Migration effects of natural amenities along the urban-rural continuum

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Abstract The importance of natural amenities in promoting development and population change has been addressed in a large body of literature. More recent studies suggest the existence of spatial heterogeneity in the migration effects of natural amenities, that is, the migration effects of natural amenities vary spatially. Nevertheless, the potential variation along the urban-rural continuum has not been addressed. In this study we examine and compare the migration effects of natural amenities in five specific urban-rural continuum types at the minor civil division level in the US state of Wisconsin. Results of spatial analysis suggest that natural amenities do indeed have differing effects on migration along this urban-rural continuum. Overall, natural amenities have the largest effect on in-migration into rural areas adjacent to metro areas and no effect on in-migration into urban areas. The effects of natural amenities on in-migration into remote rural areas rely more on growth trends within these regions. These findings have important implications for land use policy, natural resource management, and planning for social and economic development.

Keywords: natural amenity, in-migration, urban-rural continuum, spatial regime, spatial variation, spatial heterogeneity, spatial dependence

JEL Classification: R11, R14, R15, R23

1 Introduction

The importance of natural amenities in promoting development and population change has been addressed in a large body of literature, including Graves's (1979) equilibrium theory, Roback's (1982) general equilibrium formulation of household and firm locations, rural demographers' turnaround migration (e.g., Brown et al. 1997), life-cycle studies (e.g., Clark and Hunter 1992), rural development (e.g., Deller et al. 2001), and others. However, some empirical studies find little significance of natural amenities in influencing regional demographic change (c.f., Kim et al. 2005; Lewis et al. 2002). These conflicting findings are argued to be due both to the empirical complexity of measuring amenities and to the partial approach used in isolating causal relationships (Chi and Marcouiller 2011; Robbins et al. 2009; Rupasingha and Goetz 2004; Thompson et al. 2006).

The conflicting findings are further argued to be due to the existence of spatial heterogeneity in the migration effects of natural amenities, that is, the migration effects of natural amenities vary spatially (Partridge et al. 2008a). The effects vary spatially because local areas are likely to exhibit spatial variation in their growth mechanisms, areal characteristics, and temporal contexts. Although spatial heterogeneity in migration effects of natural amenities has been addressed in existing literature, the spatial heterogeneity along the urban-rural continuum has not been studied, to our best knowledge. It is important to address the spatial heterogeneity along the urban-rural continuum because natural amenities are regional-type specific, and studying the variation along the urban-rural continuum will provide specific information regarding how the effects differ in different types of areas.

This manuscript examines the possible spatial heterogeneity of natural amenity impacts on migration across urban, suburban, and rural areas. Indeed, it would seem logical to think that natural amenities have differing effects in attracting migrants to urban and rural areas because these amenities have regional-type specificity. Urban areas are rich in job opportunities, shopping centers, entertainment centers, healthcare facilities, and other attractants, while rural areas lack economic diversity and are more highly endowed with natural amenities (Isserman 2001). Migrants come to urban areas likely for the attracting factors of cities rather than for natural amenities. Natural amenities in rural areas attract migrants, but natural amenities alone are not enough to do so; other factors such as a lack of healthcare facilities and transportation infrastructure could push migrants away. We assert that natural amenities have differing effects on migration to urban and rural areas due to the amenity characteristics unique to each regional type.

Thus, the focus of the work reported here is to examine and compare migration effects of natural amenities along the urban-rural continuum. We define five types of areas representative of urban to rural status and then examine the differing migration effects of natural amenities in each type of area. This manuscript is organized into six additional sections. Following this introduction, we review the literature on migration effects of natural amenities and spatial heterogeneity in the effects and discuss the potential variations in the effects along the urban-rural continuum. We then introduce data, urban-rural classification, and methods. The subsequent results section examines and compares migration effects of natural amenities in the five regional types while controlling for spatial dependence, demographic characteristics, socioeconomic conditions, transportation accessibility, and land use and development. Finally, we close with a summary and discussion section.

2 Spatial variation in migration effects of natural amenities

2.1 Contradictory findings of prior research

Previous literature has suggested that natural amenities play an important role in regional demographic change. For example, the "turnaround migration" in the United States after 1970 was considered to have been largely caused by people's attraction to the natural amenities found throughout rural America (Brown et al. 1997; Fuguitt et al. 1989; Johnson and Beale 1994). From a conceptual perspective, there is a body of literature that suggests that natural amenities exist as latent primary factors of production in the local provision of goods and services, especially in rural areas (Graves 1979, 1980, 1983; Knapp and Graves 1989; Marcouiller 1998). In addition, equilibrium theory suggests that migration is mainly caused by differences in amenities rather than differences in economic opportunities (Graves 1983; Graves and Linneman 1979). Moreover, the presence of amenities serves as a regional benefit to be capitalized into household utility maximization decisions in Roback's (1982) static general equilibrium formulation of household and firm locations. The importance of natural amenities in attracting migrants is further supported by increasing empirical findings (e.g., Partridge 2010; Rappaport 2007). For a review of the literature, refer to Gosnell and Abrams (2009) and Kruger et al. (2008).

Despite the theoretical attraction and empirical findings of such research, some other empirical studies find little significance of natural amenities in influencing regional demographic change (c.f., Duffy-Deno 1998; Kim et al. 2005; Lewis et al. 2002). These conflicting findings are argued to be due both to the empirical complexity of measuring amenities and to the partial approach used in isolating causal relationships (Chi and Marcouiller 2011; Robbins et al. 2009; Rupasingha and Goetz 2004; Thompson et al. 2006). In order to systematically examine the effects of natural amenities on migration, some studies controlled for a variety of determinants of migration and considered spatial process effects. For example, Chi and Marcouiller (2009a, 2009b) adopted a more synthetic approach to control for other influential factors, including demographic characteristics, socioeconomic scenarios, transportation accessibility, land development, and both spatial lag and spatial error effects.

2.2 Spatial heterogeneity in the effects

The conflicting findings are further argued to be due to the existence of spatial heterogeneity in the migration effects of natural amenities, that is, the migration effects of natural amenities vary spatially (Partridge et al. 2008a). The existing literature has long recognized spatial heterogeneity of population redistribution, and some studies have found that accumulated human and physical capital, natural endowments, and economic geography are the causes (for a review of the literature, see Wu 2010 and Wu and Gopinath 2008). However, little research has examined the spatial heterogeneity of these factors' effects on population redistribution. Because local areas' growth mechanisms vary in ways traditional global standard regression models cannot easily capture, spatial heterogeneity is possible (Partridge et al. 2008a, 2008b). The global estimates of coefficients reflect collective effects but cannot reflect local variations of the effects; this inability to reflect the local variations provides misleading local dynamics information.

In terms of the potential spatial heterogeneity of natural amenity effects, natural amenities may have different effects on migration in different areas for at least three possible reasons. First, natural amenities may be valued differently by the accessibility to them. Well-developed highway networks and airport facilities are important for providing easy access to natural amenities, especially those in remote rural areas (Rasker et al. 2009). Second, natural amenities may be valued differently in different temporal contexts. For example, natural amenities are found to play a stronger role in attracting migrants during a good economy, but economic opportunities play a stronger role in times of economic downturn (Chi and Marcouiller 2011). Third, natural amenities might be valued differently by different demographic cohorts. Life-cycle literature, for instance, suggests that natural amenities are valued more by people as the people age (e.g., Clark and Hunter 1992); thus, areas with different age structures value natural amenities differently.

2.3 Spatial variation along the urban-rural continuum

According to Roback (1982), migration results from the differentials of location-specific utilities, which are assumed to depend positively on wage rates and the amenity attractiveness (both urban and natural amenities) of the area, and negatively on land costs. Because migrants have different valuation systems of natural amenities versus other factors, they migrate to different types of areas along the urban-rural continuum. People who migrate to urban areas, for example, likely value employment opportunities and urban amenities more than other factors (Fallah et al. 2010). Urban amenities include such offerings as shopping centers, entertainment centers, healthcare facilities, and cultural and educational resources (Glaeser 1997). In addition to such local amenities, easy access to commercial airports exposes residents in urban areas to opportunities in geographically distant metro cities and promotes population interactions (Irwin and Kasarda 1991; Zipf 1946). Because of the preference for such urban amenities, migrants to urban areas might see natural amenities as being less important.

Migrants to suburban areas likely value natural amenities to some extent (Partridge et al. 2008b). Suburban residents benefit from their proximity to urban amenities but can escape negative urban amenities such as higher taxes and land prices, environmental pollution, traffic congestion, and higher crime rates (Glaeser 1997), while at the same time they can enjoy the quality of life and lower housing prices in suburban areas (Isserman et al. 2009). In addition, suburban residents can not only enjoy natural amenities in their own suburban areas but also are able to more easily access natural amenities in rural areas. The only disadvantage of living in suburban areas is the travel cost to urban areas. Given that migrants to suburban areas are willing to sacrifice travel cost to urban areas, they likely value the natural environment to some extent.

It is likely that migrants to rural areas value natural amenities more than migrants to suburban and urban areas (Woods 2011), although natural amenities are surely valued differently in rural areas that are adjacent to metro cities and rural areas that are remote (Isserman et al. 2009). In rural areas that are adjacent to metro cities, residents likely value both natural amenities and urban amenities at similar levels. In such areas natural amenities have compensating wage differentials—people living in these areas are willing to accept lower wages in exchange for natural amenities (Schmidt and Courant 2006). In remote rural areas, however, natural amenities may not be appreciated as much as those in rural areas adjacent to metro cities. The inconvenience of transportation access to urban amenities might be too important to sacrifice for many people, especially those who are still in the work force (Rasker et al. 2009).

Therefore, because people migrating to different types of areas value natural amenities differently, the effects of natural amenities on migration and population redistribution vary spatially along the urban-rural continuum. Although spatial heterogeneity in the migration effects of natural amenities has been addressed in existing literature, we are not aware of any studies that address the spatial heterogeneity along the urban-rural continuum. This manuscript specifically discusses the possible spatial heterogeneity of natural amenity impacts on migration across urban, suburban, and rural areas and attempts to form a framework for this study by building upon existing literature.

3 Data

In this study, geographic units of analysis are developed at the minor civil division (MCD) level for the US Lake State of Wisconsin. In Wisconsin, MCDs are the smallest governmental functioning units that raise taxes and provide civil services. The analytical dataset consists of characteristics for 1,837 exhaustive and mutually exclusive MCDs with an average size of 29.56 square miles. The great advantage of using MCDs as the unit of analysis is their relevance to public planning and policy making. The dependent variable is in-migration from 1995–2000. Although most migration studies are conducted with net migration as the dependent variable, we use in-migration because the influence of natural amenities on migration occurs mainly through their power to attract, and thus natural amenities tend to have an effect on in-migrants rather than out-migrants. In the 1990s, Wisconsin experienced "rural rebound"—natural beauties attracted migrants, retirees in particular, to rural areas (Johnson 1999). People gradually moved from large metropolitan places to small rural places due to overall economic growth, improvement in transportation, and increasing appreciation of natural amenities.

In this research, we define natural amenities using seven directly measured variables: the presence of forests (the proportion of forest coverage), water (the proportion of water area), wetlands (the proportion of wetlands), public lands (the proportion of tax-exempt lands such as parks, trails, wildlife refuges, and fishery areas), lakeshores/riverbanks/coastlines (the total length of hydrology adjusted by the square root of the MCD area), golf courses (the proportion of golf courses adjusted by the distance from a MCD's centroid to its nearest golf area's centroid), and viewsheds (the proportion of a MCD's area with slopes between 12.5% and 20%). These variables measure region-specific natural amenity characteristics associated with environmental aesthetics, site-specific attributes, and natural resource presence. Refer to Chi and Marcouiller (2009a) for details about these natural amenity variables.

Explanatory controls include two demographics indices (age structure and race), three livability indices (wealth and education, modernization, and luxury), two accessibility indices (proximity and infrastructure, and public transportation), and one land developability index. These indices are measured as of 1990 by the use of principal factor analysis and the spatial overlay method. For details about these indices, refer to Chi

(2010b) and Chi and Marcouiller (2009a). These indices are meant to eliminate the potential problem of multicollinearity and to better facilitate interpretations. The relevant data come from a variety of primary and secondary sources, including the U.S. Census Bureau, the U.S. Geological Survey, the Federal Bureau of Investigation, the Wisconsin Departments of Natural Resources, Transportation, and Public Instruction, and several units of the University of Wisconsin-Madison.

4 Urban-rural classification

Our goal in this study is to examine the potential spatial variation of natural amenity effects on migration along the urban-rural continuum; therefore, it is necessary to apply urban-rural classification to our data. Although there are many classifications of regions along the urban-rural continuum, a single accepted standard does not exist (Balk 2009). To our best knowledge, there is not a classification of regions at the MCD level in Wisconsin that distinguishes urban, suburban, and rural areas as well as different types of rural areas. In this study, we used a combination of prior classifications for urbanized places, metro and nonmetro areas, and urban and rural counties to develop five categories representing a range of urban to rural status.

First, the U.S. Census Bureau's 2000 Census Urbanized Areas classification identifies densely settled areas that contain at least 50,000 people (U.S. Census Bureau 2004). Although this classification provides a separation of urban and rural areas, in Wisconsin there are only 14 MCDs that fall into the category of Census Urbanized Areas because of the high threshold value of 50,000 people, which limits the statistical analysis. Second, Metropolitan and Micropolitan Statistical Areas (MMSAs) are defined by the U.S. Office of Management and Budget (2003). Each metropolitan or micropolitan area is composed of a core area having a substantial population nucleus and is companioned with adjacent communities having a high degree of social and economic integration with that core. Although MMSAs distinguish metro from nonmetro areas, this classification is for counties but not for MCDs. Third, the Beale Code (USDA ERS 2004) classifies all US counties into nine categories on the basis of the size of a county and its proximity to a metropolitan area. Although this classification provides finer classification along the urban-rural continuum than the Census Urbanized Areas and MMSAs, the classification is for counties but not for MCDs.

Therefore, in order not only to distinguish urban, suburban, and rural areas but also to distinguish different rural areas, we used a combination of the three classifications to classify Wisconsin MCDs into five categories. The five categories are labeled urban, suburban, rural-adjacent, rural-exurban, and rural-remote (see Figure 1). We decided on five categories for two reasons. First, this typology includes the three primary regional types of urban, suburban, and rural, which are often used in regional economic studies. Second, distinguishing three types of rural areas allows for a more detailed analysis, as rural areas vary greatly among one another depending on both population and proximity to metropolitan areas. This five-category classification is meant to correspond to migrants' impressions of areas within an urban-rural continuum.

[FIGURE 1 ABOUT HERE]

Our urban areas include the MCDs falling into the Census Urbanized Areas category as well as their bordering MCDs.[1] These are the largest cities and their immediate neighborhoods. Suburban areas are classified as MCDs that fall into the MMSA category but are not categorized as Census Urbanized Areas; our suburban areas are not the largest cities but are located within metro areas. Rural-adjacent areas include MCDs that are located outside of MMSAs but are coded as urban areas based on their county Beale Code; these rural areas are adjacent to metro areas and their home counties have relatively large population sizes. Rural-exurban areas consist of MCDs that are coded as rural areas adjacent to metro areas based on their home county Beale Code; these rural areas are still adjacent to metro areas but their home counties tend to have relatively small population sizes. Rural-remote areas are MCDs coded as rural areas that are not adjacent to metropolitan areas based on their home county Beale Code; these rural areas are remote from metro cities.

The classification reasonably represents the range of MCD types from urban to rural, as supported by the descriptive statistics of the variables used in this study (Table 2). First, urban status decreases as population density decreases: the population size decreases and the geographic size generally increases from urban to suburban to rural-adjacent to rural-exurban to rural-remote areas. Second, urban status decreases as natural amenities increase. The proportions of natural amenities generally increase from urban to rural areas, with obvious patterns presented in forests, wetlands, public lands, riverbanks/lakeshores/coastlines, and viewsheds. Golf courses, which can be thought of as "human-made" natural amenities, decrease as regional status goes from urban to rural.

[1] A visual examination of the 14 MCDs indicated that their bordering MCDs were well qualified as urban areas.

Third, demographics, livability, accessibility, and developability generally support the corresponding characteristics of the five categories of MCDs. Suburban areas generally include younger residents while rural-remote areas have generally older residents. Livability in terms of wealth and education decreases as urban status decreases. Accessibility in terms of proximity to urban areas and transportation infrastructure decreases as urban status decreases. Urban areas and rural-remote areas exhibit relatively lower land developability than the other three region types. Although our classification of MCDs represents the urban-rural continuum reasonably well, a finer classification system could be explored in future research by comprehensively considering population density, population size, adjacency to the largest cities, and the socioeconomic contexts of each MCD.

[TABLE 2 ABOUT HERE]

5 Methods

An ordinary least squares (OLS) regression model was first run to examine the effects of natural amenities[2] on in-migration while controlling for the explanatory controls (Table 1). The model was then diagnosed for the existence of spatial dependence in model residuals, which helped suggest appropriateness of spatial regression models for controlling spatial dependence. The procedure for diagnosing spatial dependence and

[2] Natural amenities could be highly correlated as some variables, such as forests and wetlands, overlay. In this study, the Pearson's correlations between the seven natural amenity variables (in absolute values) are all below 0.4. When examining the correlations separately in the five types of areas, all correlations (in absolute values) are below 0.5, except in urban areas, where the correlation between forests and viewsheds and the one between forests and wetlands are 0.55 and 0.57. These correlations may reduce the robustness of coefficient estimates, but likely to a lesser extent, as most correlations are modest.

selecting an appropriate spatial regression model was based on Anselin's spatial regression model selection decision rule described in his GeoDa workbook (Anselin 2005, p. 199); this selection approach is intuitive and has been used in many social science studies (e.g., Chi 2010a; Chi and Marcouiller 2011). Alternative procedures for identification in spatial regression models were addressed in Pinkse and Slade (2010). The diagnostics used in this study included Moran's I statistic for residuals and Lagrange-Multiplier (LM) tests (including robust LM) for lag and error dependence.

[TABLE 1 ABOUT HERE]

Application of the Moran's I statistic suggested the existence of spatial dependence in the model residuals but could not identify the characteristic of spatial dependence (Table 1). Usually, LM tests can help detect the presence of spatial dependence in the form of an omitted spatially lagged dependent variable and/or spatial error dependence (Anselin 1988). However, for this data, LM tests for both spatial error dependence and spatial lag dependence were significant. In such instances, robust LM tests can suggest the pertinence of the spatial dependence (Anselin 1988). The robust LM tests indicated that the spatial lag model was a more appropriate model for examining the effects of natural amenities on migration.

The spatial lag model provided results similar to those of the OLS regression model. The spatial lag dependence had a positive effect on in-migration. Viewsheds had a positive effect on in-migration, as well, suggesting that MCDs with more viewsheds attracted more in-migrants. Public lands also had a positive effect on attracting in-migrants. Conversely, forests had a negative effect on in-migration, suggesting that MCDs with higher forest presence experienced lower in-migration—contradictory to prior findings such as those of areas in the America West (e.g., Rasker and Hansen 2000). Other natural amenity variables, including water, wetlands, public lands, riverbanks/lakeshores/coastlines, and golf courses, did not significantly affect in-migration. Again, we posit that these mixed findings could be due to the varying natural amenity effect on in-migration by regional type.

In this study, we applied a spatial regime model to deal with issues of spatial heterogeneity (Anselin 1990; Patton and McErlean 2003) by assuming five spatial regimes—one for urban areas, one for suburban areas, one for rural-adjacent areas, one for rural-exurban areas, and one for rural-remote areas. The model estimates coefficients and spatial lag effects separately for each regime. The spatial regime approach has been used in previous population growth studies (e.g., Chi 2010a). Alternatively, spatial variation can be addressed using geographically weighted regression (GWR) (e.g., Ali et al. 2007) or partitioning the area of study into regions exhibiting various spatial patterns (e.g., Baller and Richardson 2002). GWR was not considered in this study because although it provides an elegant means of modeling the spatially varying coefficients, the coefficients are estimated to vary continuously (refer to Partridge et al. 2008a for a review of the application of GWR in modeling spatial variation of socioeconomic processes). This study considers only five distinct area types, in which the coefficients more likely differ distinctly. In addition, while partitioning data frequently is used to address spatial heterogeneity in sociological studies, there is a practical difficulty of controlling spatial dependence because none of the areas in the five classifications in this study are contiguous. Therefore, we opted for a spatial regime model to address spatial variation.

6 Results

The effects of natural amenities on in-migration were examined across the five regional types. Results of the spatial regime model are summarized in Table 3. From a methodological perspective, our spatial regime model substantially outperforms the OLS regression and spatial lag models based on goodness-of-fit balanced with model parsimony as indicated by log likelihood, Akaike's Information Criterion (AIC), and Schwartz's Bayesian Information Criterion (BIC) (Table 3). The spatial regime model also eliminates the spatial dependence in the residuals; neither the Moran's I statistic nor the LM tests for spatial lag and spatial error dependence are significant.

[TABLE 3 ABOUT HERE]

Overall, the results suggest that the effects of natural amenities on in-migration vary substantially across the five regional types. First, none of the natural amenity variables attracted in-migrants into urban areas. This may be simply because in-migrants come to urban areas mainly for job opportunities and urban amenities rather than the specified natural amenities. This is partly supported by the significance of livability index 1 and accessibility index 2 in affecting in-migration. Livability index 1 is mainly composed of wealth and education, and accessibility index 2 represents public transportation. These two indices had significant effects on in-migration only in urban areas.

Second, in suburban areas only one natural amenity variable—water—had a significant effect on in-migration, and the effect was negative. Suburban areas have long benefited from metropolitan growth and development, thanks to improvements in transportation infrastructure and innovation in transportation and communication techniques, proximity to urban areas, and relatively lower housing prices (Isserman

2001). However, this advantage may be diminishing, as some suburban areas may already be occupied, causing migrants to reside in other, less developed suburban areas. It is more likely that the already occupied suburban areas are those with more water, as they were likely more attractive than suburban areas with fewer water areas—thus, the new in-migrants had to find suburban locations that were less developed and had less water. However, the interpretation for negative water effects needs to be tested in further research.

Third, in rural-adjacent areas, four natural amenities had significant effects on in-migration—the most among the five regional types. Rural-adjacent areas often exist as bedroom communities for commuters and have unique advantages. As noted by Isserman (2001), these areas are often typified by affordable housing prices and easy access to urban areas and often benefit from agglomeration and suburbanization effects. Natural amenities in rural areas that are adjacent to metro cities have compensating wage differentials, as people living in these areas are willing to accept lower wages in exchange for natural amenities (Schmidt and Courant 2006). The natural amenities that were significant in explaining in-migration to rural-adjacent areas were water, public lands, golf courses, and viewsheds. Note that public lands and golf courses had effects on in-migration only in the rural-adjacent areas.

Fourth, in rural-exurban areas, forests had significant negative effects and viewsheds had significant positive effects on in-migration. Rural-exurban areas can be fringe bedroom communities but often have higher proportions of non-commuters compared to rural-adjacent areas. Ruran-exurban areas exist at the outer limits of metropolitan commuter sheds. It seems that rural-exurban development relies more on factors other than natural amenities. In-migration in rural-exurban areas is positively associated with land developability. While rural-exurban areas are less populated than the previous three types of areas discussed (urban, suburban, and rural-adjacent), their lands may be limited for development because some lands, such as national, state, and county forests and parks, are tax exempt and thus are not eligible for further development. This interpretation is partially supported by our results; namely, the negative effect of the forest variable. Publicly owned forests are tax exempt and largely undevelopable lands; thus, the more forests, the lower land developability, which could lead to fewer in-migrants. In addition, spatial lag has effects on in-migration only in rural-exurban areas. A rural-exurban MCD will likely gain (or lose) population if its neighbors do so. Growth and development of rural-exurban regions are tied to broader regional growth and development (Chi 2010a).

Fifth, in rural-remote areas, only forests had a significant effect on in-migration; the effect was again negative. Remote rural regions exist within unique developmental contexts and face significant constraints to economic growth and socio-demographic change due to resource dependency, globalization, lack of economic diversity, and remoteness (Bowe and Marcouiller 2007). These regions have traditionally relied on extractive resources for economic development and have experienced a long history of population loss to metropolitan areas. Simply relying on natural amenities for in-migration does not appear to be sufficient for overturning this population trend.

7 Summary and discussion

An increasing body of literature suggests that the effects of natural amenities on development and population change exhibit spatial heterogeneity. However, the potential variation along the urban-rural continuum has not been addressed. It is important to address the spatial variation along the urban-rural continuum because doing so will provide specific information regarding how the effects differ in different types of areas. In this study, we examined and compared the effects of natural amenities on in-migration at the minor civil division level in five regional typologies representative of the urban-rural continuum in the US state of Wisconsin. Results suggest that natural amenities have differing effects on migration distinguished by regional types along the urban-rural continuum. Overall, natural amenities have the largest effect on in-migration into rural-adjacent areas (rural areas that are directly adjacent to a metro area and whose home counties have relatively large populations), which benefit from their advantageous geographic locations of easy access to both urban amenities and rural amenities and their relatively lower housing prices. As specified in our model, natural amenities had no effect on in-migration into urban areas (the largest cities and their bordering MCDs). The effects of natural amenities on in-migration into remote rural areas appear to rely more on overall regional economic growth trends. Growth in rural-exurban areas (rural areas that are adjacent to metro areas but whose home counties have relatively small population sizes) depends more on regional growth, development, and agglomeration forces of the metropolitan area in close proximity than on natural amenities.

The findings of this research are limited from two perspectives, which could be addressed in future research. First, this study focused on only one state. The findings may be better generalizeable to Midwest states that share similar economic, demographic, and social contexts than other states that do not. Many prior studies encompass larger regions. Applying the research approach to different states or to larger regions may generate more robust findings. Second, this study examined migration only from 1995–2000, a period of rural rebound in Wisconsin. The findings may not apply to other time periods with different population redistribution patterns. Studying the spatial variation of migration effects of natural amenities over several time periods will provide a more comprehensive understanding of the phenomenon.

The findings from this research have important implications for urban and regional planning. Growth and development varies along the urban-rural continuum with differing effects of natural amenities, demographic characteristics, socioeconomic conditions, transportation accessibility, land developability, and spatial lag effects. These factors jointly determine the direction of growth and development of an area. Thus, the practice of urban and regional planning that takes place along the urban-rural continuum needs contextual sensitivity with respect to land use policy, natural resource management, and planning for social and economic development.

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TABLE 1. Results of OLS regression model and spatial lag model

Explanatory variable	OLS regression model	Spatial lag model
The proportion of forest area	–0.048***	–0.044***
	(0.011)	(0.011)
The proportion of water area	0.025	0.023
	(0.031)	(0.030)
The proportion of wetland area	–0.023	–0.020
	(0.019)	(0.019)
The proportion of public land area	0.026	0.027†
	(0.016)	(0.016)
The length of riverbanks/lakeshores/coastlines	7.073E–5	8.171E–5
	(2.407E–4)	(2.383E–4)
Golf courses	–1.322E–8	–1.716E–8
	(1.377E–7)	(1.363E–7)
Viewsheds (12.5%–20%)	0.122***	0.116***
	(0.034)	(0.034)
The in-migration rate across the county from 1985–1990	0.327***	0.312***
	(0.027)	(0.027)
Demographic index 1 (age structure)	0.006*	0.006*
	(0.002)	(0.002)
Demographic index 2 (race)	0.012***	0.012***
	(0.003)	(0.003)
Livability index 1 (wealth and education)	0.008***	0.008***
	(0.002)	(0.002)
Livability index 2 (modernization)	–0.002	–0.002
	(0.003)	(0.003)
Livability index 3 (luxury)	–0.024***	–0.022***
	(0.003)	(0.003)
Accessibility index 1 (proximity and infrastructure)	–0.005*	–0.006*
	(0.003)	(0.002)
Accessibility index 2 (public transportation)	–5.512e–4	–1.432e–4
	(0.003)	(0.003)
Developability index	0.047**	0.048**
	(0.016)	(0.016)
Spatial lag	/	0.116***
		(0.028)
Constant	0.241***	0.205***
	(0.016)	(0.018)
Measures of fit		
Log likelihood	2264.53	2272.36
AIC	–4495.07	–4508.72
BIC	–4401.30	–4409.44
Tests for spatial dependence		

Moran's I (error)	0.053***	/
Lagrange Multiplier test (lag)	15.167***	15.657***
Robust Lagrange Multiplier test (lag)	7.000**	/
Lagrange Multiplier test (error)	9.560**	1.079
Robust Lagrange Multiplier test (error)	1.393	/

Notes: † $p \leq 0.10$; * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$; standard errors in parentheses.

TABLE 2. Descriptive statistics of the five categories of MCDs

Explanatory variable	All	Urban	Suburban	Rural-Adjacent	Rural-Exurban	Rural-Remote
Population size in 2000	2,920	19,320	2,897	2,205	1,004	952
	(16,117)	(57,094)	(5,299)	(3,937)	(1,320)	(1,170)
Geographic size (miles squared)	30.53	20.77	27.08	24.69	31.22	54.08
	(26.87)	(19.32)	(21.81)	(19.17)	(25.43)	(43.08)
The in-migration rate of MCDs from 1995–2000	0.31	0.34	0.32	0.31	0.31	0.31
	(0.08)	(0.10)	(0.07)	(0.08)	(0.08)	(0.08)
The in-migration rate across the county from 1985–1990	0.14	0.14	0.13	0.14	0.15	0.17
	(0.07)	(0.06)	(0.06)	(0.07)	(0.07)	(0.08)
The proportion of forest area	0.30	0.16	0.20	0.18	0.36	0.56
	(0.23)	(0.16)	(0.18)	(0.16)	(0.22)	(0.16)
The proportion of water area	0.03	0.05	0.03	0.03	0.02	0.05
	(0.07)	(0.12)	(0.07)	(0.06)	(0.05)	(0.06)
The proportion of wetland area	0.12	0.06	0.10	0.12	0.13	0.22
	(0.13)	(0.06)	(0.10)	(0.12)	(0.13)	(0.16)
The proportion of public land area	0.05	0.02	0.03	0.04	0.04	0.18
	(0.14)	(0.07)	(0.06)	(0.12)	(0.12)	(0.27)
The length of riverbanks/lakeshores/coastlines	17.05	14.46	16.11	15.84	17.45	21.65
	(10.00)	(9.59)	(9.32)	(9.89)	(9.91)	(10.73)
Golf courses	7,853	15,461	8,918	7,603	6,124	8,260
	(13,257)	(30,677)	(15,339)	(8,446)	(8,793)	(10,097)
Viewsheds (12.5%–20%)	0.05	0.02	0.03	0.04	0.06	0.05
	(0.07)	(0.03)	(0)	(0.06)	(0.08)	(0.08)
Demographic index 1	0.00	–0.15	0.29	0.01	–0.06	–0.23
	(0.83)	(0.70)	(0.64)	(0.69)	(0.91)	(0.98)
Demographic index 2	0.00	0.84	0.00	0.04	–0.12	–0.16
	(0.72)	(1.71)	(0.47)	(0.54)	(0.46)	(0.79)
Livability index 1	0.00	1.49	0.60	0.13	–0.47	–0.54
	(0.96)	(1.38)	(1.06)	(0.60)	(0.53)	(0.53)
Livability index 2	0.00	0.55	–0.10	0.10	–0.10	0.03
	(0.92)	(0.92)	(0.84)	(0.92)	(0.93)	(0.82)
Livability index 3	0.00	0.04	0.19	0.26	–0.01	–0.89
	(0.89)	(0.48)	(0.61)	(0.66)	(0.97)	(1.02)
Accessibility index 1	0.00	1.59	0.11	–0.12	–0.21	–0.23
	(0.86)	(2.17)	(0.69)	(0.47)	(0.32)	(0.35)
Accessibility index 2	0.00	0.56	–0.20	0.01	–0.03	0.08
	(0.53)	(0.67)	(0.60)	(0.40)	(0.45)	(0.51)
Developability index	0.72	0.62	0.78	0.74	0.74	0.57
	(0.19)	(0.27)	(0.16)	(0.18)	(0.17)	(0.21)
Sample size (*N*)	1,837	130	363	383	782	179

Note: The number refers to the mean of each variable in its corresponding type of MCD; standard errors are in parentheses.

TABLE 3. Results of spatial regime model with lag dependence

Explanatory variable	Urban	Suburban	Rural-Adjacent	Rural-Exurban	Rural-Remote
The proportion of forest area	–0.110	–0.017	–0.011	–0.040*	–0.085*
	(0.067)	(0.031)	(0.031)	(0.017)	(0.043)
The proportion of water area	0.035	–0.119†	0.170*	0.053	–0.065
	(0.073)	(0.075)	(0.074)	(0.055)	(0.128)
The proportion of wetland area	0.203	–0.090	0.036	–0.022	–0.014
	(0.145)	(0.059)	(0.046)	(0.028)	(0.051)
The proportion of public land area	–0.044	0.041	0.074†	0.027	–0.021
	(0.116)	(0.066)	(0.039)	(0.027)	(0.038)
The length of	6.01E–5	0.001	–0.001	2.46E–4	0.001
riverbanks/lakeshores/coastlines	(0.001)	(0.001)	(0.001)	(3.91E–4)	(0.001)
Golf courses	–5.36E–8	–1.59E–7	8.80E–7†	8.03E–8	2.39E–7
	(2.18E–7)	(2.64E–7)	(5.29E–7)	(3.17E–7)	(6.13E–7)
Viewsheds (12.5%–20%)	0.030	0.044	0.138†	0.109*	0.114
	(0.291)	(0.100)	(0.085)	(0.048)	(0.106)
The in-migration rate across the county	0.354**	0.376***	0.426***	0.210***	0.276**
from 1985–1990	(0.115)	(0.073)	(0.066)	(0.040)	(0.087)
Demographic index 1	–0.063***	0.006	–0.012†	0.009**	0.021**
	(0.016)	(0.007)	(0.007)	(0.003)	(0.008)
Demographic index 2	0.009	0.019	0.023**	0.005	0.013
	(0.005)	(0.010)	(0.008)	(0.006)	(0.009)
Livability index 1	0.015†	0.002	0.001	–0.001	0.000
	(0.008)	(0.006)	(0.007)	(0.005)	(0.013)
Livability index 2	0.031	–0.008	0.006	–0.006	0.016
	(0.017)	(0.009)	(0.007)	(0.004)	(0.009)
Livability index 3	–0.076***	–0.018*	–0.024***	–0.024***	–0.032***
	(0.016)	(0.009)	(0.008)	(0.004)	(0.009)
Accessibility index 1	–0.018***	–0.002	–0.018*	–0.002	–0.026
	(0.005)	(0.007)	(0.009)	(0.008)	(0.017)
Accessibility index 2	0.026*	–0.003	–0.003	0.001	–0.008
	(0.011)	(0.007)	(0.010)	(0.006)	(0.013)
Developability index	0.174***	–0.054	0.146***	0.065**	–0.032
	(0.053)	(0.048)	(0.037)	(0.024)	(0.051)
Spatial lag	0.220	0.166	0.030	0.286***	0.046
	(0.157)	(0.092)	(0.075)	(0.055)	(0.112)
Constant	0.072	0.265***	0.123**	0.144***	0.279***
	(0.071)	(0.053)	(0.044)	(0.029)	(0.071)
Measures of fit					
Log likelihood			2365.97		
AIC			–4551.94		
BIC			–4055.51		
Tests for spatial dependence					
Moran's I (error)			–0.032		
Lagrange Multiplier test (lag)			0.000		
Lagrange Multiplier test (error)			3.418		

Notes: † $p \leq 0.10$; * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$; standard errors in parentheses.

FIGURE 1. Classification of MCDs in Wisconsin, USA