (c.f. Lewis et al., 2003; Cline et al., 2011; Lorah and Southwick, 2003; Eichman et al., 2010; Cordell et al., 1992; Duffy-Deno, 1997, 1998; Lewis et al., 2002; Rasker, 2006; Mockrin et al., 2018). Duffy-Deno (1998) quantified the effect of federally owned land designated as wilderness on employment and population density in 250 non-metropolitan counties of the eight states of the Intermountain West region. In this study, there were no

* Corresponding author.
E-mail addresses: dkim82@sungkyul.ac.kr (D. Kim), dave.marcouiller@wisc.edu (D.W. Marcouiller).

https://doi.org/10.1016/j.landusepol.2020.104883
Received 17 April 2019; Received in revised form 2 May 2020; Accepted 27 June 2020

observable significant effects on population and employment growth related to the proportion of federal wilderness areas. However, in an earlier study, Duffy-Deno (1997) found that state parks had a small effect on increases in population and employment densities in the same region. Lewis et al. (2003) also found that public lands managed for multiple uses (including extractive) had a significant positive effect on net migration, but not on employment and income growth in 92 non-metro counties in the northeastern United States between 1990 and 1999.

Eichman et al. (2010) found that land protection policies for public lands embodied in the Northwest Forest Plan had statistically significant but negative effects on employment growth in 73 counties of Oregon, Washington, and northern California, although these effects were offset by the positive effect on net migration. Cline et al. (2011) also showed that protected public lands can increase visitor expenditures by increasing recreational activities and tourism, although these can change land use patterns and restrict the use of natural resources. In addition, Mockrin et al. (2018) found that in-migration in the 2000s was positively correlated with the presence of public lands in Western non-metropolitan counties. They highlighted that population growth and housing growth was related to the presence of public lands in non-metropolitan US counties.

Public land management varies by administrative agency. For example, a large amount of federally owned public land in the United States is managed by the US Department of Interior within several agencies including the National Park Service (NPS), the Fish and Wildlife Service (USFWS), and the Bureau of Land Management (BLM). Further, the Forest Service (USFS) within the US Department of Agriculture (USDA) manages both National Forests and National Grasslands throughout the nation. State-level Departments of Natural Resources also manage parks and forestlands while local units of government are responsible for county and municipal parks, forests, and other locallly owned public lands. These public lands are classified based on their ownership and management characteristics (Cline et al., 2011). It is commonly accepted that these differing types of public lands experience differing uses and their effects on regional economies should not be expected to be the same. The purpose, research design, and analytical methods used to evaluate such effects have varied across previous studies (c.f. Lewis et al., 2003; Cline et al., 2011; Rasker and Hackman, 1997; Rudzitis and Johansen, 1991; Bergstrom et al., 1990; Frentz et al., 2004).

Of particular interest to estimate the associations of public lands with economic growth are disequilibrium adjustment and econometric models (c.f. Lewis et al., 2003; Duffy-Deno, 1997, 1998; Lewis et al., 2002; Rasker, 2006), survey-based approaches (c.f. Rudzitis and Johansen, 1991; Rudzitis and Johnson, 2000), input-output analyses (c.f. Bergstrom, 1990; Keith and Fawson, 1995), and econometric trend analyses (c.f. Rasker and Hackman, 1996; Power, 2001). This said, such studies have failed to consistently and conclusively observe significant effects on local economies. There are at least four potential reasons why previous studies have failed to find substantive local economic associations with the presence of public lands. First, few studies have focused on the differential effects of various types of public lands though Frentz et al. (2004) pointed out that population growth rates varied as a result of differing public land management strategies. Second, most studies have used classic simultaneous equations to control endogeneity bias and account for the interrelationship between population and employment jointly determined by public lands, but they have not considered spatial dependence. Consequently, the results may still be affected by estimation bias. Third, most previous research has relied on county-based data that is not relevant to planning and public policy making at the local level. Hence, previous research may provide limited information on the effect of public lands on local economies. Finally, previous studies generally have not considered changes in the economic effects of public lands over time because they relied on cross-sectional data.

To overcome these challenges, our study incorporates four distinct improvements. First, public lands are segmented into 13 different types including 8 types of federally administered lands (national forest, national park, national lakeshore, national monuments, national recreation area, national scenic riverway, national wildlife refuge, and federally protected wilderness), 3 types of state land (state forest, state park, and state recreation area), and 2 types of local land (local park and local recreation area). Second, we apply a spatial simultaneous equations model to control for spatial dependence. Third, we empirically use the Minor Civil Division (MCD) as the unit of analysis to broaden our knowledge of local economic associations with the presence of public lands. Finally, using US census data from 1990 to 2010, we examine how the economic effects of public lands have changed between the periods of 1990 – 2000 and 2000 – 2010 because economic growth patterns are different between these two periods (this will be discussed in the next Section).

To further clarify the objectives of this study, we address two research questions. First, how do various types of public lands have different effects on population change and employment growth? Second, to what extent do alternative public land types have differential effects on local economic growth over time? By answering these questions, the work reported here helps expand our understanding of the role of public lands in local economic growth. In addition, empirical findings are expected to support evidence from previous research on the effects of public lands on economic growth. Also, planning and policy implications can be drawn from this study, which will enable an exploration of management strategies for public lands that will improve local economies.

We have organized this paper into four sections. Followiing this introductionSection 2 presents the study area and data, and describes the methods and empirical approach used for analysis of the spatial data. In Section 3, we present the empirical results related to the effects of public lands on population and employment growth, and in Section 4, we discuss the findings and consider policy implications and directions for future research.

2. Data and methods

2.1. Study area and data

The study area used for this assessment includes the three U.S. Lake States of Michigan, Minnesota, and Wisconsin. Roughly 19 percent of the US Lake States exists as public land. The federal government controls approximately 8.8 million acres (7.3 % of the area managed by the USDA Forest Service, USDI Fish and Wildlife Service, and USDI Bureau of Land Management), state governments control approximately 14.5 million acres (11.3 % of the area managed as parks, forests, recreation areas and wildlife refuges) and local units of government (municipal and town) control 0.2 % of the area (Eagan, 2010; Gorte et al., 2012; Michigan DNR, 2013; Minnesota DNR, 2000). Federal, State, and local public lands provide natural amenity endowments, protect ecosystem function, and provide recreation opportunities that are important sources of economic development (Bergstrom and Cordell, 1990; Green et al., 2005).

In this study, we employed the minor civil division (MCD) as the unit of analysis. The analytical dataset consists of 6,019 MCDs across the three states. The MCDs (including towns, townships, villages, or cities) are mutually exclusive governmental and administrative units that are legal entities designated as county subdivisions of 28 states by the United States Census Bureau. In addition, MCDs are relatively stable from one decennial census to another and only present minor changes in their boundaries and areas over time. Michigan, Minnesota, and Wisconsin are strong MCD states because their MCDs are actively functioning units of local government that provide a wide range of public services suupported by local tax revenues. Thus, it is expected that using MCD data will allow for and provide more geographicallyspecific conclusions about local development planning policies with respect to public lands.

The data used in this analysis are compiled from a variety of primary and secondary sources. Population and employment data for the MCDs are acquired from the US Census Bureau; the population data from the DP-1 Demographic Profile; the 1990 and 2000 employment data from the DP-3 Economic Characteristics; and the 2010 employment data from the 2010 American Community Survey (ACS; 5-year estimates). The natural amenity characteristics and public land data are compiled from a variety of sources; the shoreline and water area information from the National Hydrography Dataset of the U.S. Geological Survey; the forest data from the National Land Cover Database of the US Geological Survey; and the wetland data from Michigan, Minnesota, and Wisconsin Departments of Natural Resources. The public land data come from the US Department of Agriculture (USDA), the US Fish and Wildlife Service, the US Forest Service, the US Bureau of Land Management, smart data compression in ESRI, and the Michigan, Minnesota, and Wisconsin Departments of Natural Resources (DNRs). Other variables such as educational attainment, median household income, and transportation networks are obtained from the US Census Bureau, 2010 ACS (5-year estimates), and the National Atlas of the United States. In order to adjust the minor changes in boundaries of MCD, we converted 1990 and 2000 MCD boundaries to 2010 MCD boundaries. All the attribute data were converted based on area. A detailed description of the data used in this study and their sources are summarized in Table 1.

2.2. Empirical model

Following regional disequilibrium adjustment models (c.f. Steinnes and Fisher, 1974; Carlino and Mills, 1987), an empirical structural model with two equations was developed to determine how public lands explain local differences in population and employment growth rates in the US Lake States region. Particularly, because population growth and employment growth are not only mutually interactive, but also have spatial spillover effects, we employ a spatial simultaneous equation model to deal with the two effects together. The basic equations are as follows:

$$\Delta P_{i,t} = f_P\left[(\Delta E_{i,t},\ W\Delta E_{i,t}),\ W\Delta P_{i,t},\ P_{i,t-1},\ |L_i,\ S_{i,t-1}\right]$$

$$\Delta E_{i,t} = f_E\left[(\Delta P_{i,t},\ W\Delta P_{i,t}),\ W\Delta E_{i,t},\ E_{i,t-1},\ |L_i,\ T_{i,t-1}\right]$$

where the two endogenous variables $\Delta P_{i,t}$ and $\Delta E_{i,t}$ represent population and employment growth rates at the MCDi between 1990 and 2000 and between 2000 and 2010, respectively; $P_{i,t-1}$ and $E_{i,t-1}$ are the initial or lagged population and employment densities in MCDi, respectively; L_i is the percentage of public lands in MCDi; and $S_{i,t-1}$ and $T_{i,t-1}$ are sets of additional lagged exogenous variables in the respective equations. For the estimation, a linear specification of the above basic model structure is represented as follows:

$$\Delta P_{i,t} = \alpha_0 + \alpha_1\,\Delta E_{i,t} + \alpha_2\left(\sum_{j=1}^{n} w_{ij}(\Delta P_{j,t})\right) + \alpha_3\left(\sum_{j=1}^{n} w_{ij}(\Delta E_{j,t})\right) + \alpha_4\, P_{i,t-1} + \sum_k \alpha_k L_{i,k} + \sum_l \alpha_l S_{i,l,t-1} + \varepsilon_i^P$$

$$\Delta E_{i,t} = \beta_0 + \beta_1\,\Delta P_{i,t} + \beta_2\left(\sum_{j=1}^{n} w_{ij}(\Delta P_{j,t})\right) + \beta_3\left(\sum_{j=1}^{n} w_{ij}(\Delta E_{j,t})\right) + \beta_3 E_{i,t-1} + \sum_k \beta_k L_{i,k} + \sum_l \beta_l T_{i,l,t-1} + \varepsilon_i^E$$

where i = 1,…6,019; α_1 and β_1 are the coefficients of the endogenous variables; α_2, α_3, β_2, and β_3 are the coefficients of the spatially lagged variables; α_4 and β_4 are the coefficients of the initial population and

Table 1
Data Sources.

Variable	Description	Data Source
Population Growth Rate	The rate of population growth: 1990 – 2000, 2000 – 2010	1990, 2000, 2010 U.S. Census DP-1 Demographic Profile
Employment Growth Rate	The rate of employment growth: 1990 – 2000, 2000 – 2010	1990, 2000 U.S. Census DP-3 Economic characteristics 2010 American Community Survey, 5 year estimates
Public Lands		
National Forest	The percentage of National Forest	USFS
National Park	The percentage of National Park	NPS
National Lakeshore	The percentage of National Lakeshore	NPS
National Monument	The percentage of National Monument	NPS, USFS, BLM, USFWS
National Recreation Area	The percentage of National Recreation Area	NPS, USFS, BLM
National Scenic Riverway	The percentage of National Scenic Riverway	BLM
National Wildlife Refuge	The percentage of National Wildlife Refuge	USFWS
Wilderness	The percentage of Wilderness	USFS, BLM, USFWS
State Forest	The percentage of State Forest	Michigan, Minnesota, and Wisconsin Department of Natural Resources
State Park	The percentage of State Park	
State Recreation Area	The percentage of State Recreation Area	
Local Parks	The percentage of Local Parks	Smart Data Compression in ESRI
Local Recreation Area	The percentage of Local Recreation Area	Smart Data Compression in ESRI
Natural amenities		
Shoreline	The length of lakes and major rivers divided by MCD areas (km/km2)	USGS 1999 National Hydrography 1:100,000
Wetland	The percentage of wetland area	Michigan, Minnesota, and Wisconsin Department of Natural Resources
Forest	The percentage of Forest area	USGS 2001 National Land Cover 1:24,000
Others		
Highway density	Total lengths of primary roads adjusted by MCD's area (km/km2)	National Atlas of the United States.
Distance to metro	Distance to nearest metro city (km)	Smart Data Compression in Esri, Fips Metropolitan Area (CBSA) code
Median household income	Median household income in 1990, 2000	19,902,000 US census DP-4 Housing characteristics 2010 American community survey-5 year estimates
More than Bachelor's degree	The percentage of population (age ≥ 25) with more than bachelor's degree in 1990, 2000	19,902,000 US census DP-3 Economic characteristics 2010 American community survey-5 year estimates

[1]NPS = USDI National Park Service; USFS = USDA Forest Service; BLM = USDI Bureau of Land Management; USFWS = USDI Fish and Wildlife Service.

employment values; α_k and β_k are the coefficients of the public lands variables; α_l and β_l are the coefficients of the lagged exogenous variables; k represents the number of specifically segmented public lands; l is the number of exogenous variables in the respective equations; ε_i^P and ε_i^E are disturbance terms; and w_{ij} is a measure of proximity between area i and j. An inverse distance-based weights matrix is used for the analysis because the study unit is the MCD whose centroid has an irregular distribution (Anselin et al., 2006) and thus certain spatial units are more clustered than others.

In inverse distance-based weights matrices, row standardizing has the advantage of using relative distance rather than absolute distance. Nearby MCDs are given a relatively greater weight, with the spatial interaction diminishing rapidly as distance increases. The measurement of the spatial weights matrix used in this study is described as follows:

$$w_{ij} = \begin{cases} 1/d^{\alpha}_{ij} \; if \; d_{ij} \leq C \\ 0 \; if \; d_{ij} > C \; or \; i = j \end{cases}$$

where C is a distance cutoff beyond which a spatial interaction between two units does not exist, d_{ij} is the distance between the centroids of MCD i and j, and α is a dampening coefficient. The choice of C and α is an empirical question. To determine which threshold distance of C and value of α are more appropriate in this analysis, we test with five distance cutoffs ranging from 20 to 40 miles (The value of C considered: 20, 25, 30, 35, 40 mile) and four values for α starting from 0.5 to 2. The values of 30 miles as a threshold distance and 1 as a dampening coefficient are more appropriate than other values because they fit the data better and provide consistent and robust results with the empirical model.

The econometric model used the Generalized Spatial Three-Stage Least Squares (GS3SLS) estimator developed by Kelejian and Purcha (2004) for estimations after diagnosing for spatial autocorrelation and spatial dependence. There are three reasons for choosing this empirical model. First, the dependent variables reflect mobile factors that respond to spatial variations in firm profitability and household utility, which adjust to an evolving general spatial equilibrium. Second, many previous studies have employed 3SLS to explore the effects of public lands on population and employment growth (Lewis et al., 2003, 2003); however, ignoring spatial dependence causes biased estimation results. Thus, spatial econometric techniques are needed to obtain consistent and precise estimation results. Third, this modeling approach permits simultaneous relationships between employment and population growth; in particular, it can investigate whether the positive effects of public lands on population or employment growth offset to the negative effects on employment or population growth.

2.3. Variables

As mentioned above, we use two jointly dependent variables, population and employment growth rates between 1990 and 2000 and between 2000 and 2010. There are substantial differences in the growth rates of population and employment between two time periods because an economic condition has changed from economic expansion (1990s) to economic downturn (2000s) (see Table 3). Thus, there is a need to assess changes in the economic effects of public lands over time. As shown in Table 3, average population growth rate was about 10.93 % in the 1990s, but average population growth rate in the 2000s was 2.48 %. In addition, average employment growth rate was about 43.47 % in the 1990s, but average employment growth rate in the 2000s was only about 3.57 %. This suggests that the economic growth patterns were different between these two periods. This likely reflects an economic boom in the 1990s and, due to the financial crisis, an economic downturn in the 2000s in the United States (Martin et al., 2016). To better understand the role of public lands on economic growth, two periods should be differently analyzed. A ten-year time period for dependent variables is considered appropriate because it is long enough to investigate medium to long-term equilibrium of simultaneous population and business migration by reducing the effects of short-term idiosyncratic changes (Ferguson et al., 2007; Jeanty et al., 2010).

Independent variables play a role in controlling for differences across MCDs that explain spatial variations in employment and population growth. To mitigate simultaneity and endogeneity bias, the initial 1990 and 2000 levels of independent variables are included in the model. The primary goal of this study was to examine differing effects of alternative public land types on economic growth. Because the role for each public land type has not been previously identified in local economies, public lands have been categorized according to ownership and specific types. They are first classified as national, state, or local public lands and then subdivided into 13 additional designations: federal land includes national forests, national parks, national lakeshores, national monuments, national recreation areas, national scenic riverways, national wildlife refuges, and wilderness areas; state land include state forests, state parks, and state recreation areas; and local land includes local parks and local recreation areas. In addition, it is assumed that the extent and type of public land in all MCDs of this study area has been constant during the study period. The available data do not readily enable investigating the time profile of public land disposition but ad hoc assessment and previous literature review (see Lewis et al., 2002) suggests the vast majority were acquired as a result of designation and/or tax reversion during the early to mid-1900s and have remained static for the past 50 years. While the Lake States has recently witnessed a limited number of mostly state and local-level parkland acquisitions, temporal assessment of public land is not deemed significant for this analysis and remains for further research over longer time periods. The geographic distribution of public lands in the Lake States region is shown in Fig. 1, which is worked using ArcGIS10.5. A generalized description for the various public land types assessed in this study are summarized in Table 2,3. The descriptions are from USFS, NPS, BLM, USFWS, DNR, and local governments in the US Lake States. The variables for public land by type are measured as public land area divided by the total land area of the MCD which represents the proportional coverage of each type of public land.

Specific focus of the work reported here is how alternative public land types affect population change and employment growth. For many people, public lands are amenities because they provide outdoor recreational opportunities, open space, and environmental quality-of-life (Phillips, 2006; Charnley, 2006). In this sense, public lands may contribute positively to migration. Also, according to an amenity-based model of development (Goodstein, 1999; Power, 1996), public lands enhance the attractiveness of the surrounding rural communities to attract tourists, new residents, and businesses that stimulate local economic development. Thus, public lands play an important role in amenity migration that attracts financial and human capital, tourists, and new businesses creating demand for additional jobs (Charnley, 2006).

Several independent variables were used in this model. These included natural amenities, human capital, transportation infrastructure, proximity to metropolitan areas, household income, and the percentage of employment in agriculture, forestry, fishing, and mining. In addition to public lands, other natural amenities are expected to play an important role in firm profitability and household utility in local communities (Roback, 1982). Empirical definitions of natural amenities vary widely because existing literature applies differing approaches to measuring regional amenity attributes. Examples include composite single indices to highly aggregated sets of factors (c.f. Green et al., 2005; Deller et al., 2001; Marcouiller et al., 2004; Kim et al., 2005; Chi and Marcouiller, 2013). There are not widely accepted standardized methods for measuring natural amenities. In this study, we useed three natural amenity variables from a previous study that focused on the Lake States region (Kim et al., 2005). These included shoreline, wetlands, and forests among a variety of natural amenity attributes and were selected to reduce the probability of autocorrelation among

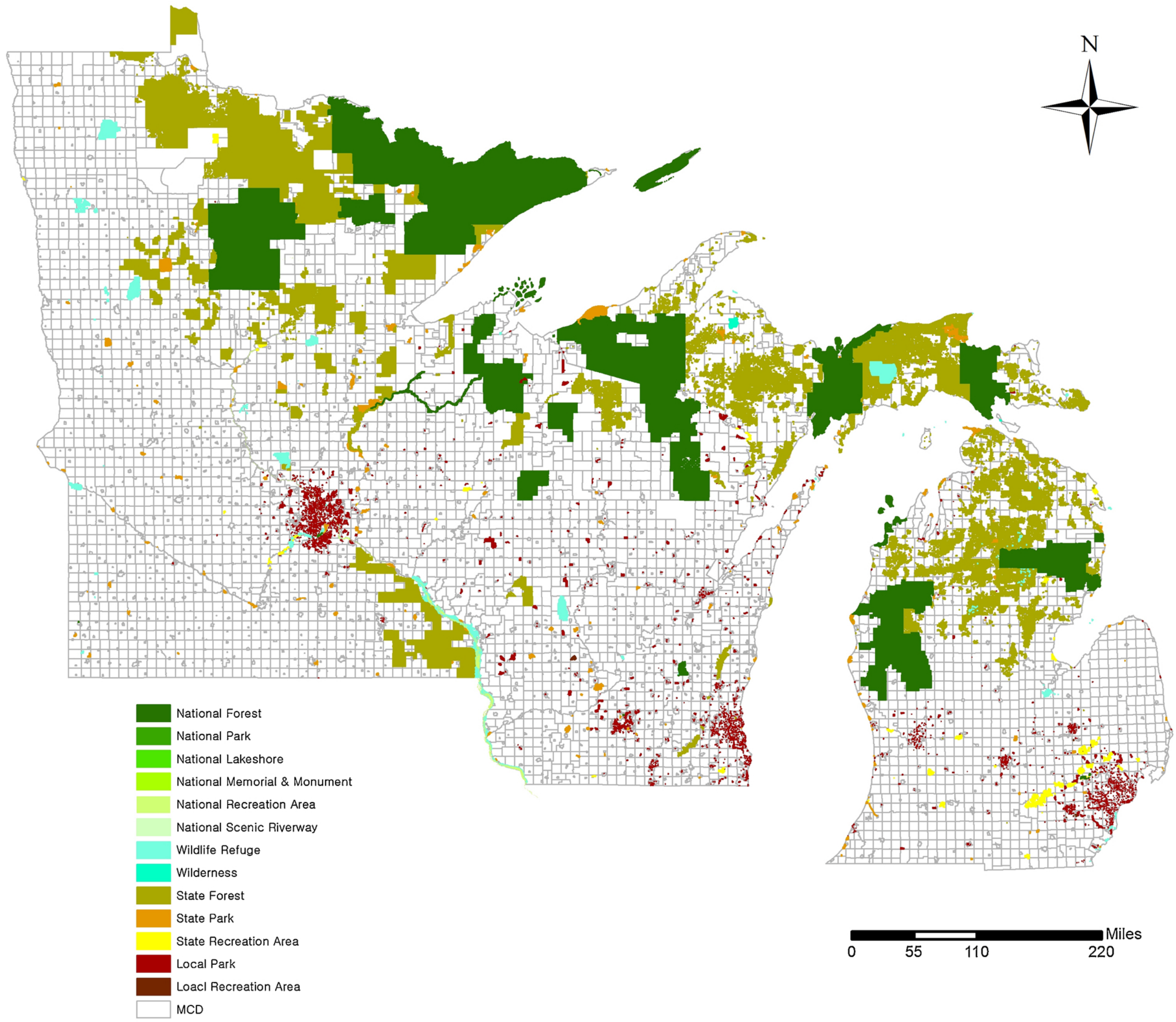


Fig. 1. Geographic Distribution of Public Land in the U.S. Lake States.

natural amenity variables (e.g. water area and shoreline). The shoreline density variable represented shoreline length of lakes and major rivers divided by MCD area. The wetlands variable represented the proportional coverage of wetlands and the forest variable represents the proportional coverage of forest within the MCD. Although they may overlap with public lands, there are differences in the accessibility between natural amenities and public lands. Thus, it is expected that the extent to which natural amenities have effects on economic growth differs from the effects of public lands. Also, given its geographic focus within the Lake States, our study does not consider other natural amenity variables that researchers have used in previous studies, such as climate (Rappaport, 2007) and coasts (Rappaport and Sachs, 2003).

Human capital or workforce quality is also important for local economic growth and was measured using the percentage of MCD residents older than 25 years with a bachelor's degree or higher (PEDU). This variable is included in both the population and employment growth equations. Highway density (HWD) represents the availability of transportation infrastructure and accessibility to markets and is included in both equations. Better accessibility enhances the regional attractiveness to households and firms; therefore, this variable is expected to have a direct positive effect on population and employment growth. Proximity to metropolitan regions has been a significant determinant of population growth in rural areas since the 1950s (Partridge et al., 2008). The regional economics literature suggests that agglomeration economies are associated with an increase in productivity of firms through labor market pooling, input sharing, and knowledge spillover (Rosenthal and Strange, 2001). Hence, easy access to urban amenities strengthens household utility and contributes to reducing a firm's production costs through agglomeration economics (Glaeser and Maré, 2001). In this study, distance to a metropolitan area (DIS_METRO) was used to control for the agglomeration effects on population and employment growth.

Median household income (MHI) is a proxy for retail consumer markets and the range of the consumer and is incorporated in the population growth equation. The percentage of employment in agriculture, forestry, fishing, hunting, and mining industries (AGFF) can allow us to examine whether or not the local economy still depends on extractive industries. It is an important factor for employment growth in the US Lake States because this region has traditionally been reliant on agriculture, timber, mining, and manufacturing for household income. This variable is expected to influence employment growth in the Lake States region. Descriptive statistics and variable definitions are summarized in Table 3.

3. Empirical results

Because of the use of spatially referenced data, spatial autocorrelations and spatial dependency may occur in the model residuals. Moran's I statistics and Lagrange multiplier (LM) diagnostics tests were performed to assess the extent of spatial autocorrelation and spatial

Table 2
Different types of public lands in the U.S. Lake States.

Types of public lands	Description and attributes	Agency
National Forest	Largely forest and woodland areas owned or controlled by the federal government. These areas are managed for multiple uses categorized as watershed protection, sustainable harvests of wood and other commodities (mining and grazing), wildlife, and recreation.	USFS
National Park	A Park operated by the federal government. Land management of this area focuses on outdoor recreational use and generally prohibits hunting, harvesting timber, mining, and other consumptive uses.	NPS
National Lakeshore	Coastal areas that are federally designated. They typically contain natural and recreational significance.	NPS
National Monument	Landmarks that memorialize historic people, event, or structures that commemorate something of national importance.	NPS, USFS, BLM, USFWS
National Recreation Area	Areas generally located near lakes or rivers and managed primarily for water-based outdoor recreational opportunities.	NPS, USFS, BLM
National Scenic Riverway	Natural places along significant rivers with abundant natural features and managed primarily for outdoor recreation.	NPS
National Wildlife refuge	A national network of lands and waters managed for the restoration of fish, wildlife, and plant resources and the conservation of their habitats.	USFWS
Wilderness	Areas to preserve the natural condition without permanent improvements or human influence.	USFS, BLM, USFWS
State Forest	Forest land owned by state agencies and managed for multiple uses including outdoor recreation, watershed and habitat preservation, and sustainable forest harvesting.	DNR
State Park	Lands owned by state agencies for their natural, historic, or cultural resources and managed for the protection and conservation of these resources for provision of outdoor recreational opportunities.	DNR
State Recreation area	An area of land controlled by the state and managed for the conservation of natural resources and the provision of recreational opportunities.	DNR
Local Park	Typically smaller parcels of land owned and managed by local units of government (e.g. cities, municipalities and towns) and used as open green spaces for recreation. Often these are highly developed recreational resources used predominantly by local residents.	Local government (e.g. municipality)
Local Recreation Area	A recreation area maintained by the local unit of government (e.g. cities, municipalities, and town) and used as open green space for recreation.	Local government (e.g. municipality)

[2]NPS = USDI National Park Service; USFS = USDA U.S. Forest Service; BLM = USDI Bureau of Land Management; USFWS = U.S. Fish and Wildlife Service; DNR = Department of Natural Resources.

dependence in the models. Test results suggest that global spatial autocorrelation are relatively weak but statistically significant in the models based on the Moran's I statistics (see Table 4). Additionally, the LM tests suggest that the spatial lag model provides more appropriate control of spatial dependence in the model residuals (see Table 4).

A correlation matrix of the explanatory variables is provided in Appendices A and B. In order to reduce multicollinearity, variables that were highly correlated with other variables were omitted from the final models (variables for local road density, state highway density, median housing value, etc.). Interpretation of diagnostic results confirmed that multicollinearity effects were not a major issue with the final specifications. In this section, we present and discuss the spatial simultaneous

Table 3
Descriptive Statistics and Variable Definitions.

Variable	Definition	Mean	Std.
ΔP (2000 − 2010)	The rate of population growth, 2000 − 2010	2.4892	22.0076
ΔP (1990 − 2000)	The rate of population growth, 1990 − 2000	10.9357	41.9795
ΔE (2000 − 2010)	The rate of employment growth, 2000 − 2010	3.5791	34.2486
ΔE (1990 − 2000)	The rate of employment growth, 1990 − 2000	43.4750	422.8798
POP_DEN (2000)	The number of total population divided by the MCD's Area (2000)	138.2313	297.0111
POP_DEN (1990)	The number of total population divided by the MCD's Area (1990)	139.6698	309.0478
EMP_DEN (2000)	The number of total employment divided by the MCD's Area (2000)	68.2962	148.4774
EMP_DEN (1990)	The number of total employment divided by the MCD's Area (1990)	68.6477	250.1721
N_FOREST	The percentage of National Forest	3.7217	17.2075
N_PARK	The percentage of National Park	0.0124	0.5388
N_LAKES	The percentage of National Lakeshore	0.0336	0.9101
N_MEMO	The percentage of National Monument	0.0003	0.0142
N_REC	The percentage of National Recreation Area	0.1190	1.2083
N_SCENIC	The percentage of National Scenic Riverway	0.0356	0.8690
N_WILDLIFE	The percentage of National Wildlife refuge	0.2979	2.8997
N_WILDERNESS	The percentage of Wilderness	0.0861	1.7448
S_FOREST	The percentage of State Forest	4.6090	16.3670
S_PARK	The percentage of State Park	0.2819	2.1413
S_REC	The percentage of State Recreation area	0.1332	1.7484
L_PARK	The percentage of Local Parks	0.3857	1.8669
L_REC	The percentage of Local Recreation Area	0.0149	0.4253
SHORELINE	The length of lakes and major rivers divided by MCD's area (km/km^2)	0.232	0.4073
WETLAND	The percentage of wetland area	11.8250	11.8544
FOREST	The percentage of forest area	12.2069	17.0625
PEDU (2000)	The percentage of population (age $\geq$ 25) with more than bachelor's degree (2000)	14.9726	9.4718
PEDU (1990)	The percentage of population (age $\geq$ 25) with more than bachelor's degree (1990)	11.2034	8.1447
HWD	Total lengths of primary roads adjusted by MCD's area (km/km^2)	0.1491	0.2791
DIS_METRO	Distance to nearest Metro Cities (km)	90.1821	81.4248
MHI (2000)	Median household Income (2000)	42022.85	12571.35
MHI (1990)	Median household Income (1990)	26650.19	9099.37
AGFF (2000)	The percentage of employment in Agriculture, forestry, fishing, hunting, and mining (2000)	8.9733	10.1298
AGFF (1990)	The percentage of employment in Agriculture, forestry, fisheries, and mining (2000)	14.3284	5.2186

Table 4
Diagnostics for Spatial Autocorrelation and Dependence in the Ordinary Least Squares Estimation.

	1990 – 2000		2000 – 2010	
	Population growth rate	Employment growth rate	Population growth rate	Employment growth rate
Moran's I	0.050***	0.075***	0.0950***	0.008***
Lagrange Multiplier (lag)	252.213***	471.620***	907.072***	11.699***
Robust LM (lag)	114.594***	64.146***	227.564***	3.490[a]
Lagrange Multiplier (error)	189.430***	424.020***	680.887***	7.496***
Robust LM (error)	51.811***	16.546***	1.379	0.593
N	6019	6019	6019	6019

[a] $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

equation estimates of population and employment growth rates over two time periods. The GS3SLS estimator developed by Kelejian and Purcha (2004) was used to estimate parameters of the system of simultaneous equations.

3.1. Empirical results for the period 2000 – 2010

The GS3SLS parameter estimates of the population and employment growth rate equations for the period of 2000 – 2010 are reported in Table 5. The estimated effect of employment growth rate on population growth rate is positive and highly significant, and the effect of population growth rate on employment growth rate is also positive and highly significant. These findings support the strong interdependency between population and employment growth rates at the MCD level. The estimated effects indicated that a 1% point increase in employment growth rate leads to a 0.73 % point increase in population growth rate and a 1% point increase in population growth rate leads to a 1.18 % point increase in employment growth rate. These results were consistent with the fundamental relationship between population and employment established by previous studies (Greenwood et al., 1986; Carlino and Mills, 1987) and suggest that migration had a stronger effect on job creation than job creation has on migration (Lewis et al., 2003).

The estimated coefficients for the spatial lag variables had positive and significant effects (W1y ΔP and W1y ΔE), indicating that population growth rates in MCDs were positively affected by population growth rates in neighboring MCDs and employment growth rates in MCDs were positively affected by employment growth rates in neighboring MCDs as well. The results suggest that population and employment growth rate in an MCD tends to have "spillover" effects on neighboring MCDs. However, the results also show a negative effect of W1y ΔP in the employment growth rate equation and a negative effect of W1y ΔE in the population growth rate equation. This suggests that higher population growth rates of neighboring MCDs were likely to lead to lower employment growth rates in a given MCD and higher employment growth rates of neighboring MCDs tended to have lower population growth rates in a given MCD. These results are consistent with economic theories and past empirical studies (Gebremariam et al., 2011). The interaction between population and employment in neighboring MCDs illustrates the competitive relationship between MCDs and suggests meaningful policy implications that land use policies or

Table 5
Estimation Results for the Population and Employment Growth Rates Model.

	1990 – 2000						2000 – 2010					
	Population Equation			Employment Equation			Population Equation			Employment Equation		
	Coef.		t-stat	Coef.		t-stat	Coef.		t-stat	Coef.		t-stat
ΔP				1.5533	***	2.58				1.1755	***	15.12
ΔE	0.0338	***	3.07				0.7347	***	15.13			
W1yΔP	3.6056	***	14.55	−1.5364		−0.40	2.7253	***	9.72	−3.026	***	−6.43
W1yΔE	−0.1305	***	−3.40	2.8429	***	8.30	−1.2386	***	−7.01	1.7224	***	7.25
POP_DEN	−0.0069	***	−3.22				0.0008		0.67			
EMP_DEN				−0.0603	**	−2.57				−0.0023		−0.69
PEDU	0.0859		0.98	−3.1394	***	−4.32	0.0503		1.35	−0.0861	*	−1.82
MHI	−0.00001		−0.08				0.00002		0.91			
AGFF				0.9637	*	1.72				−0.0192		−0.49
SHORELINE	−0.018		−0.01	10.0192		0.74	3.8866	***	5.09	−4.7023	***	−4.23
WETLAND	−0.1627	***	−3.17	−0.40		−0.75	0.0064		0.23	−0.025		−0.63
FOREST	0.0213		0.59	0.1693		0.47	0.0266		1.43	−0.0336		−1.28
N_FOREST	0.0133		0.4	−0.0431		−0.13	−0.0003		−0.02	−0.0036		−0.14
N_PARK	4.7904	***	4.82	1.3249		0.12	0.1476		0.28	−0.3737		−0.50
N_LAKES	−0.1858		−0.32	1.6698		0.28	0.2751		0.89	−0.3383		−0.77
N_MEMO	0.6905		0.15	3.4865		0.08	−26.6791		−1.36	32.7958		1.17
N_REC	−0.1718		−0.36	−5.1388		−1.07	−1.4786	***	−5.65	1.8312	***	4.84
N_SCENIC	0.4004		0.7	−2.0592		−0.36	−0.2007		−0.63	0.2104		0.46
N_WILDLIFE	−0.0986		−0.49	3.0406		1.54	0.2459	**	2.35	−0.2689	*	−1.77
N_WILDERNESS	0.1536		0.5	−0.2259		−0.07	−0.0956		−0.58	0.1528		0.65
S_FOREST	0.054		1.57	−0.1411		−0.41	−0.0041		−0.23	0.0061		0.23
S_PARK	0.4119		1.63	−1.9811		−0.77	0.2572	*	1.93	−0.3717	**	−1.99
S_REC	0.0024		0.01	4.5855		1.46	−0.1609		−0.97	0.2068		0.87
L_PARK	−0.2988		−0.83	24.0621	***	8.15	−0.2721	*	−1.68	0.2919		1.24
L_REC	−0.0806		−0.06	−3.4412		−0.27	−0.0055		−0.01	−0.0855		−0.09
HWD	0.6849		0.35	16.667		0.84	0.4475		0.40	−0.0763		−0.05
DIS_METRO	0.0033		0.39	−0.0364		−0.44	−0.0101	*	−1.95	0.0047		0.64
cons	−6.4026	***	−8.79	−8.0013	**	−2.11	−6.156	***	−4.87	5.7125	***	3.47
$nR^2 \sim X^2_{(24,24)}$[a]	15.35	***		17.35	***		51.9	***		31.43	***	
R^2 (SqCorr) [b]	0.0541			0.0612			0.2675			0.1082		
N	6019			6019			6019			6019		

[3] a: 24, 24 represent the degree of freedoms which are equal to the over-identifying restrictions in the population, employment equations, respectively; b: Squared correlation between predicted and observed dependent variables.
* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

approaches are required at broad regional scales rather than at the local or MCD scale because of economic spillovers among MCDs.

As discussed above, a primary objective of this study was to examine how public lands influenced local economic growth. As noted, results on the effect of public lands were mixed. Among federal public land variables, the estimated effect of federal recreation area proportions was -1.4786 and highly significant in the population growth rate equation. In the employment growth rate equation, the effect of the percentage of federal recreation area was 1.8312 and highly significant. The findings suggest that the effect of the proportion of federal recreation areas reduced population growth by 1.48 % and increased employment growth by 1.83 % for every 1 % of national recreation area that is shared with the land area of an MCD during the 2000 − 2010 period. That is, a higher percentage of recreation areas managed by federal entities was more likely to attract jobs but less likely to encourage population growth in MCDs. In contrast to the results of federal recreation areas, the estimated coefficient of the percentage of federal wildlife refuges was 0.2459 and significant (t = 2.35) in the population growth rate equation. In the employment growth rate equation, the coefficient of federal wildlife refuges was -0.2689 and marginally significant (t = -1.77). In other words, MCDs with a greater percentage of federal wildlife refuges experience greater population growth, whereas employment growth tends to decline in these MCDs. The magnitude of the coefficients suggests that, all else equal, MCDs with federal wildlife refuge proportions 1 % higher experience a 0.25 % higher population growth rate and 0.27 % lower employment growth rate. These results can be explained by characteristics of federal wildlife refuges. These lands provide amenities contributing to overall quality-of-life for residents but also act as a greenbelt that prevents private sector land development (Power, 2001).

In terms of state managed public lands, the estimated effect of state parks was 0.2572 and marginally significant (t = 1.93) in the population growth rate equation. In the employment growth rate equation, the effect of state parks was − 0.3717 and statistically significant (t = − 1.99). Results suggest that these lands are associated with effects that encourage population growth but discourage job growth. This is probably because state parks are generally intended to protect places of natural, historic, or cultural interest. Hence, the percentage of state parks as an amenity may lead to an increase in population growth but a decrease in employment growth. In terms of local public lands, the estimated effect of the percentage of local parks on population growth rates was negative and marginally significant (t = -1.68). These results suggest that population growth is likely to decline in the MCDs with a greater percentage of local parks which runs counter to most conventional wisdom. The remaining coefficients of the public land types were not statistically significant, indicating that the corresponding variables do not significantly affect economic growth.

Among the assessed natural amenities, the estimated coefficient on shoreline density was positive and highly significant in the population growth rate equation, indicating that MCDs with greater shoreline densities experienced higher population growth rates. This result may be explained by retirement and recreational migration or a growing demand for higher-end residential developments close to lakes and rivers. In contrast, the estimated coefficient on shoreline density waa negative and significant in the employment growth rate equation. This finding suggests that MCDs with higher shoreline densities experienced lower employment growth rates. In general, shorelines are not typically owned publicly for recreation and thus provide primarily private opportunities for outdoor recreation. Consequently, these sites may not be attractive to short-term destination tourists, which may lead to the negative result on local employment growth, especially in tourism-related sectors.

The effect of the percentage of population with a bachelor or higher degree was negative and marginally significant (t = − 1.82) in the employment growth rate equation. MCDs that have a greater percentage of people with a bachelor's degree and above experienced lower employment growth rates. One of the possible reasons for this may be that types and number of tourism-related jobs created in the Lake States do not require skills related to higher levels of education. The estimated coefficient on distance to metropolitan areas had a significant negative effect on population growth rates (t = − 1.95), indicating that MCDs farther distant from metropolitan regions tended to experience lower rates of population growth during the 2000 − 2010 period. This finding was consistent with the migration literature (Rosenthal and Strange, 2001) which demonstrates that both agglomeration and amenity effects are more important in urban and suburban areas.

3.2. Empirical results for the period 1990 − 2000

The GS3SLS estimation results from 1990 to 2000 can also be compared to results from 2000 − 2010 in Table 5. Initial conditions played a significant role in explaining population and employment growth during the 1990 − 2000 period. The estimated effect of initial population on population growth rate was negative and significant and the effect of initial employment on employment growth rate was also negative and significant. Results suggest that MCDs with higher levels of population and employment at the beginning of the period (1990) tended to experience lower rates of population and employment growth. These can be explained by growth convergence and are consistent with the results of previous research (Deller et al., 2001).

Results clearly show that various types of public lands have differing effects on population and employment growth rates between the periods of 1990 − 2000 and 2000 − 2010. National parks played an important role in explaining population growth from 1990 to 2000; results suggest that the higher percentage of national parks encourage population growth during the 1990s; however, they had no significant effect from 2000 to 2010. In addition, the percentage of local parks in MCDs had a significant and highly positive effect on job growth rates in the 1990s based on the result that MCDs with a greater percentage of local parks experience higher employment growth rates during the 1990 − 2000 period. In addition, the coefficient for percentage of wetlands had a significant and negative effect on population growth from 1990 to 2000. This is likely due to restrictions on building in wetlands that drove away housing construction to neighboring MCDs. However, the effect of wetland was not significant in the 2000s. These findings suggest that the effects of public lands and natural amenities can be differ through time because life style, personal preferences, and economic structure are dynamic. More detailed analysis is warranted and remains for future research.

The effect of educational attainment (percentage of the population with a bachelor's degree and above) had a significant negative effect on employment growth rate during the 1990 − 2000, which was consistent with the results from 2000 to 2010. Another interesting finding is that the percentage of employment in agricultural, forestry, fisheries, and mining industries had a significant and positive effect on employment growth rate from 1990 to 2000. This suggests that MCDs with a higher percentage of employment in traditional commodity-based industries tended to experience higher job growth rates. Such growth is related to a higher share of extractive industries in the Lake States region, which was an important determinant that enhanced local economic growth in the 1990s but not the 2000s. This is likely due to technological innovations in traditional commodity-based industries, which consequently led to job declines in these industries during this period (Bell and York, 2010).

3.3. Estimation results with the aggregated public lands

To examine the effects of public lands on population and employment growth rates at the aggregated level, we combined public lands at the national, state, and local levels. Table 6 shows the estimation results. N_P_LAND, S_P_LAND, and L_P_LAND denotes national, state, and local public lands, respectively. Our results show that there was no

Table 6
Estimation Results for the Population and Employment Growth Rates Model (aggregated public lands).

	1990 – 2000						2000 – 2010					
	Population Equation			Employment Equation			Population Equation			Employment Equation		
	Coef.		t-stat	Coef.		t-stat	Coef.		t-stat	Coef.		t-stat
ΔP				1.1570		0.97				1.1918	***	15.27
ΔE	0.0063		0.58				0.7804	***	15.51			
W1yΔP	3.5682	***	13.31	2.7785	***	7.39	2.4554	***	8.08	1.6761	***	7.10
W1yΔE	0.1604	***	3.71	3.7445		0.90	−1.2883	***	−6.89	−2.8515	***	−6.10
POP_DEN	−0.0001	***	−3.34				0.0000		0.93			
EMP_DEN				−0.0006	**	−2.54				0.0000		−0.84
PEDU	0.0888		1.01	−3.1201	***	−4.31	0.0700	*	1.85	−0.1033	**	−2.20
MHI	0.0000		−0.23				0.0000		0.86			
AGFF				0.5067		0.80				−0.0067		−0.19
SHORELINE	−0.0012		−0.09	0.1285		0.97	0.0310	***	3.99	−0.0369	***	−3.47
WETLAND	−0.1679	***	−3.27	−0.3116		−0.57	0.0316		1.09	−0.0453		−1.17
FOREST	0.0216		0.60	0.0950		0.26	0.0254		1.30	−0.0303		−1.16
N_P_LAND	0.0216		0.70	0.0630		0.20	−0.0057		−0.33	0.0064		0.27
S_P_LAND	0.0636	*	1.88	−0.1429		−0.41	−0.0050		−0.27	0.0062		0.24
L_P_LAND	−0.1639		−0.42	23.3358	***	8.12	−0.2534		−1.52	0.2864		1.26
HWD	0.0064		0.33	0.1591		0.79	−0.0035		−0.30	0.0071		0.45
DIS_METRO	0.0002	*	1.84	−0.0002		−0.20	0.0000		−0.71	0.0001		0.79
cons	−0.3661	***	−8.39	−1.1905	**	−2.40	−0.0536	***	−4.19	0.0528	***	3.25
$nR^2 \sim X^2_{(15,15)}$ [a]	23.5	***		15.97	***		56.93	***		37.12	***	
R^2 (SqCorr) [b]	0.0571			0.0667			0.3775			0.1018		
N	6019			6019			6019			6019		

[3] a: 15, 15 represent the degree of freedoms which are equal to the over-identifying restrictions in the population, employment equations, respectively; b: Squared correlation between predicted and observed dependent variables.
* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

significant effect of federally administered public lands in the 2000s. This is probably because sub-categories of federal lands have differing characteristics. Hence, empirical analysis at the aggregated level may not provide accurate impacts of federal public lands, especially during the 2000s. Nevertheless, state public lands were significantly associated with population growth while local public lands were significantly related to employment growth in the 1990s. One possible reason is that state public lands, such as state parks, are generally intended to protect places of natural, historic, or cultural interest. Hence, state parks as an amenity may lead to an increase in population growth, but a decrease in employment growth. Local public lands were significantly associated with employment growth.

3.4. Estimation results with samples of Northern Lake States

As shown in Fig. 1, there are substantially more public lands in the northern parts of the Lake States than the southern parts of those states. To estimate effects of public lands on population and economic growth in northern parts, we conducted the same analysis with samples of only northern parts of the states (see Appendix C). Table 7 shows the estimation results. In the 1990s, national park, national monument, and state forest hade positive effects on population growth, while national parks had positive effects on employment growth. In contrast, national forest and national park had negative effects on population growth, but national wildlife refuges had a positive effect on population growth in the 2000s. Particularly, results suggest that effects of public lands on population and employment growth were much stronger in the northern Lake States in both decades. Note from the results that values of some coefficients, especially national parks, were much larger in models of northern parts as compared to models with the entire sample (R2 is also much improved). This suggests that public lands, such as national parks, in the northern Lake States were significant attractants of resident migrants as well as visitors for outdoor recreation.

A notable result of this analysis focused on remoteness. In the northern part of the Lake States, distance to metropolitan region (or remoteness) was negatively associated with population and employment growth in the 1990s. As shown in Table 5, this variable was not significant in the analysis with the entire samples. This indicates that proximity to metrowas a significant hindrance to population and employment growth in the rural northland with abundant public lands as shown in Table 7.

4. Conclusions and policy implications

In this study, we examined associations between the presence of different types of public lands with population and employment growth using a spatial simultaneous equations model for data covering 6,019 MCDs in the US Lake States of Minnesota, Wisconsin, and Michigan. Results suggest that certain types of public lands were important determinants of local economic and population growth during the decades of the 1990s and 2000s although these effects varied by time period. Among the thirteen types of public lands, national parks, national wildlife refuges, national recreation areas, state parks, and local parks were significant explanatory elements behind local economic growth. Notably, such public lands had differing and mixed effects on population and employment growth rates between the two decades (1990 – 2000 and 2000-2010).

Specifically, the effect of national parks on population growth rates and the effect of local parks on employment growth rates during the 1990s were positive and significant at any reasonable confidence level (Table 5). The importance of these effects suggests that MCDs with a higher percentage of national parks experienced population growth while MCDs with a greater percentage of local parks tended to experience higher employment growth rates during the 1990s. For the 2000 – 2010 period, effects of national wildlife refuges and state parks on population growth rates were positive and significant whereas the effects on employment growth rates were negative and significant. These findings suggest that a higher percentage of national wildlife refuges and state parks directly encourages population growth while directly decreasing employment growth during the 2000 – 2010 period. Such negative effects on employment growth rates may be offset partially by the positive effect on population growth rates because of the simultaneous determination of population and employment growth rates. In contrast, federal recreation areas were found to have a

Table 7
Estimation Results for the Population and Employment Growth Rates Model (northern parts of the Lakes States).

	1990 − 2000						2000 − 2010					
	Population Equation			Employment Equation			Population Equation			Employment Equation		
	Coef.		t-stat	Coef.		t-stat	Coef.		t-stat	Coef.		t-stat
ΔP				−5.3762	***	−7.28				0.6182	***	2.56
ΔE	−0.0302	***	−3.23				0.1960	***	4.018			
W1yΔP	3.8630	***	14.47	5.2393	***	5.47	6.3540	***	11.270	3.7223	***	4.41
W1yΔE	0.0389		0.34	21.4919	***	5.86	−0.3532		−1.004	−2.7557		−1.30
POP_DEN	−0.0003	***	−6.65				0.0000		0.295			
EMP_DEN				−0.0051	***	−5.21				−0.0003		−1.45
PEDU	0.1047		1.16	−0.2528		−0.30	0.0369		0.691	−0.3138	**	−2.40
MHI	0.0001		−0.20				0.0001	***	4.044			
AGFF				0.3259		0.70				−0.0930		−0.77
SHORELINE	0.0598	***	3.66	0.3729	**	2.26	0.0026		0.232	0.0149		0.50
WETLAND	−0.1980	***	−4.91	−1.5777	***	−3.80	−0.0774	***	−2.632	−0.1470	*	−1.85
FOREST	−0.0213		−0.71	0.2859		0.99	0.0597	***	3.055	−0.0521		−0.98
N_FOREST	0.0035		0.18	−0.0847		−0.43	−0.0249	*	−1.848	−0.0331		−0.90
N_PARK	5.1526	***	9.11	35.4631	***	5.37	−0.6510	*	−1.753	−0.8005		−0.79
N_LAKES	−0.2468		−0.74	−0.8779		−0.26	0.0903		0.412	−0.0692		−0.12
N_MEMO	84.1245	*	1.81	524.8565		1.13	−6.5523		−0.217	−33.5523		−0.41
N_REC	0.0043		0.00	−6.7973		−0.33	−0.5091		−0.412	−3.9382		−1.19
N_SCENIC	0.4887		1.53	1.9226		0.60	−0.1189		−0.523	−0.1585		−0.26
N_WILDLIFE	−0.1395		−0.64	−0.7925		−0.37	0.2596	*	1.798	−0.2749		−0.70
N_WILDERNESS	0.0926		0.53	0.5576		0.32	0.0909		0.769	0.2651		0.83
S_FOREST	0.0871	***	3.28	0.4014		1.48	0.0190		1.094	0.0074		0.16
S_PARK	0.0501		0.28	0.0573		0.03	0.0170		0.145	−0.5293	*	−1.71
S_REC	−0.3303		−1.13	−2.7051		−0.93	−0.1835		−0.948	0.0059		0.01
L_PARK	0.8064		0.89	4.2076		0.47	−0.9061		−1.496	−0.9108		−0.55
L_REC	−42.9724		−0.18	120.7850		0.05	−20.9094		−0.130	61.6098		0.14
HWD	−0.0358		−1.39	0.2163		0.83	0.0085		0.490	0.0257		0.55
DIS_METRO	−0.0001	**	−2.12	−0.0021	***	−3.39	0.0001		1.541	−0.0002		−1.18
cons	−0.0532		−1.39	−0.7469	**	−2.32	−0.1106	***	−4.715	0.0888	**	2.32
$nR^2 \sim X^2_{(24,24)}$ [a]	28.17			15.25			15.88			13.15		
R^2 (SqCorr) [b]	0.1350			0.3636			0.1210			0.0703		
N	2046			2046			2046			2046		

[3] a: 15, 15 represent the degree of freedoms which are equal to the over-identifying restrictions in the population, employment equations, respectively; b: Squared correlation between predicted and observed dependent variables.
* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

negative effect on population growth rate while the effect on employment growth was found to be positive. These significant effects of federal recreation areas indicate that a greater percentage of these lands were associated with declines in population growth and increases in employment growth during the 2000 − 2010 period. These results also suggest that positive effects on employment growth serves to offset negative effects on population growth.

These findings provide additional empirical evidence that contributes to existing literature on the relationships between economic indicators and public lands by finding differential effects by alternative public land types on population and employment growth. Earlier studies found that public landshad positive effects on population growth and insignificant or minor effects on employment growth. However, findings from this study suggest that national parks, national wildlife refuges, and state parks had statistically significant and negative effects on employment growth while federal recreation had positive effects on employment growth. Also, results suggest that certain types of public lands have become more important determinants of local economic growth during the 2000 − 2010 period in comparison with the effects of public lands during the 1990 − 2000 period. That may be explained by the notion that demand for amenities has increased since 1990 and thus public lands with opportunities for outdoor recreation have become more important motivators for rural tourism and overall amenity migration.

Several policy implications can be drawn from the findings of this study. First, results suggest that population growth and employment growth tend to spill over to neighboring MCDs. These spillover effects clearly suggest that connections and cooperation between different local units of government located close to public lands could generate more productive and efficient regional economic development outcomes. States, counties, and affiliated local planning agencies should encourage frameworks to foster cooperation between local governments. Based on regional development agendas, horizontally aligned intergovernmental efforts could more effectively manage local benefits derived from public lands and jointly promote economic development strategies. Local governments commonly share public lands managed by federal or state governments through payments in lieu of taxes. Joint efforts could logically play an important role in strengthening small or economically weak MCDs through policy integration.

Second, important policy implications involve strategies that address management of public lands associated with multiple use for local economic development. Multiple use resource management can act to secure multiple outputs including commodity resources (timber, minerals, livestock grazing, etc.) as well as recreation and ecosystem function. Combining complementary timber managmenet strategies with recreational uses as multifunctional rural landscapes enhances opportunities that foster local economic growth. This concept of multiple use is in accordance with a multifunctionality perspective that incorporates simultaneous engagement in production, consumption, and protection of rural landscapes. There is growing evidence that multifunctional rural development planning can creaate jobs and wealth for local communities (Hibbard and Lurie, 2012; Nielsen-Pincus and Moseley, 2013). Thus, extending multiple use concepts within a multifunctional rural landscape approach could provide an important alternative, not only for ecological protection but also for regional economic diversification and sociocultural resilience (Nielsen-Pincus and Moseley, 2013).

We acknowledge that it is not easy to compare the economic effects of different types of public lands through the analysis used in this study because of dramatic MCD and public land heterogeneity. Further, evaluations are dynamic and vary with broader macroeconomic change. Economic booms and busts affect regional economic structure in resource-dependent regions (Martin et al., 2016). For example, commodity production on public lands is subject to global economic structure which is dynamic. Local citizens and their units of government are wise to appreciate the complexities associated with the use of public lands for their own economic sustainance.

Although our study provides important evidence on the economic effects of public lands to local communities, it has several limitations. First, laws and policies affecting change on public lands have a history of implementation that requires further study. The results of our work may be enhanced through a similar analysis using broader time series data focusing on policy instruments that affect change in public land management. Long-term historical data on policy and planning for the various public land types requires extensive additional work. Second, county public lands were not included in the study because of a lack of data despite the fact that Minnesota, Wisconsin, and Michigan are unique in the extent of this type of public ownership (Stier et al., 1999). Including and distinguishing county public lands in this analysis could further clarify differential effects of ownership of public lands with respect to local economic growth. Third, while this analysis provided focus on public lands in the US Lake States, its geographic generalizability may be limited due to the unique context of public lands within these three states. It is difficult to draw general conclusions on the effects that public lands have on local economies outside of this Lake States region. Thus, future research should extend this analysis into broader study geographies that have alternative amounts and types of public land. This would lead to generating a broader and more robust set of results to help us understand the effects of public lands on local economic change. Fourth, it is worthwhile to examine the effects of both industrial and non-industrial private land use with public land use. Private land management may have certain relationships with regulations and restrictions employed by public land management Consideration of these limitations provides ample opportunity for future research in the assessment of the role of public lands in local economic condition.

CRediT authorship contribution statement

Danya Kim: Conceptualization, Methodology, Formal analysis, Visualization, Investigation, Writing - original draft. **David W. Marcouiller:** Supervision, Writing - review & editing.

Appendix A. Correlation Matrix of the Explanatory Variables (Base year: 2000)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
ΔP (1)	1.00																
ΔE (2)	0.43	1.00															
Pop_den (3)	0.06	−0.01	1.00														
Emp_den (4)	0.07	−0.01	0.99	1.00													
HMV (5)	0.16	0.04	0.12	0.14	1.00												
Hou_den (6)	0.04	−0.02	0.98	0.97	0.12	1.00											
Srou_den (7)	−0.02	−0.03	0.09	0.08	0.10	0.16	1.00										
Pedu (8)	0.09	0.00	0.30	0.33	0.66	0.31	0.13	1.00									
PEMPagrf (9)	−0.21	−0.04	−0.33	−0.33	−0.26	−0.33	−0.17	−0.24	1.00								
PEMPmanu (10)	0.04	−0.02	0.08	0.08	0.03	0.07	−0.05	−0.19	−0.28	1.00							
MHI (11)	0.12	−0.01	0.07	0.10	0.78	0.05	−0.06	0.62	−0.15	0.11	1.00						
Shoreline (12)	0.13	0.02	0.17	0.18	0.27	0.22	0.29	0.27	−0.26	−0.02	0.13	1.00					
Waterarea (13)	0.03	0.01	−0.01	−0.01	0.26	0.05	0.24	0.24	−0.18	−0.12	0.06	0.43	1.00				
Wetland (14)	0.01	−0.01	−0.26	−0.25	−0.08	−0.25	−0.02	−0.18	−0.06	0.03	−0.15	0.01	0.01	1.00			
Forest (15)	0.02	−0.02	−0.21	−0.21	−0.05	−0.21	0.04	−0.06	−0.05	0.00	−0.14	0.01	0.00	0.17	1.00		
N_forest (16)	−0.03	−0.03	−0.09	−0.09	−0.05	−0.08	0.02	−0.05	−0.06	−0.10	−0.15	0.03	0.06	0.16	0.26	1.00	
N_park (17)	−0.03	−0.02	−0.01	−0.01	0.00	−0.01	0.00	0.03	−0.01	−0.04	−0.01	0.01	0.11	0.00	0.00	0.02	1.00
N_lakes (18)	0.01	−0.01	−0.02	−0.02	0.06	−0.01	0.03	0.07	−0.02	−0.03	0.00	0.01	0.12	−0.01	0.03	0.01	0.00
N_memo (19)	−0.02	0.00	0.00	−0.01	−0.01	0.00	0.00	0.00	0.00	−0.03	0.00	0.00	0.02	−0.01	0.00	0.00	0.00
N_rec (20)	0.00	0.04	0.01	0.02	0.01	0.02	0.00	0.03	−0.04	0.01	0.02	0.27	0.16	−0.03	0.08	−0.02	0.00
N_scenic (21)	−0.01	0.00	−0.01	−0.01	0.00	−0.01	0.01	0.00	−0.02	−0.03	−0.03	0.02	0.01	0.01	−0.01	−0.01	0.00
N_wildre (22)	0.04	0.02	−0.03	−0.02	−0.01	−0.02	−0.01	−0.01	0.00	0.02	0.00	0.15	0.10	0.10	0.06	−0.02	0.00
N_wilder (23)	0.00	0.01	−0.02	−0.02	0.03	−0.02	0.00	0.05	−0.01	−0.06	−0.01	0.04	0.04	0.03	0.01	0.23	0.00
S_forest (24)	−0.02	−0.01	−0.11	−0.11	−0.03	−0.11	0.00	−0.04	0.00	−0.13	−0.12	0.03	0.04	0.26	0.24	0.13	0.03
S_park (25)	0.00	−0.02	−0.03	−0.03	0.03	−0.03	0.03	0.04	−0.03	−0.05	0.00	0.06	0.05	0.01	0.04	0.00	0.00
S_rec (26)	0.01	0.00	0.00	0.00	0.07	0.00	0.00	0.03	−0.05	0.02	0.07	0.07	0.04	0.02	0.01	−0.02	0.00
L_park (27)	0.04	0.00	0.32	0.34	0.17	0.32	0.01	0.23	−0.13	0.02	0.17	0.15	0.02	−0.04	−0.03	−0.04	0.00
L_rec (28)	0.00	−0.01	0.01	0.01	0.04	0.01	0.00	0.02	−0.02	0.02	0.05	0.02	0.00	−0.01	0.02	−0.01	0.00
Airport (29)	0.03	−0.02	0.09	0.09	0.06	0.09	0.01	0.11	−0.14	0.01	0.04	0.06	0.04	−0.02	−0.04	−0.02	0.00
Local_road (30)	0.10	0.04	0.84	0.83	0.02	0.82	0.18	0.22	−0.38	0.10	−0.01	0.20	−0.05	−0.34	−0.25	−0.11	−0.02
ST_hwy (31)	0.08	0.00	0.62	0.62	0.02	0.62	0.11	0.18	−0.29	0.10	0.00	0.15	−0.04	−0.23	−0.19	−0.10	−0.02
Hwy (32)	0.07	0.03	0.39	0.38	0.01	0.38	0.05	0.13	−0.25	0.04	0.00	0.12	−0.02	−0.16	−0.13	−0.09	−0.01
Dis_metro (33)	−0.16	0.00	−0.25	−0.26	−0.35	−0.24	0.01	−0.17	0.26	−0.33	−0.37	−0.10	0.04	0.12	0.07	0.11	0.04

	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)
ΔP (1)																
ΔE (2)																
Pop_den (3)																
Emp_den (4)																
HMV (5)																
Hou_den (6)																
Srou_den (7)																
Pedu (8)																
PEMPagrf (9)																
PEMPmanu (10)																

MHI (11)																
Shoreline (12)																
Waterarea (13)																
Wetland (14)																
Forest (15)																
N_forest (16)																
N_park (17)																
N_lakes (18)	1.00															
N_memo (19)	0.00	1.00														
N_rec (20)	0.00	0.00	1.00													
N_scenic (21)	0.00	0.00	0.00	1.00												
N_wildre (22)	0.00	0.00	0.37	0.00	1.00											
N_wilder (23)	0.00	0.00	0.00	0.00	−0.01	1.00										
S_forest (24)	0.02	0.00	0.06	−0.01	0.04	0.04	1.00									
S_park (25)	0.00	0.00	0.03	−0.01	0.00	0.00	0.04	1.00								
S_rec (26)	0.00	0.00	−0.01	0.00	0.00	0.00	−0.01	0.00	1.00							
L_park (27)	−0.01	0.00	0.03	−0.01	0.01	−0.01	−0.06	−0.01	0.07	1.00						
L_rec (28)	0.00	0.00	0.00	0.00	0.00	0.00	−0.01	0.00	0.26	0.01	1.00					
Airport (29)	−0.01	0.04	0.02	0.00	0.02	0.01	−0.02	0.00	−0.01	0.05	0.00	1.00				
Local_road (30)	−0.02	0.00	0.00	−0.01	−0.04	−0.04	−0.14	−0.02	0.01	0.22	0.01	0.06	1.00			
ST_hwy (31)	−0.02	0.00	0.03	−0.01	−0.02	−0.03	−0.12	−0.03	−0.01	0.24	0.00	0.06	0.62	1.00		
Hwy (32)	−0.02	0.00	0.11	0.01	−0.01	−0.02	−0.08	0.02	0.01	0.14	0.00	0.10	0.44	0.19	1.00	
Dis_metro (33)	0.04	0.03	−0.05	0.00	0.01	0.05	0.13	0.01	−0.04	−0.16	−0.02	−0.04	−0.19	−0.19	−0.11	1.00

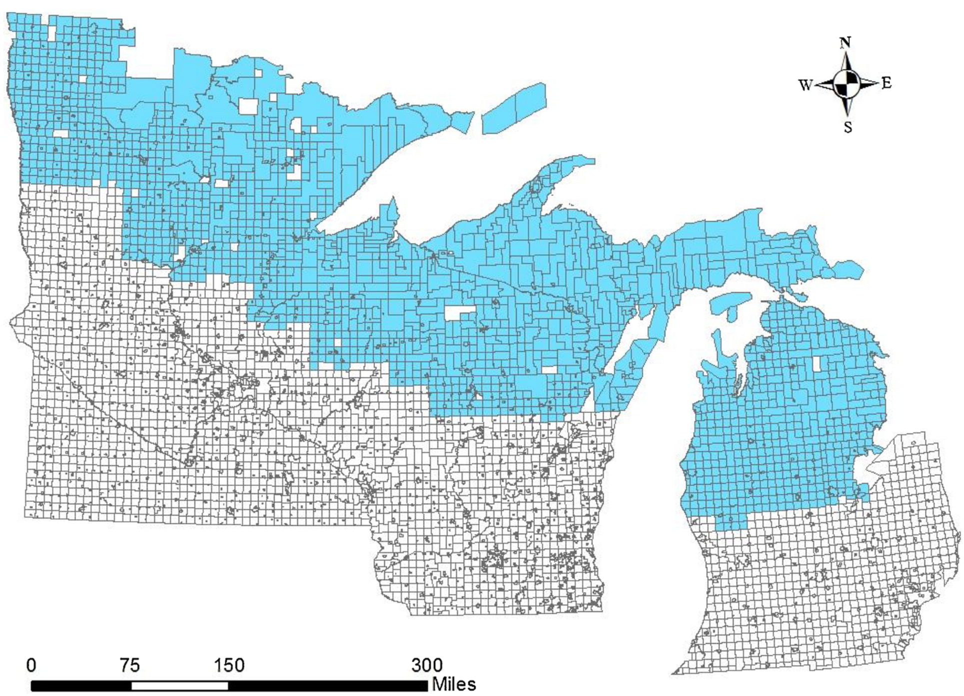
Appendix B. Correlation Matrix of the Explanatory Variables (Base year: 1990)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
ΔP (1)	1.00																
ΔE (2)	0.09	1.00															
Pop_den (3)	−0.03	0.01	1.00														
Emp_den (4)	−0.02	−0.03	0.61	1.00													
HMV (5)	0.10	0.05	0.18	0.12	1.00												
Hou_den (6)	−0.03	0.00	0.98	0.59	0.16	1.00											
Srou_den (7)	0.04	−0.01	0.05	0.03	0.08	0.12	1.00										
Pedu (8)	0.04	−0.03	0.32	0.23	0.66	0.32	0.10	1.00									
PEMPagrf (9)	−0.19	0.00	−0.33	−0.21	−0.25	−0.34	−0.17	−0.27	1.00								
PEMPmanu (10)	0.04	−0.03	0.09	0.07	0.07	0.08	−0.03	−0.11	−0.39	1.00							
MHI (11)	0.03	−0.06	0.14	0.12	0.77	0.11	−0.08	0.58	−0.13	0.17	1.00						
Shoreline (12)	0.05	0.03	0.18	0.10	0.31	0.22	0.27	0.28	−0.27	0.03	0.17	1.00					
Waterarea (13)	0.08	0.01	0.01	0.00	0.24	0.06	0.32	0.19	−0.20	−0.04	0.05	0.53	1.00				
Wetland (14)	0.03	0.01	−0.26	−0.16	−0.11	−0.26	−0.01	−0.17	−0.08	0.11	−0.18	0.01	0.04	1.00			
Forest (15)	0.08	0.00	−0.22	−0.14	−0.08	−0.21	0.04	−0.06	−0.04	0.06	−0.16	0.00	0.01	0.17	1.00		
N_forest (16)	0.04	0.00	−0.09	−0.05	−0.08	−0.08	0.04	−0.05	−0.08	0.00	−0.15	0.02	0.07	0.17	0.26	1.00	
N_park (17)	0.06	0.01	−0.01	−0.01	−0.01	−0.01	0.00	0.01	−0.01	−0.03	−0.01	0.01	0.02	0.00	0.00	0.02	1.00
N_lakes (18)	0.01	0.00	−0.01	−0.01	0.03	−0.01	0.03	0.07	−0.03	−0.02	−0.01	0.01	0.04	−0.01	0.03	0.01	0.00
N_memo (19)	0.00	0.00	0.01	0.00	−0.01	0.01	0.00	0.00	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	0.00	0.00
N_rec (20)	0.00	0.01	0.01	0.01	0.03	0.02	−0.01	0.03	−0.04	0.03	0.03	0.25	0.21	−0.03	0.08	−0.02	0.00
N_scenic (21)	0.02	0.00	−0.01	−0.01	−0.01	−0.01	0.01	0.01	−0.03	−0.02	−0.04	0.02	0.01	0.01	−0.01	−0.01	0.00
N_wildre (22)	−0.01	0.04	−0.03	−0.02	0.01	−0.02	−0.01	0.00	0.00	0.01	−0.01	0.13	0.14	0.10	0.05	−0.02	0.00
N_wilder (23)	0.01	0.00	−0.02	−0.01	0.00	−0.02	0.00	0.02	−0.02	−0.03	−0.02	0.03	0.04	0.03	0.01	0.23	0.00
S_forest (24)	0.04	0.00	−0.11	−0.07	−0.05	−0.11	0.00	−0.04	−0.03	−0.05	−0.13	0.03	0.06	0.26	0.24	0.13	0.03
S_park (25)	0.04	0.00	−0.03	−0.02	0.02	−0.03	0.02	0.05	−0.03	−0.05	0.00	0.06	0.05	0.02	0.04	0.00	0.00
S_rec (26)	0.01	0.03	−0.01	−0.01	0.06	−0.01	0.00	0.02	−0.05	0.03	0.06	0.06	0.05	0.02	0.01	−0.02	0.00
L_park (27)	0.03	0.12	0.30	0.19	0.22	0.30	−0.01	0.21	−0.13	0.05	0.18	0.14	0.03	−0.04	−0.03	−0.04	0.00
L_rec (28)	0.00	0.00	0.01	0.00	0.04	0.00	0.00	0.02	−0.02	0.03	0.05	0.02	0.01	−0.01	0.02	−0.01	0.00
Airport (29)	0.00	0.01	0.08	0.04	0.09	0.08	0.00	0.12	−0.14	0.02	0.08	0.06	0.04	−0.02	−0.04	−0.02	0.00
Local_road (30)	0.02	0.03	0.82	0.51	0.09	0.82	0.14	0.25	−0.40	0.08	0.06	0.22	0.00	−0.34	−0.26	−0.11	−0.02
ST_hwy (31)	0.04	0.03	0.57	0.36	0.09	0.57	0.07	0.18	−0.28	0.08	0.06	0.15	−0.01	−0.22	−0.19	−0.09	−0.01
Hwy (32)	0.00	0.01	0.39	0.23	0.07	0.40	0.04	0.16	−0.25	0.04	0.05	0.12	0.01	−0.16	−0.13	−0.08	−0.01
Dis_metro (33)	−0.08	−0.03	−0.24	−0.15	−0.34	−0.23	0.01	−0.17	0.25	−0.34	−0.36	−0.10	0.02	0.12	0.07	0.11	0.04

	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)
ΔP (1)																
ΔE (2)																
Pop_den (3)																
Emp_den (4)																
HMV (5)																
Hou_den (6)																
Srou_den (7)																
Pedu (8)																
PEMPagrf (9)																
PEMPmanu (10)																
MHI (11)																
Shoreline (12)																
Waterarea (13)																

Wetland (14)																
Forest (15)																
N_forest (16)																
N_park (17)																
N_lakes (18)	1.00															
N_memo (19)	0.00	1.00														
N_rec (20)	0.00	0.00	1.00													
N_scenic (21)	0.00	0.00	0.00	1.00												
N_wildre (22)	0.00	0.00	0.36	0.00	1.00											
N_wilder (23)	0.00	0.00	0.00	0.00	−0.01	1.00										
S_forest (24)	0.02	0.00	0.06	−0.01	0.04	0.04	1.00									
S_park (25)	0.00	0.00	0.03	0.00	0.00	0.00	0.04	1.00								
S_rec (26)	0.00	0.00	−0.01	0.00	0.00	0.00	−0.01	0.00	1.00							
L_park (27)	−0.01	0.00	0.03	−0.01	0.02	−0.01	−0.06	−0.01	0.07	1.00						
L_rec (28)	0.00	0.00	0.00	0.00	0.00	0.00	−0.01	0.00	0.27	0.00	1.00					
Airport (29)	−0.01	0.04	0.02	0.00	0.02	0.01	−0.01	0.00	−0.01	0.06	0.00	1.00				
Local_road (30)	−0.02	0.02	0.01	−0.01	−0.04	−0.04	−0.14	−0.02	0.01	0.21	0.00	0.05	1.00			
ST_hwy (31)	−0.01	0.01	0.03	−0.01	−0.02	−0.03	−0.12	−0.03	−0.01	0.22	0.00	0.05	0.58	1.00		
Hwy (32)	−0.02	0.01	0.11	0.01	−0.01	−0.02	−0.08	0.01	0.01	0.14	0.00	0.09	0.44	0.17	1.00	
Dis_metro (33)	0.04	0.02	−0.06	0.00	0.01	0.05	0.13	0.01	−0.04	−0.16	−0.02	−0.05	−0.19	−0.17	−0.11	1.00

Appendix C. Northern Parts of the Great Lake States



Appendix D. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.landusepol.2020.104883.

References

Anselin, L., Syabri, I., Kho, Y., 2006. GeoDa: an introduction to spatial data analysis. Geogr. Anal. 38 (1), 5–22.

Bell, S., York, R., 2010. Community economic identity: the coal industry and ideology construction in West Virginia. Rural Sociol. 75 (1), 111–143.

Bergstrom, J.C., Cordell, K.H., 1990. Economic impacts of recreational spending on rural areas: a case study. Econ. Dev. Q. 4, 29–39.

Bergstrom, J.C., Cordell, H.K., Watson, A.E., Ashley, G.A., 1990. Economic impacts of state parks on state economies in the South. South. J. Agric. Econ. 22, 69–78.

Carlino, G., Mills, E., 1987. The determinants of county growth. J. Reg. Sci. 27, 39–54.

Charnley, S., 2006. The northwest forest plan as a model for broad-scale ecosystem management: a social perspective. Conserv. Biol. 20, 330–340.

Chi, G., Marcouiller, D.W., 2013. In-migration to remote rural regions: the relative impacts of natural amenities and land developability. Landsc. Urban Plan. 117, 22–31.

Cline, S.A., Weiler, S., Aydin, A., 2011. The value of a name: estimating the economic impact of public land designation. Soc. Sci. J. 48, 681–692.

Cordell, H.K., Bergstrom, J.C., Watson, A.E., 1992. Economic growth and interdependence effects of state park visitation in local and state economies. J. Leis. Res. 24, 253–268.

Deller, S., Tsai, T.H.S., Marcouiller, D.W., English, D., 2001. The role of amenities and quality of life in rural economic growth. Am. J. Agric. Econ. 82, 352–365.

Dobbs, D., Ober, R., 1995. The Northern Forest. White River Junction, Vt. Chelsea Green Publishing Co.

Duffy-Deno, K.T., 1997. The effect of state parks on the county economics of the West. J. Leis. Res. 29, 201–224.

Duffy-Deno, K.T., 1998. The effect of federal wilderness on county growth in the intermountain Western United States. J. Reg. Sci. 38, 109–136.

Eagan, K., 2010. Governing Wisconsin: "Public Lands". Wisconsin Legislative Reference Bureau, No. 32. Available at. http://www.legis.wi.gov/lrb/GW.

Eichman, H., Hunt, G., Kerkvliet, J., Plantinga, A., 2010. Local employment growth, migration, and public land policy: evidence from the Northwest Forest Plan. J. Agric. Res. Econ. 35, 316–333.

Ferguson, M., Ali, K., Olfert, M.R., Partridge, M.D., 2007. Voting with their feet: jobs versus Amenities. Growth Change 38 (1), 77–110.
Frentz, I., Farmer, F., Guldin, J., Smith, K., 2004. Public lands and population growth. Soc. Nat. Resour. 17, 57–68.
Gebremariam, G.H., Gebremedhin, T.G., Schaeffer, P.V., 2011. Employment, income, and migration in Appalachia: a spatial simultaneous equations approach. J. Reg. Sci. 51, 102–120.
Glaeser, E., Maré, D., 2001. Cities and skills. J. Labor Econ. 19, 316–342.
Goodstein, E., 1999. Coal miners, timber workers, and developers. The Trade-Off Myth: Fact and Fiction About Jobs and the Environment. Island Press, Washington, DC.
Gorte, R.W., Vincent, C., Hanson, L., Rosenblum, M., 2012. Federal Land Ownership: Overview and Data. Congressional Research Service. https://www.fas.org/sgp/crs/misc/R42346.pdf.
Green, G.P., Deller, S.C., Marcouiller, D.W., 2005. Amenities and Rural Development: Theory, Methods, and Public Policy. Edward Elgar Publishing, New York.
Greenwood, M., Hunt, G., McDowell, J., 1986. Migration and employment change: empirical evidence on the spatial and temporal dimensions of the linkage. J. Reg. Sci. 26 (2), 223–234.
Hibbard, M., Lurie, S., 2012. Creating socio-economic measures for community-based natural resource management: a case from watershed stewardship organizations. J. Environ. Plan. Manag. 55, 525–544.
Jeanty, W., Partridge, M., Irwin, E., 2010. Estimation of a spatial simultaneous equation model of population migration and housing price dynamics. Reg. Sci. Urban Econ. 40, 343–352.
Keith, J., Fawson, C., 1995. Economic development in rural Utah: Is wilderness the answer? Annuals of Regional Science 29, 303–313.
Kelejian, H., Purcha, I., 2004. Estimation of simultaneous systems of spatially interrelated cross sectional equations. J. Econom. 118, 27–50.
Kim, K.K., Marcouiller, D.W., Deller, S.C., 2005. Natural amenities and rural development: understanding spatial and distributional attributes. Growth Change 36, 273–297.
Lewis, D., Hunt, G., Plantinga, A., 2002. Public conservation land and economic growth in the Northern Forest Region. Land Econ. 78, 245–259.
Lewis, D., Hunt, G., Plantinga, A., 2003. Does public lands policy affect local wage growth? Growth Change 34, 64–86.
Lorah, P., Southwick, R., 2003. Environmental protection, population change, and economic development in the rural Western United States. Popul. Environ. 24, 255–272.
Marcouiller, D.W., Kim, K.K., Deller, S.C., 2004. Natural amenities, tourism and income distribution. Ann. Tour. Res. 31, 1031–1050.
Martin, R., Sunley, P., Gardiner, B., Tyler, P., 2016. How regions react to recessions: resilience and the role of economic structure. Reg. Stud. 50, 561–585.
Michigan Department of Natural Resources (DNR), 2013. Managed Public Land Strategy. State of Michigan.
Minnesota Department of Natural Resources (DNR), 2000. Public Land and Mineral Ownership in Minnesota. Division of Lands and Minerals.
Mockrin, M., Stewart, S., Matonis, M., Johnson, K., Hammer, R., Radeloff, V., 2018. Sprawling and diverse: the changing U.S. Population and implications for public lands in the 21st Century. J. Environ. Manage. 215, 153–165.
Nielsen-Pincus, M., Moseley, C., 2013. The economic and employment impacts of forest and watershed restoration. Restor. Ecol. 21, 207–214.
Niemi, E., Whitelaw, E., Johnson, A., 1999. The Sky Did Not Fall: the Pacific Northwest's Response to Logging Reductions. Report prepared for Earthlink Canada Foundation Sierra Club of British Columbia, ECONorthwest.
Partridge, M.D., Rickman, D.S., Ali, K., 2008. Recent immigration and economic outcomes in rural America. Am. J. Agric. Econ. 90, 1326–1333.
Patric, J.K., Harbin, R.L., 1998. Whither Wilderness? How Much Is Enough? Heartland Policy Study #88. The Heartland Institute., Chicago, IL.
Phillips, R., 2006. Jobs and income associated with resource and recreation outputs in Northwest Forest plan—The first Ten years. In: Charnley, S., Donohue, E.M., Stuart, C., Dillingham, C., Buttolph, L.P., Kay, W.M., McLain, R.J., Moseley, C., Phillips, R.P. (Eds.), Socioeconomic Monitoring Results, Vol. III: Rural Communities and Economies. General Tech. Rep. No. PNE-GTR-649. USDA/Forest Service, Pacific Northwest Experiment Station, Portland, OR.
Power, T.M., 1991. Ecosystem preservation and the economy of the Greater Yellowstone area. Conserv. Biol. 5, 395–404.
Power, T.M., 1996. Lost Landscapes and Failed Economies: The Search for a Value of Place. Island Press, Washington, DC.
Power, T.M., 2001. The Economic Impact of the Proposed Maine Woods National Park and Preserve. Restore: The North Woods., Hallowell, Maine.
Power, T.M., Barrett, R.N., 2001. Post-cowboy Economics: Pay and Prosperity in the New American West. Island Press, Washington, DC.
Rappaport, J., 2007. Moving to nice weather. Reg. Sci. Urban Econ. 37, 375–398.
Rappaport, J., Sachs, J., 2003. The United States as a coastal nation. J. Econ. Growth 8, 5–46.
Rasker, R., 1993. Rural development, conservation, and public policy in the Greater Yellow Stone ecosystem. Soc. Nat. Resour. 6, 109–126.
Rasker, R., 2006. An exploration into the economic impact of industrial development versus conservation on western public lands. Soc. Nat. Resour. 19, 191–207.
Rasker, R., Hackman, A., 1996. Economic development and the conservation of large carnivores. Conserv. Biol. 10, 991–1002.
Roback, J., 1982. Wages, rents, and the quality of life. Journal of Political Economics 90, 1257–1278.
Rosenthal, S., Strange, W., 2001. The determinants of agglomeration. J. Urban Econ. 50, 191–229.
Rudzitis, G., Johansen, H., 1991. How important is wilderness? Results from a United States survey. Environ. Manage. 15, 227–233.
Rudzitis, G., Johnson, R., 2000. The Impact of Wilderness and Other Wildlands on Local Economies and Regional Development Trends. Proc. RMRS–P–15–Vol 2. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.
Steinnes, D., Fisher, W., 1974. An econometric model of intraurban location. J. Reg. Sci. 14, 65–80.
Stier, J.C., Kim, K.K., Marcouiller, D.W., 1999. Forest productivity and land ownership. Can. J. For. Res. 29, 1736–1742.