Rethinking the Migration Effects of Natural Amenities: Part I

Guangqing Chi
Department of Sociology and Social Science Research Center
Mississippi State University
PO Box C
Mississippi State, MS 39762 USA

David W. Marcouiller
Department of Urban and Regional Planning
University of Wisconsin-Madison
Madison, WI 53706 USA

Introduction

Increasingly, conventional academic wisdom suggests that natural amenities play a significant role in regional demographic change. In large part, the post-1970 "turnaround migration," was thought to be a function of the attractive power of natural amenities in rural America (Brown et al 1997; Fuguitt and Brown 1990; Fuguitt et al 1989; Fuguitt and Zuiches 1975; Humphrey 1980; Johnson 1982, 1989; Johnson and Beale 1994; Johnson and Purdy 1980; Zuiches and Rieger 1978). However, empirical studies often find little significance of natural amenities in influencing socio-demographic change (c.f. Duffy-Deno 1998; Kim et al 2005; Lewis et al 2002). These conflicting findings, we argue, are due both to the empirical complexity of amenities and to the partial approach used in isolating causal relationships. Most previous studies examine the effect of natural amenities on migration without controlling for other influential factors such as demographic characteristics, socioeconomic scenarios, transportation accessibility, and land development. In Part I of this study we attempt to adopt a more systematic approach to study the role of natural amenities in affecting migration at the local level through empirical analysis in the U.S. Lake State of Wisconsin at the minor civil division level between 1995 and 2000.

 XXXII: 3
(Autumn/automne 2009), 331-348.
ISSN: 0705-4580 Printed in Canada/Imprimé au Canada

Historic Context of Migration

Throughout human history, migration has resulted as an evolutionary process driven by a variety of determinants. It is thought that the natural amenity component of regional resource assets has played a role in affecting migration only recently. Thus, it is important to place natural amenities within the historic context of population redistribution and migration. Regional scientists, demographers, human geographers, and scholars in other disciplines have studied the history of population distribution and settlement patterns, and explored geophysical, agglomerative, and urbanization determinants of changes (Jaret 1983; Moore and Thorsnes 1994; Morris 1994). An exhaustive literature review of population-related theories and empirical studies resulted in approximately 70 variables that were considered significantly relevant to migration. These variables fall within the broad realms of demographic characteristics, socioeconomic conditions, physical infrastructure, environmental and geophysical factors, cultural resources, and potential legal constraints (Table 1).

A relatively recent process of suburbanization started at the beginning to middle of the 20th Century when the innovation of transportation tools allowed people to live in suburbs and work in city centers. This early suburban development was exclusively residential with commercial development becoming important since the 1930s (Pucher and Lefevre 1996). Another interesting process of ruralization and exurbanization started in the 1970s with turn-around migration back to non-metropolitan areas. The driving notion behind this turn-around was that migrants understood, internalized, and were moved to act by the attractiveness of natural amenities as a principal motivating factor. Centralization re-gained power in the 1980s especially in some metropolitan areas, while rural areas rebounded in the 1990s (Johnson 1999). These different human settlement processes are characterized by different driving factors. Thus, a synthetic view of natural amenities' effects on population growth demands a systematic examination of migration's driving factors. A combination of increased affluence, development of transportation infrastructure, active regional competitiveness, globalization, and environmental awareness/sensitivity have driven development into a post-industrial (some say post-consumer) phase which has quality-of-life and amenities as central determinants of migration (Buttel 1995; Castle 1993; Freudenberg 1992; Galston and Baehler 1995; Marcouiller et al 2002; Thompson et al 2006).

This discussion leads us to two research questions. How can we develop a more integrative approach to modeling migration? Does this approach provide a relatively more comprehensive view of the role natural amenities play in explaining socio-demographic change? These are the relevant questions addressed in the work reported here.

Part I of this paper is organized into three additional sections. This introduction is followed by a discussion of data and methods used. The subsequent results section organizes and develops our synthetic approach using several individual metrics that represent natural amenities and four indices that capture demographics, livability, accessibility, and developability. These are examined as explanatory variables used to understand in-migration from 1995-2000 at the minor civil division level in Wisconsin. Finally, we close Part I with a concluding summary section that thematically ties itself to Part II.

TABLE 1 A Review of the Literature on Migration Factors

Key variables	Relevant studies
Demographic characteristics	
Population size	Humphrey 1980; Smith et al 2001
Population density	Humphrey 1980; Humphrey et al 1977; Lutz 1994; Moore and Thorsnes 1994
Age structure	DaVanzo 1981; Humphrey 1980; Shryock 1964
Racial and ethnic composition	Friedman and Lichter 1998; Shryock 1964
Gender	Greenberg et al 1978
Socioeconomic conditions	
Employment opportunities	Fuguitt et al 1989; Johnson 1982; Johnson and Beale 1994; Lyson and Gillespie 1995; Smith et al 2001
School performance	Lyson 2002
Crime rate	Carlino and Mills 1987; Clark and Murphy 1996; Deller et al 2001; Graves 1979; Messner and Anselin 2004; Schachter and Althaus 1989
Income and real estate value	Fuguitt et al 1989; Johnson and Beale 1994; Lyson and Gillespie 1995; Marcouiller et al 2004; Smith et al 2001
Educational attainment	DaVanzo 1981; Mincer 1978
Institutional populations	Humphrey et al 1977; Mincer 1978
Household demographic characteristics	DaVanzo 1981; Mincer 1978; Shryock 1964
Public infrastructure	Aschauer 1989, 1990; Berndt and Hansson 1992; Biehl 1991; Dalenberg and Partridge 1997; Duffy-Deno and Eberts 1991; Garcia-Mila and McGuire 1992; Holtz-Eakin 1994; Hulten and Schwab 1984; Morrison and Schwartz 1996; Nadiri and Mamuneas 1994; Shah 1992
Local efforts to expand public services	Johnson and Beale 1994; Thompson et al 2006
Occupational structure	Browning and Gibbs 1971; Frisbie and Poston 1975, 1976, 1978; Gibbs and Browning 1966; Gibbs and Martin 1958; Hirschl et al 1998; Poston and Frisbie 1998; Sly 1972
County seat status	Johnson and Purdy 1980
Transportation and community infrastructure	
Residential preference	Astone and McLanahan 1994; Bartel 1979; Brown et al 1997; Fuguitt and Brown 1990; Fuguitt and Zuiches 1975; Mincer 1978; Zuiches and Rieger 1978
Highways	Chi et al 2006; Smith et al 2001; Voss and Chi 2006
Traffic volume	Hobbs and Campbell 1967
Distance to access of highways	Humphrey 1980; Smith et al 2001
Journey to work	Greenberg et al 1978
Local capital expenditures on transportation	Humphrey 1980; Humphrey et al 1977; Levinson 2008

TABLE 1 A Review of the Literature on Migration Factors, continued

Natural amenities	
Forests	Fuguitt et al 1989; Johnson and Beale 1994; Kim et al 2005; Marcouiller 1998
Water features	Clark and Murphy 1996; Graves 1979; Schachter and Althaus 1989
Climate (sunshine, precipitation, humidity, and temperature)	Graves 1980; Kim et al 2005; Marcouiller et al 2004
Topography (mountains, canyons, and hills)	Clark and Murphy 1996; Fuguitt et al 1989; Kim et al 2005
Environmental disamenities (e.g., landfills and power plants)	Kim et al 2005; Marcouiller et al 2002
A variety of proxies such as spending on hotels, motels, trailer parks, and camps, the proportion of population employed in entertainment and recreation and other service industries, the proportion of income derived from entertainment, recreation, and hotels, and the proportion of seasonal housing units	Johnson and Beale 1994; Marcouiller 1997
Land conversion and development	
Geophysical characteristics (water, wetland, slope, and tax-exempt lands)	Cardille et al 2001; Stanbery 1952; Smith et al 2001
Legal constraints (including land use planning legislation and programs such as comprehensive plans, "smart growth" laws, zoning ordinances, farmland protection programs, environmental regulations such as Clean Water Act, shoreland and wetland zoning, and others)	Greenberg et al 1978; Smith et al 2001
Built-up lands (existing residential, commercial, and industrial developments, as well as transportation infrastructure)	Cowen and Jensen 1998; Land Information & Computer Graphics Facility 2000, 2002

Data and Methods Used

In order to address these questions, we categorize migratory factors and develop four indices: (1) *demographics* (local demographic characteristics), (2) *livability* (a measure of social and economic conditions), (3) *accessibility* (transportation and community infrastructure), and (4) *developability* (the potential for land conversion and development). In addition, we use seven individual variables that capture regional differences in the presence of natural amenities.

This study focuses on the state of Wisconsin as the research case, and examines in-migration from 1995 to 2000 (the dependent variable) at the Minor Civil Division (MCD) level.[1] Our analytical dataset consists of 1,837 adjusted

1. The great advantage of using MCDs is their relevance to planning and public policy-making. Wisconsin is a "strong MCD" state and its MCDs (towns, cities, and villages) are functioning governmental units with elected officials who provide services and raise revenues. In most parts of the State, census tracts have an average size similar to MCDs and provide an alternative unit of analysis. However, census tracts are geographic units delineated by the Census Bureau only

MCDs with an average size of 29.56 square miles.[2] Ideally the dependent variable can be better represented by net migration rather than in-migration. We use the latter for two reasons. First, net migration data does not exist at the MCD level in Wisconsin and would be very difficult to create. Second, natural amenities influence migration mainly through their attractive power, and thus the effects of natural amenities tend to affect decision of in-migrants rather than out-migrants. The data used in this study 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.

In this study we applied principal factor analysis (PFA) and spatial overlay methods for index generation. As discussed in a previous section, migration is influenced by numerous factors. However, the large number of variables often raises the problem of serious and unnecessary multicollinearity which affects the efficiency of regression models. This dilemma can be solved by reducing the dimensions of variables. The natural amenity variables are used individually in regression models in order to better interpret each amenity variable's effects on migration.

PFA with varimax rotation and the Kaiser (1960) criterion is used to generate three of the four indices –– demographics, accessibility, and livability. A number of studies employ principal component analysis (PCA) to generate factors for studying the effects of natural amenities on economic growth and development (e.g., Deller et al 2001; English et al 2000; Kim et al 2005; Marcouiller et al 2004). PCA seeks the set of factors which account for both the common and unique variance of the variables, and can be seen as a variance-focused approach. In contrast, PFA seeks the least number of factors which represent the common variance of the variables and is a correlation-focused approach reproducing the inter-correlation among the variables. We are interested only in the common variance of the variables, and thus the PFA is used to generate indices. To decide the number of factors to be used for representing each index, we use the Kaiser criterion which keeps the factors with eigenvalues over 1. In addition, we implement varimax rotation, the most common rotation method, to the factor analysis in order to better facilitate the interpretation of factors.

The developability index is generated by the spatial overlay, a set of methods that can be utilized to integrate several geographical data layers that share all or part of the same area into one data layer that identifies the spatial relationships. The variables used to generate the developability index include water, wetland, slope, tax-exempt lands, and built-up lands, which are seen as undevelopable. In this research, we first overlaid the data layers of these variables to create one layer representing all undevelopable lands in Wisconsin. This layer is then intersected with a geographic MCD layer to create a layer that contains the information for undevelopable lands at the MCD level. We then calculated the proportion of undevelopable land for each MCD. Finally, we generated the developability index by subtracting the proportion of undevelopable land from one.

Next, the generated factors as well as individual natural amenity variables are

---

for counting population purpose, and they have no political or social meanings.

2. The MCD geography consists of non-nested, mutually exclusive and exhaustive political territory. MCD boundaries are not stable over time and thus they were adjusted to be consistent.

incorporated into three ordinary least squares (OLS) regression models in different compositions to examine and compare their effects on migration. Model OLS 1 accounts only for the natural amenity variables, Model OLS 2 also considers the temporal effects of migration, and Model OLS 3 adds the factors of demographics, livability, accessibility, and developability. Their performance is evaluated on the basis of measures of fit, which include R^2, log likelihood, Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and multicollinearity condition number.

Results

Defining Natural Amenities

Natural amenities include a large number of region-specific characteristics associated with environmental aesthetics, site specific attributes, and natural resource presence. Definitions of natural amenities vary widely, as different researchers focus on different sets of variables to study the influences of natural amenities. No single accepted method for measuring natural amenities exists (Kim et al 2005; Marcouiller et al 2004). Natural amenities can be measured directly using physical variables including hydrology (Clark and Murphy 1996; Graves 1979, 1983; Schachter and Althaus 1989; Smith et al 2001), forests (Fuguitt et al 1989; Gustafson et al 2005; Hammer et al 2004; Kim et al 2005; Marcouiller et al 2002; Marcouiller et al 2004), topography (mountains, canyons, and hills), climate (sunshine, precipitation, humidity, and temperature), and outdoor recreation attributes (Kim et al 2005; Marcouiller et al 2002; Marcouiller et al 2004; Smith et al 2001). In this study we use seven typical and directly measured variables to represent natural amenities (Figure 1). They include 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), lakeshore/riverbank/coastline (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 slope (the proportion of a MCD's area with slope between 12.5% and 20%).[3]

Explanatory Controls

Demographics: The demographic index was based on population density, and the proportions of young, old, blacks, and Hispanics. The PFA by varimax rotation with the Kaiser criterion produces two demographic indices (Table 2). The first factor accounted for 31.43% variance, mainly explained by the proportions of young and old. The second factor accounted for 28.72% variance, explained by population density and the proportions of blacks and Hispanics. Thus Demographic Index 1 can be seen as an age-structure factor, and Demographic Index 2 can be roughly seen as a race factor.

3. The range of 12.5%-20% is subjective.

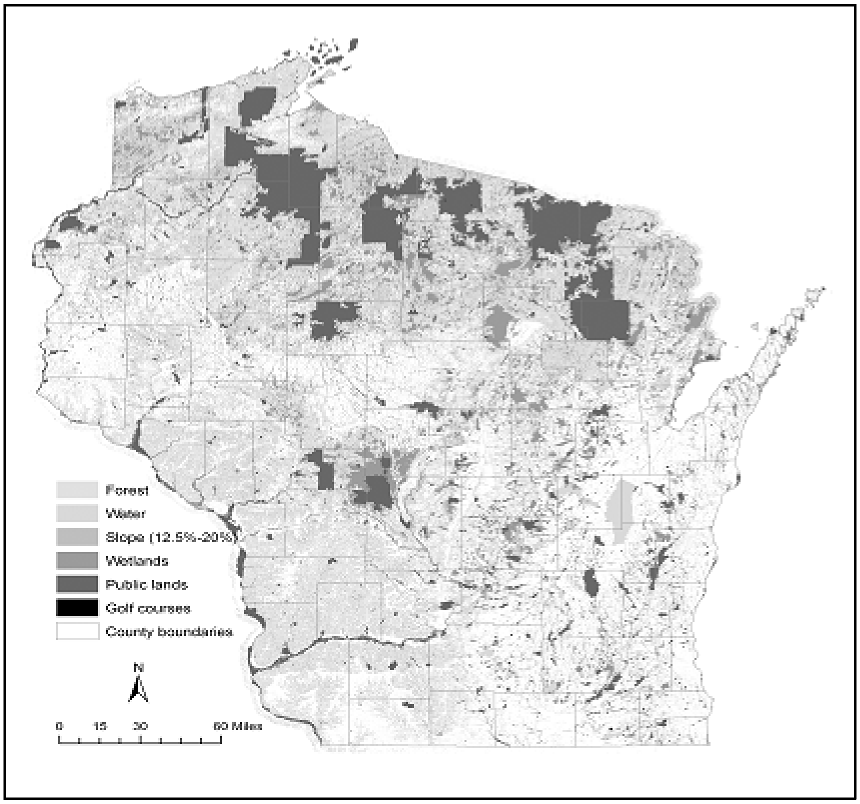

FIGURE 1 Natural Amenities in Wisconsin

Liveability: Liveability refers to developmental amenities and urban-like conditions suitable for convenient lifestyles and quality-of-living. The variables included school performance (measured in average American College Testing scores), unemployment rate, crime rate, income, real estate value, educational attainment (measured in the proportions of adults graduated from high school and college), proportion of college students, proportion of female-headed households, proportion of housing units using public water, proportion of new housing units, proportion of seasonal housing units, county seat status, and occupational structure (proportion of workers in agriculture and retail sectors). Three of the factors had eigenvalues larger than 1 (reported in Table 2). Factor 1 accounted for 26.31% of total variance and was explained by income, real estate value, and educational attainment. Factor 2 accounted for 15.20% variance and was explained by the proportion of housing units using public water and the proportion of workers in agricultural and retail industries. Factor 3 accounted for 11.79% variance and was explained by unemployment rate, the proportion of new and seasonal housing units, and the proportion of workers in agricultural and retail industries.

TABLE 2 Principal Factor Analysis by Varimax Rotation with Kaiser Criterion

Demographic variables	Factor loadings		
	Factor 1	Factor 2	
Variance explained	31.43%	28.72%	--
Population density	-0.264	0.437	--
Young	0.784	-0.008	--
Old	-0.559	-0.013	--
Blacks	0.084	0.592	--
Hispanics	0.031	0.470	--
Livability variables	Factor loadings		
	Factor 1	Factor 2	Factor 3
Variance explained	26.31%	15.20%	11.79%
Unemployment rate	0.379	-0.065	0.447
School performance	0.210	0.035	-0.023
Crime rate	0.390	0.120	-0.141
Income	0.882	-0.208	0.223
High school education	0.728	-0.020	0.090
Bachelor’s degree	0.771	0.116	-0.038
College students	0.394	0.201	0.063
Female-headed households	-0.084	0.352	-0.006
Public water	0.094	0.832	0.152
New housing	-0.370	-0.028	0.604
Seasonal housing	-0.217	-0.214	-0.661
Real estate value	0.875	-0.130	-0.048
County seat status	0.008	0.371	0.050
Retail	0.139	0.413	-0.321
Agriculture	-0.367	-0.650	0.460
Accessibility variables	Factor loadings		
	Factor 1	Factor 2	
Variance explained	29.72%	15.02%	--
Residential preference	0.460	0.141	--
Accessibility to airports	0.348	0.171	--
Accessibility to highways	-0.008	0.049	--
Highway infrastructure	0.781	0.119	--
Journey to work	0.134	0.472	--
Public transportation	0.297	-0.071	--
Buses	0.631	-0.099	--

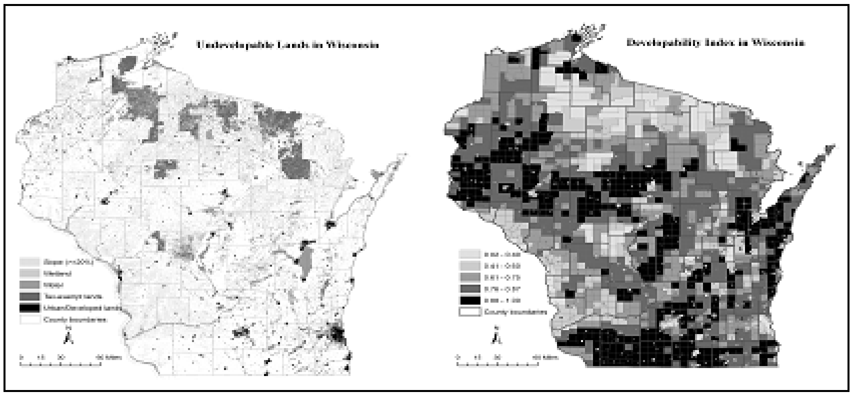

FIGURE 2 Undevelopable Lands and Developability in Wisconsin

Accessibility: The variables used to construct the accessibility index include residential preference,[4] accessibility to airports, accessibility to highways, highway infrastructure, a journey to work metric, public transportation, and buses. Two factors were generated. Factor 1 accounted for 29.72% variance and was explained by residential preference, accessibility to airports, highway infrastructure, and buses. Factor 2 accounted for 15.02% variance and was explained by journey to work. For interpretation, factor 1 can be understood as an index of transportation infrastructure, and factor 2 as an index of travel behavior.

Developability: The variables used to characterize "developability" included water, wetland, slope, tax-exempt lands, and built-up lands. The developability of a region is thought to be determined by its geophysical characteristics, built-up lands, cultural resources, and legal constraints (Frentz et al 2004). Ideally we would use all of these variable types to derive the developability index but considering data availability we used only geophysical and built-up land variables. The proportion of developable lands in each MCD is spatially summarized in Figure 2 and provides an interesting mechanism to predict the direction and trend of land development. For descriptive purposes, it logically presents an explanatory element of population redistribution.

Model Specifications

Individual natural amenity variables and generated factors were analyzed using three OLS regression models to examine their effects on migration. The OLS regression model was specified as:

$$Y = X\beta + \varepsilon \qquad \textbf{(1)}$$

4. The measurement of residential preference, accessibility to airports, and accessibility to highways incorporated spatial effects in neighboring states (Minnesota, Iowa, Illinois, and Upper Michigan).

where Y denotes the vector of response variables, X denotes the matrix of explanatory variables, β denotes regression coefficients of the explanatory variables, and ε denotes the vector of error terms that are independent but identically distributed. Model OLS 1 considers only the seven natural amenity variables in examining the in-migration rate 1995-2000 (Table 3). Model OLS 2 also takes into account the in-migration rate 1985-90[5] in order to control the temporal dimension of the dependent variable. Model OLS 3 further incorporates the indices into the model. The comparison of Model OLS 2 and Model OLS 1 indicated that the in-migration rate in the previous ten years played a significant role in affecting the goodness-of-fit of the model specification. Model OLS 2 exhibited a much larger R^2 (0.139) than Model OLS 1 (R^2 = 0.023). Other measures of fit (log likelihood, AIC, and BIC) also suggest OLS 2 is a better model than OLS 1.

The comparison between Models OLS 3 and OLS 2 suggested the importance of systematically considering in-migration's driving factors. The incorporation of the indices improves the goodness-of-fit of the model specification, as indicated by the statistics of R^2, log likelihood, AIC, and BIC. Overall, among the three OLS models, OLS 3 provided the best goodness-of-fit. The multicollinearity condition numbers in the three OLS models are all less than 30, a threshold value by which the multicollinearity is diagnosed (Anselin 2005). An OLS model using all variables individually rather than using indices generates a multicollinearity condition number of 140. Thus, the use of indices eliminates the multicollinearity problem.

The coefficients and significance of the seven natural amenity variables vary from OLS 1 to OLS 2 to OLS 3. In Model OLS 1, four amenity variables –– the proportions of water area, wetland area, and public land, and golf courses –– are significant in explaining in-migration. In Model OLS 2, the proportion of wetland area and golf courses remain significant, but the proportions of water area and public land become insignificant. In Model OLS 3, none of the previously identified amenity variables were significant, but the proportion of forest area and slope became significant in explaining in-migration. The in-migration rate in 1985-90 and six of the eight indices are significant. The variation of coefficients and significance of the natural amenity variables was due to the inclusion/exclusion of the temporal dimension and other driving factors of migration, which helps explain why existing studies are often found to generate contradictory findings.

Summary

In Part I of this study, we developed a critical review of the existing literature that focused on the role of natural amenities in explaining rural socio-demographic change. Our discussion centered on the overly narrow scope of applied research to-date. In response, we developed a more comprehensive set of indices to represent a more holistic approach to modeling migration in the presence of natural amenities. When combined with other control variables, these indices were

5. The in-migration rate 1985-90 was calculated as in-migrants from a different county, rather than from a different MCD. The data of in-migrants from a different MCD from 1985-90 was not collected in the decennial census.

TABLE 3 OLS Regression Models and Diagnostics

Explanatory variables	OLS 1	OLS 2	OLS 3
Constant	0.317*** (0.004)	0.259*** (0.005)	0.241*** (0.016)
The proportion of forest area	0.016 (0.009)	-0.012 (0.009)	-0.048*** (0.011)
The proportion of water area	0.078** (0.028)	0.026 (0.027)	0.025 (0.031)
The proportion of wetland area	-0.057*** (0.018)	-0.045** (0.016)	-0.023 (0.019)
The proportion of public land area	0.039** (0.014)	0.019 (0.014)	0.026 (0.016)
The length of riverbank/lakeshore/coastline	-4.165e-4 (2.186e-4)	1.551e-4 (2.084e-4)	7.073e-5 (2.407e-4)
Golf courses	4.570e-7** (1.435e-7)	2.761e-7* (1.352e-7)	-1.322e-8 (1.377e-7)
Slope	-0.010 (0.033)	-0.005 (0.031)	0.122*** (0.034)
The in-migration rate across county in 1985-90	--	0.401*** (0.026)	0.327*** (0.027)
Demographic index 1	--	--	0.006* (0.002)
Demographic index 2	--	--	0.012*** (0.003)
Livability index 1	--	--	0.008*** (0.002)
Livability index 2	--	--	-0.002 (0.003)
Livability index 3	--	--	-0.024*** (0.003)
Accessibility index 1	--	--	-0.005* (0.003)
Accessibility index 2	--	--	-5.512e-4 (0.003)
Developability index	--	--	0.047** (0.016)
Measures of fit			
R^2	0.023	0.139	0.202
Log likelihood	2078.66	2195.24	2264.53
AIC	-4141.32	-4372.48	-4495.07
BIC	-4097.20	-4322.83	-4401.30
Multicollinearity condition number	5.88	8.63	29.30

Note: 1. * significance at 0.05, ** significance at 0.01, ***significance at 0.001; standard errors in brackets.

modeled using alternative approaches which provided insights into the empirical methods used to assess the role of natural amenities in explaining migration.

Our results suggest that migration effects of natural amenities vary by the inclusion/exclusion of many contextual forces that act to drive rural population change. Their migration attraction appears to exist only when other conditions (demographics, livability, accessibility, and developability) are met. The results of this study challenge conclusions from other related studies which examine how one or more of the five groups of variables, in isolation, influence migration without controlling the others. Conclusions from such studies appear suspect as a result of their narrowness of scope. Rural development of amenity-rich regions as measured using socio-demographic change is determined jointly by demographic, social, economic, political, geographic, and cultural forces. None of the five groups of variables appear well-suited to independently explain socio-demographic change. We would further assert that this is true for explaining rural economic change characteristics such as income and job growth, income distribution, and sectoral diversity. Conventional academic wisdom needs continual criticism; caution is needed when interpreting scientific findings, especially when most studies are conducted from a partial perspective.

From a methodological perspective, it is essential to systematically consider migratory factors, reduce their dimensions, and incorporate temporal effects in order to examine the effects of natural amenities on migration. The incorporation of other migratory factors and the temporal effect improved the models' goodness-of-fit. The use of indices provided two advantages over individual variables as explanatory variables — eliminating multicollinearity in regression models, and allowing the integration of two seemingly unmixable modeling approaches (environmental and demographic). This said, using indices has limitations. Indices suffer from an inherent interpretation problem; as an aggregate of several individual variables, an index can be difficult to discern underlying inferences.

While Part I provided a comprehensive understanding of the migration effects of natural amenities, the spatial dynamics of migration and its driving factors were not considered. Migration has been shown to be a spatially explicit phenomenon as evidenced by a rather broad literature (Chi and Zhu 2008). Thus, it is important to consider spatial interactions between migration and causal migratory factors in explanatory regional models. Indeed, estimation of model parameters and statistical inference can be unreliable if the spatial effects exist but are not accounted for in a model. In Part II, we will adopt a spatial regression approach to examine the migration effects of natural amenities.

References

Anselin, L. 2005. *Exploring Spatial Data with GeoDa™: A Workbook*. Urbana, IL: Spatial Analysis Laboratory, University of Illinois at Urbana-Champaign.

Aschauer, D.A. 1989. "Is Public Expenditure Productive?" *Journal of Monetary Economics* 23: 177-200.

_______. 1990. "Highway Capacity and Economic Growth". *Economic Perspectives* 14: 14-24.

Astone, N. and S. McLanahan. 1994. "Family Structure, Residential Mobility and

School Report: A Research Note". *Demography* 31: 575-584.

Bartel, A. 1979. "The Migration Decision: What Role Does Job Mobility Play?" *American Economic Review* 69: 775-786.

Berndt, E.R. and B. Hansson. 1992. "Measuring the Contribution of Public Infrastructure Capital in Sweden". *Scandinavian Journal of Economics* 94: S151-172.

Biehl, D. 1991. "The Role of Infrastructure in Regional Development", in: R.W. Vickerman (ed.), *Infrastructure and Regional Development, Vol. 1*. London: Pion Limited, 9-35.

Brown, D.L., G.V. Fuguitt, T.B. Heaton and S. Waseem. 1997. "Continuities in Size of Place Preferences in the United States, 1972-1992". *Rural Sociology* 62: 408-428.

Browning, H.L. and J.P. Gibbs. 1971. "Intraindustry Division of Labor: The States of Mexico". *Demography* 8: 233-245.

Buttel, F. 1995. "Twentieth Century Agricultural-Environmental Transitions: A Preliminary Analysis". *Research in Rural Sociology and Development* 6: 1-21.

Cardille, J.A., S.J. Ventura and M.G. Turner. 2001. "Environmental and Social Factors Influencing Wildfires in the Upper Midwest, USA". *Ecological Applications* 11: 111-127.

Carlino, G.A. and E.S. Mills. 1987. "The Determinants of County Growth". *Journal of Regional Science* 27: 39-54.

Castle, E. 1993. "A Pluralistic, Pragmatic and Evolutionary Approach to Natural Resource Management". *Forest Ecology and Management* 56: 279-295.

Chi, G., P.R. Voss and S.C. Deller. 2006. "Rethinking Highway Effects on Population Change". *Public Works Management and Policy* 11: 18-32.

Chi, G. and J. Zhu. 2008. "Spatial Regression Models for Demographic Analysis". *Population Research and Policy Review* 27: 17-42.

Clark, D. and C. Murphy. 1996. "Countywide Employment and Population Growth: An Analysis of the 1980s". *Journal of Regional Science* 36: 235-256.

Cowen, D.J. and J.R. Jensen. 1998. "Extraction and Modeling of Urban Attributes Using Remote Sensing Technology", in D. Liverman, E.F. Moran, R.R. Rindfuss and P.C. Stern (eds.), *People and Pixels: Linking Remote Sensing and Social Science*. Washington DC: National Academy Press, 164-188.

Dalenberg, D.R. and M.D. Partridge. 1997. "Public Infrastructure and Wages: Public Capital's Role as a Productive Input and Household Amenity". *Land Economics* 73: 268-284.

DaVanzo, J. 1981. "Microeconomic Approaches to Studying Migration Decisions", in: G.F. DeJong and R.W. Gardner (eds.), *Migration Decision Making: Multidisciplinary Approaches to Microlevel Studies in Developed and Developing Countries*. New York: Pergamon Press, 90-129.

Deller, S.C., T-H.S.Tsai, D.W. Marcouiller and D.B.K. English. 2001. "The Role of Amenities and Quality-of-Life in Rural Economic Growth". *American Journal of Agricultural Economics* 83: 352-365.

Duffy-Deno, K.T. 1998. "The Effect of Federal Wilderness on County Growth in the Intermountain Western". *Journal of Regional Science* 38: 109-136.

Duffy-Deno, K.T. and R.W. Eberts. 1991. "Public Infrastructure and Regional Economic Development: A Simultaneous Equations Approach". *Journal of*

Urban Economics 30: 329-343.

English, D.B.K., D.W. Marcouiller and H.K. Cordell. 2000. "Tourism Dependence in Rural America: Estimates and Effects". *Society and Natural Resources* 13: 185-202.

Frentz, I.C., F.L. Farmer, J.M. Guldin and K.G. Smith. 2004. "Public Lands and Population Growth". *Society and Natural Resources* 17: 57-68.

Freudenburg, W. 1992. "Addictive Economies: Extractive Industries and Vulnerable Localities in Changing World Economy". *Rural Sociology* 57: 305-332.

Friedman, S. and D.T. Lichter. 1998. "Spatial Inequality and Poverty among American Children". *Population Research and Policy Review* 17: 91-109.

Frisbie, W.P. and D.L. Poston. 1975. "Components of Sustenance Organization and Nonmetropolitan Population Change: A Human Ecological Investigation". *American Sociological Review* 40: 773-784.

_______. 1976. "The Structure of Sustenance Organization and Population Change in Nonmetropolitan America". *Rural Sociology* 41: 354-370.

Frisbie, W.P. and D.L. Poston. 1978. "Sustenance Differentiation and Population Redistribution". *Social Forces* 57: 42-56

Fuguitt, G. and D.L. Brown. 1990. "Residential Preferences and Population Redistribution". *Demography* 27: 589-600.

Fuguitt, G.V., D.L. Brown and C.L. Beale. 1989. *Rural and Small Town America*. New York: Russell Sage Foundation.

Fuguitt, G.V. and J.J. Zuiches. 1975. "Residential Preferences and Population Distribution". *Demography* 12: 491-504.

Galston, W. and K. Baehler. 1995. *Rural Development in the United States: Connecting Theory, Practice, and Possibilities*. Washington, DC: Island Press.

Garcia-Mila, T. and T.J. McGuire. 1992. "The Contribution of Publicly Provided Inputs to States' Economies". *Regional Science and Urban Economics* 22: 229-242.

Gibbs, J.P. and H.L. Browning. 1966. "The Division of Labor, Technology, and the Organization of Production in Twelve Countries". *American Sociological Review* 31: 81-92.

Gibbs, J.P. and W.T. Martin. 1958. "Urbanization and Natural Resources: A Study in Organizational Ecology". *American Sociological Review* 23: 266-277.

Graves, P. 1979. "A Life-Cycle Empirical Analysis of Migration and Climate by Race". *Journal of Urban Economics* 6: 135-147.

_______. 1980. "Migration and Climate". *Journal of Regional Science* 20: 227-237.

_______. 1983. "Migration with a Composite Amenity". *Journal of Regional Science* 23: 541-546.

Greenberg, M.R., D.A. Krueckeberg and C.O. Michaelson. 1978. *Local Population and Employment Projection Techniques*. New Brunswick, NJ: Center for Urban Policy Research.

Gustafson, E.J., R.B. Hammer, V.C. Radeloff and R.S. Potts. 2005. "The Relationship between Environmental Amenities and Changing Human Settlement Patterns between 1980 and 2000 in the Midwestern USA". *Landscape Ecology* 20: 773-789.

Hammer, R.B., S.I. Stewart, R.L. Winkler, V.C. Radeloff and P.R. Voss. 2004. "Characterizing Dynamic Spatial and Temporal Residential Density Patterns from 1940-1990 across the North Central United States". *Landscape and Urban Planning* 69: 183-199.

Hirschl, T.A., D.L. Poston and W.P. Frisbie. 1998. "The Effects of Public and Private Sustenance Organizations on Population Redistribution in New York State", in: M. Micklin and D.L. Poston (eds.), *Continuities in Sociological Human Ecology*. New York: Plenum Press, 251-268.

Hobbs, D.J. and R.R. Campbell. 1967. "Traffic Flow and Population Change". *Business and Government Review* 8: 5-11.

Holtz-Eakin, D. 1994. "Public Sector Capital and the Productivity Puzzle". *Review of Economics and Statistics* 76: 12-21.

Hulten, C.R. and R.M. Schwab. 1984. "Regional Productivity Growth in U.S. Manufacturing, 1951-78". *American Economic Review* 74: 152-162.

Humphrey, C.R. 1980. "The Promotion of Growth in Small Urban Places and its Impact on Population Change". *Social Science Quarterly* 61: 581-594.

Humphrey, C.R., R.R. Sell, J.A. Krout and R.T. Gillaspy. 1977. "Net Migration Turnaround in Pennsylvania Nonmetropolitan Minor Civil Divisions, 1960-1970". *Rural Sociology* 42: 332-351.

Jaret, C. 1983. "Recent Neo-Marxist Urban Analysis". *Annual Review of Sociology* 9: 499-525.

Johnson, K.M. 1982. "Organization Adjustment to Population Change in Nonmetropolitan America: A Longitudinal Analysis of Retail Trade". *Social Forces* 60: 1123-1139.

_______. 1989. "Recent Population Redistribution Trends in Nonmetropolitan America". *Rural Sociology* 54: 301-326.

_______. 1999. "The Rural Rebound". *PRB Reports on America* 1: 1-21.

Johnson, K.M. and C.L. Beale. 1994. "The Recent Revival of Widespread Population Growth in Nonmetropolitan Areas of the United States". *Rural Sociology* 59: 655-667.

Johnson, K.M. and R.L. Purdy. 1980. "Recent Nonmetropolitan Population Change in Fifty-Year Perspective". *Demography* 17: 57-70.

Kaiser, H.F. 1960. "The Application of Electronic Computers to Factor Analysis". *Educational and Psychological Measurement* 20: 141-151.

Kim, K.K., D.W. Marcouiller and S.C. Deller. 2005. "Natural Amenities and Rural Development: Understanding Spatial and Distributional Attributes". *Growth and Change* 36: 275-298.

Land Information & Computer Graphics Facility. 2000. *Mapping Growth Management Factors: A Practical Guide for Land Use Planning*. Madison, WI: University of Wisconsin-Madison.

Land Information & Computer Graphics Facility. 2002. *Population and Land Allocation: Evolution of Geospatial Tools Helps Citizens Engage in Land-Planning Process*. Madison, WI: University of Wisconsin-Madison.

Levinson, D. 2008. "Density and Dispersion: The Co-Development of Land Use and Tail in London". *Journal of Economic Geography* 8: 55-77.

Lewis, D.J., G.L. Hunt and A.J. Plantinga. 2002. "Public Conservation Land and Employment Growth in the Northern Forest Region". *Land Economics* 78: 245-259.

Lutz, W. 1994. *Population-Development-Environment: Understanding Their Interactions in Mauritius*. New York: Springer-Verlag.

Lyson, T.A. 2002. "What Does a School Mean to a Community? Assessing the Social and Economic Benefits of Schools to Rural Villages in New York". *Journal of Research in Rural Education* 17:131-137.

Lyson, T.A. and G.W. Gillespie. 1995. "Producing More Milk on Fewer Farms: Neoclassical and Neostructural Explanations of Changes in Dairy Farming". *Rural Sociology* 60: 493-504.

Marcouiller, D.W. 1997. "Toward Integrative Tourism Planning in Rural America". *Journal of Planning Literature* 11: 337-357.

_______. 1998. "Environmental Resources as Latent Primary Factors of Production in Tourism: The Case of Forest-Based Commercial Recreation". *Tourism Economics* 4: 131-145.

Marcouiller, D.W., J.G. Clendenning and R. Kedzior. 2002. "Natural Amenity-Led Development and Rural Planning". *Journal of Planning Literature* 16: 515-542.

Marcouiller, D.W., K.K. Kim and S.C. Deller. 2004. "Natural Amenities, Tourism and Income Distribution". *Annals of Tourism Research* 31: 1031-1050.

Messner, S.F. and L. Anselin. 2004. "Spatial Analyses of Homicide with Areal Data", in: M.F. Goodchild and D.G. Janelle (eds.), *Spatially Integrated Social Science* Oxford: Oxford University Press, 127-144.

Mincer, J. 1978. "Family Migration Decisions". *Journal of Political Economy* 86: 749-773.

Moore, T. and P. Thorsnes. 1994. *The Transportation /Land Use Connection*. Washington, DC: The American Planning Association.

Morris, A. 1994. *History of Urban form before the Industrial Revolutions*. England: Longman Ltd.

Morrison, C.J. and A.E. Schwartz. 1996. "State Infrastructure and Productive Performance". *The American Economic Review* 86: 1095-1111.

Nadiri, M.I. and T.P. Mamuneas. 1994. "The Effects of Public Infrastructure and R&D Capital on the Cost Structure and Performance of U.S. Manufacturing Industries". *Review of Economics and Statistics* 76: 22-37.

Poston, D.L. and W.P. Frisbie. 1998. "Human Ecology, Sociology, and Demography", in: M. Micklin and D.L. Poston (eds.), *Continuities in Sociological Human Ecology*. New York: Plenum Press, 27-50.

Pucher, J. and C. Lefevre. 1996. *The Urban Transport Crisis*. London: McMillan Press.

Schachter, J. and P. Althaus. 1989. "An Equilibrium Model of Gross Migration". *Journal of Regional Science* 29: 134-159.

Shah, A. 1992. "Dynamics of Public Infrastructure, Industrial Productivity and Profitability". *The Review of Economics and Statistics* 74: 28-36.

Shryock, H.S. 1964. *Population Mobility within the United States*. Chicago, IL: Community and Family Study Center, University of Chicago.

Sly, D.F. 1972. "Migration and the Ecological Complex". *American Sociological Review* 37: 615-628.

Smith, S.K., J. Tayman and D.A. Swanson. 2001. *State and Local Population Projections: Methodology and Analysis*. New York: Kluwer Academic/Plenum Publishers.

Stanbery, V.B. 1952. *Better Population Forecasting for Areas and Communities: A Guide Book for Those Who Make or Use Population Projections.* Washington DC: Superintendent of Documents, U.S. Government Printing Office.

Thompson, E., G. Hammond and S. Weiler. 2006. *Amenities, Local Conditions, and Fiscal Determinants of Factor Growth in Rural America*. Kansas City, MO: RWP 06-08 Federal Reserve Bank.

Voss, P.R. and G. Chi. 2006. "Highways and Population Change". *Rural Sociology* 71: 33-58.

Zuiches, J.J. and J.H. Rieger. 1978. "Size of Place Preferences and Life Cycle Migration: A Cohort Comparison". *Rural Sociology* 43: 618-633.