Lake Amenities, Environmental Degradation, and Great Lakes Regional Growth

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28 December 2012

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December 28, 2012

Funding for this research was provided by Ohio Sea Grant [project R/ME-032]. Previous versions of this paper were presented at the 2011 AAEA Meeting in Pittsburgh, PA, and the 2011 RSAI Meeting in Miami, FL, as well as at seminars at The Ohio State University; University of Akron; New Mexico State University; California State University, Long Beach; Washington State University; and University of Alaska Anchorage; we thank all participants for their feedback.

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Abstract.

Regional migration and growth are increasingly associated with high-quality *in situ* natural amenities. However, most of the previous U.S. research has focused on the natural amenities of the Mountain West or the South. The Great Lakes, with their abundant fresh water and natural amenities, would also appear well-positioned to provide the foundation for this type of economic growth. Yet, while some parts of the western Great Lakes region are prime examples of amenity-led growth, other areas in the eastern Great Lakes may not have capitalized on their natural amenities, perhaps because of their strong industrial legacy. Using a unique county-level dataset for the Great Lakes region (including Indiana, Illinois, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin), we test whether growth in the region is associated with proximity to lake amenities and whether there are offsetting industrial legacy or pollution effects. We also examine whether amenities have additional attraction value for those with high levels of human capital. Consistent with theory that suggests that natural amenities are normal or superior goods, we find that coastal areas in the region are positively associated with increases in shares of college graduates. However, we find little evidence that lake amenities contribute to broader household migration, especially after 2000. Based on these results, there may be opportunities to leverage Great Lake amenities to support economic growth in terms of attracting individuals with high levels of human capital who are most likely to make quality of life migration decisions.

I. Motivation and Literature Review

Regional migration and growth are increasingly associated with high-quality *in situ* natural amenities. The U.S. Great Lakes, with their abundant fresh water and natural amenities, would seem to provide the foundation for amenity-linked economic growth. However, industrialization and environmental degradation, especially in the former rust belt cities of the eastern Great Lakes region, suggests the link between amenities and economic growth in this region may be less clear. At the same time, with persistent economic sluggishness and the ongoing economic restructuring that has eroded the region's economy, finding new ways to capitalize on its assets and generate growth is paramount. Policymakers are interested in whether the Great Lakes are quality of life (QOL) enhancing assets that can attract households and support regional economic growth.

Underlying the research on amenities and economic growth is the Tiebout (1956) theoretical notion that people "vote with their feet" and sort to reside in places with particular bundles of economic and site-specific public goods and amenities. Indeed, the Tiebout approach is closely associated with the spatial equilibrium model first associated with Rosen (1979) and Roback (1982). In this, the utility that individuals get from a particular location depends on both the QOL-enhancing effects and the productivity generating wages they receive (Tiebout, 1956; Rosen, 1979; Roback, 1982; Rappaport and Sachs, 2003). Households then move toward locations with higher levels of utility. Firm locations and movements, which affect household wages, depend on the relative benefits firms receive in terms of productivity, wages, and capital costs. Related to the spatial equilibrium approach is the Environmental Kuznets Curve in which environmental quality first declines then rises with rising levels of economic development (Rupasingha et al., 2004), consistent with amenities being a normal or superior good.

A wealth of previous empirical work has demonstrated the link between population growth and natural amenities (e.g., Graves, 1976; 1980; Rappaport, 2001; 2004; Rappaport and Sachs, 2003; McGranahan, 2001; McGranahan, 2008; Deller et al, 2001, Partridge et al, 2008) and urban amenities (Glaeser, 1999; Glaeser and Maré, 2001; Florida, 2002a; 2002b). However, most recently, Partridge et al. (2012) found evidence that amenities may have become less important to migration and population change after 2000. Additionally, Banzaf and Walsh (2008) found that environmental degradation associated with toxic releases is associated with decreases in population and income, supporting the idea that people sort away from environmental disamenities.

Since employment growth is determined by both household and firm migration, even if people are moving toward places with higher levels of QOL, this may not correspond with employment growth. Gabriel and Rosenthal (2004) provided evidence that regional factors that are QOL-enhancing and attract retirees may not be productivity enhancing. Conversely, areas with more pollution may, all else equal, be less attractive to households but be productivity-enhancing for manufacturing and similar industries because of looser environmental regulations (Jeppesen et al., 2002). While Monchuk and Miranowski (2007) found evidence that natural amenities are associated with employment growth in the Midwest, Partridge et al. (2008) found tremendous spatial variation in the effect of natural amenities on growth.

A concern for policymakers in the region is that high-amenity places are often converted into recreation or retirement destinations which may have a lot of low-paying hospitality-oriented jobs. However, an offsetting factor is that because amenities are normal, superior, or even luxury (Kerr, 2011) goods, high-amenities areas may be most attractive to those with higher-incomes and workers with higher-skills (Roback, 1988; Moretti, 2004). The implication is that high amenity areas will have a larger share of workers with high levels of human capital, which can be proxied by those with college degrees. In this case, amenities can lead to new firms entering the region who demand high-skilled labor and thus bid up the wages (Deller et al., 2001; Partridge and Rickman, 2003b; Kim et al., 2005). Increasing numbers of high-skilled workers and the firms that hire them can lead to knowledge spillovers and other productivity benefits that can increase wages (Rosenthal and Strange, 2001; 2003). Thus, these effects can help transform high-amenity regions into economically diverse regions that include higher-paying, higher-skilled jobs.

Access to amenities could also contribute to population and job growth over a wide geographic area. For example, Schmidt and Courant (2006) show that certain amenities, such as national monuments, can influence economic outcomes for hundreds of kilometers. Other papers have examined the geographical reach of site-specific attributes including access to cities, public goods, and natural amenities (Ferguson et al., 2008; Partridge et al., 2008; and Irwin, 2002). Thus, the influence of the Great Lakes may not just be on the immediately adjacent counties but also on counties that are "near" the lakes as people move to be close enough to the lakes to enjoy them in their leisure time.

In considering the potential for Tiebout-style sorting in response to Great Lakes amenities, we hypothesize that people who favor Great Lakes natural amenities will self-sort to live close to the water (all else constant). However, if there is also nearby environmental degradation in the form of existing industry, abandoned industrial sites, or declining water quality, individuals will choose to locate elsewhere. The question is do households value the lake amenities and can the region chart a new economic future that is based on the lakes as *in situ* natural resources rather than one based on industrialization and extraction?

To explore this question, this paper examines whether proximity to lake amenities is associated with population and employment growth. We also test whether lake amenities have additional attraction value for individuals with high levels of human capital, building on the work by Moretti (2004) and Roback (1988). Our analysis uses a unique dataset that includes geographically-defined variables related to natural amenities and environmental disamenities. While there is a plethora of research in the environmental literature that examines the effect of individual environmental disamenities on regional growth or local housing values, this is one of the first attempts to use detailed pollution and other environmental data to assess how environmental degradation can offset the benefits to regional growth from natural amenities.

We also separately control for whether a county is located on the coast of one of the Great Lakes and the distance to the nearest Great Lake; these measures help sort out whether positive lake amenity effects spillover into the region. Hence, our basic identification strategy will be whether proximity to the Great Lakes matters after conditioning on key factors that influence growth including initial industry composition, (other) natural amenities, and in some specifications, state fixed effects. The empirical model asks whether proximity to lake amenities influence growth in a given state after conditioning on other factors that also influence economic growth.

We also include a measure for whether or not a county is in the eastern versus the western part of the region in order to control for historic economics factors that might make economic prospects in the east (those counties closer to Lakes Erie, Huron, or Ontario) different than that in the west (those counties closer to Lakes Michigan or Superior). As shown in **Table 1**, since 1990, the Western Great Lakes appear to be doing better economically, with anecdotal evidence that they are benefiting from amenity-driven growth. However, there has been little empirical examination of this potential "east-west" divide. If the difference in growth rates is due to the fact that eastern counties are more industrialized and have more pollution, then once we control for such disamenities any differences should disappear.

Despite the growing body of literature demonstrating the positive growth effects of natural amenities, this is one of the only recent studies to focus specifically on the Great Lakes region. While some of the earliest investigations into the relationship between natural amenities and growth were for the areas around Lakes Michigan and Superior (Wehrwein and Johnson, 1943), much of the recent research has instead focused on the natural amenities of the mountain west or the South. Given the spatial heterogeneity of amenity effects (Partridge et al., 2008), national studies are not always instructive in explaining how amenities would affect growth in this region.

The results reveal that, consistent with a story that high-skilled workers should be more attracted to places with higher levels of amenities, coastal areas in the Great Lakes region are positively associated with increases in shares of college graduates, relative to other parts of the region. However, after controlling for industrial disamenities, there is no statistical difference in this effect for places in the eastern part of the region versus the west.

At the same time, there is only weak evidence that lake amenities are associated with overall population or employment growth in the Great Lakes region. And after 2000, population and employment growth declined region-wide. Since proximity to the lakes was associated with rising rents in the 1990s, this suggests increasing household value and/or firm productivity from lake amenities. The overall decline in firm and household migration after 2000 could also be due to the value of amenities being capitalized into rents and wages; providing little reason for additional movement after 2000. Another possible explanation is that the economic downturn of the 2000s may have reduced demand for access to lake amenities because they are normal, superior, or even luxury goods. Finally, there is evidence that the environmental quality in the lakes worsened after the late 1990s and this could explain a devaluing of the lake amenity post-2000.

Based on these results, it appears that Great lakes communities may be able to leverage their proximity to lake amenities to support economic growth, especially in terms of attracting individuals within the region with high levels of human capital who are most likely to make migration decisions based on QOL measures. We caution that additional analysis is needed to identify which policies would be most effective for specific portions of the region and to assess their costs. Further, if the recent deterioration of lake water quality in the region becomes widely known, it could act as a disamenity and repel those households most likely to consider migrating to the region. Such patterns would support the need to maintain or enhance environmental quality in order to maximize economic growth.

The remainder of this paper is organized into the following sections: Section II outlines the theoretical framework used for estimation; Section II presents the empirical specifications; Section IV discusses the unique dataset used in this analysis; Section V discusses the key results; and, lastly, Section VI summarizes and concludes.

II. Theoretical Framework

Our empirical analysis is based on a two-equation spatial equilibrium framework (from Roback, 1982; Partridge et al., 2010; and Jeanty et al., 2010) in which firms maximize profits and households maximize utility. In this model, the representative household chooses amounts of a composite traded good (Y), land (L^h), and site-specific characteristics (s) to maximize utility subject to a budget constraint:

$$\max U_i \left(Y_i, L_i^h \middle| s_i\right) \qquad s.t.\, w_i = Y_i + r_i L_i^h, \tag{1}$$

where wage and rental payments are w and r and the price of the composite good is normalized to 1. The *s* vector includes all characteristics that make regions heterogeneous, including natural and urban amenities and environmental disamenities.

In spatial equilibrium, because households can sort to the location with the highest utility, wages and rents will adjust so that the indirect utility is the same in all regions, and is equal to $\bar{V}$, otherwise, some households would have an incentive to move.

$$\bar{V} = V_i(w_i, r_i \,|s_i) \tag{2}$$

The representative firm produces Y using a constant-returns-to-scale production function $Y_i = f\left(L_i^f, N_i \middle| s_i\right)$ where N is the number of workers. Here the area characteristics act as profit shifters. For example, a higher share of college graduates may raise the productivity of the firm.

Again, under the assumption of perfect mobility, in spatial equilibrium, wages and rents will adjust so that unit costs are equalized across regions, and are equal to 1. We utilize the unit cost function because of the constant returns to scale assumption.

$$C_i(w_i, r_i \,|s_i) = 1 \tag{3}$$

Given a partial adjustment process, in the long run, spatial equilibrium will be reached when utility and cost differentials are eliminated across all regions. In equilibrium, because the value of amenities is capitalized into wages and rents, Roback (1982) and others have shown that regional differences in wages and rents can be used to value location-specific attributes.

However, as shown by Rappaport (2004), spatial equilibrium is the long-run steady state of a growth model and migration toward equilibrium (i.e. being out of the steady state) can be persistent. Even small frictions to labor and capital mobility, productivity, or QOL can draw this adjustment process out for decades. The literature includes a number of papers that have found ongoing migration toward equilibrium in the United States (Graves and Mueser, 1993; Rappaport, 2007; Greenwood et al. 1991; and Partridge et al. 2012).

Thus, we assume there will be ongoing movements toward equilibrium. And, since regional utility and cost differentials are the main drivers of firm and household relocations across regions, the movement of households μ_i and the movement of firms η_i are functions of these differentials:

$$\mu_i = f\{[\bar{V} - V_i(\mathrm{w_i}, \mathrm{r_i}\,|\mathrm{s_i})]\theta_i\} \tag{4}$$

$$\eta_i = f\{[\mathrm{C}_i(\mathrm{w_i}, \mathrm{r_i}\,|\mathrm{s_i}) - 1]\tau_i\} \tag{5}$$

where θ_i reflects frictions to household movement, such as moving costs and imperfect information, and τ_i is an adjustment factor related to firm movement, such as moving costs and barriers to entry.

The model can also be expanded to include two types of workers in the spirit of Roback (1988) and Moretti (2004), high-human capital workers and low human-capital workers. In that case, there would be two household migration equations with each type responding to different long-run spatial equilibrium utility levels.

III. Empirical Specifications

Following Roback (1982) and a host of other empirical papers that have subsequently used the Roback model (e.g., Partridge et al., 2010; Jeanty et al., 2010), we thus consider how population and employment changes are affected by natural amenities, especially access to the Great Lakes, and environmental disamenities (equations (6) and (7), below). Population changes are affected by migration of households, related to equation (4). While we are interested in assessing movement of households or migration due to utility differentials, Rappaport (2007) and Faggian et al. (2012) show that population change is a good proxy for household migration and reveals the representative household's assessment of where his/her well-being is improved. Employment changes are determined in the labor market by the movement of both households and firms, equations (4) and (5) above. Household movements affect labor supply and firm movements affect labor demand; and they jointly determine a region's employment level.

To better understand who is moving, and assuming amenities are normal or superior (or luxury) goods, we also investigate whether higher-educated individuals or those with higher levels of human capital are choosing to locate near amenities in the region. Specifically, we consider the change in the share of college graduates in the region as demonstrated in equation (8). This allows us to test Moretti's (2004) and Roback's (1988) extension of the original Roback (1982) model.

For each county *i* in state *s*, the reduced form estimation equations are:

$$\Delta POP_{is} = \alpha^{P} + \beta_1^{P}\mathrm{AMENITY}_{is} + \beta_2^{P}X_{is}^{P} + \sigma_s^{P} + \varepsilon_{is}^{P} \quad (6)$$

$$\Delta EMP_{is} = \alpha^{E} + \beta_1^{E}\mathrm{AMENITY}_{is} + \beta_2^{E}X_{is}^{E} + \sigma_s^{E} + \varepsilon_{is}^{E} \quad (7)$$

$$\Delta COLLGRAD_{is} = \alpha^{C} + \beta_1^{C}\mathrm{AMENITY}_{is} + \beta_2^{C}X_{is}^{C} + \sigma_s^{C} + \varepsilon_{is}^{C} \quad (8)$$

AMENITY includes the natural amenities and industrial disamenities, X is a vector of control variables (described in Section V), σ's are state fixed effects that account for common state-specific factors such as regulatory regime and tax structure, and the ε's are error terms. State fixed effects will control for any specific state policies that might lead to higher or lower growth rates. As explained below, we examine changes in both the 1990s and from 2000 to 2007.[1] We specifically choose to cut off our analysis in 2007 in order to avoid including the most recent recession in our analysis. We consider the two decades separately because other research has found some evidence that in recent years the effect of amenities may be changing while the role of economic migration has declined. (Partridge et al., 2012). Using 2000 as our split between the time periods also relates to the availability of data in the year 2000. Perhaps the structural change takes place in a nearby year, but due to data limitations, we cannot accurately test for that. Nevertheless, when considering the entire 1990 to 2007 period, we find that results are similar to those in the 1900s, suggesting that not splitting the data would mask the potential

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[1] After 2000, county-level data on college graduates is only available for all counties from the American Community Survey 5-year Estimates, which provide average data from 2005 to 2009 for all U.S. counties, rather than for a single year. We use that average as our value for college graduate share in 2007 to calculate the change in college graduate share from 2000 to 2007.

changes in the effect of amenities after 2000. To minimize endogeneity, we use beginning period values for the explanatory variables contained in X; i.e. for 1990 to 2000, we include 1990 explanatory variables, and for 2000 to 2007, we include explanatory variables from 2000.

These models allow us to test whether lake amenities are positively associated with changes in population, employment, and the share of the population with high-human capital in the Great Lakes region. They also provide a means of testing whether there is an offsetting impact from pollution and industrial disamenities and whether there are differences in the eastern versus the western parts of the region. As seen in **Table 1**, eastern counties have experienced slower population growth, are closer to federally-designated hazardous waste (Superfund) sites, have more power plants, and have more water and air pollution than those in the west.

Given that population and employment growth declined after 2000, and because of evidence that the effect of amenities may be changing (Partridge et al., 2012), we are also interested in whether there was a change in preference for lake amenities or a change in productivity associated with being closer to one of the lakes. Thus, we consider the change in the value of the amenity from the 1990s to the post-2000 time period by using a first differencing approach.[2] This approach involves subtracting the change in the measures of growth for population, employment, and college graduates in the 1990s from the change in that same measure in the post-2000 period. This method allows us to difference out the county-level fixed effects and minimize omitted variable bias. The time-invariant amenity measures are assumed to have different coefficient values in each time period, and the state fixed effects and the east dummy variable (explained below) are eliminated from the estimation equation. The resulting equations also combine the constants and error terms into common terms. The new vector Z includes the time-varying amenity and disamenity measures and the variables previously contained in X in equations 6, 7, and 8.

The reduced form estimation is as follows, where Y is population, employment, or college graduates:

$$\Delta Y_{is00} - \Delta Y_{is90} = \alpha^{Y} + (\beta^{Y}_{1,00} - \beta^{Y}_{1,90})\mathrm{AMENITY}_{is} + \beta^{Y}_{2,00} Z^{Y}_{is00} - \beta^{Y}_{2,90} Z^{Y}_{is90} + \varepsilon^{Y}_{is}$$
$$= \alpha^{Y} + \Delta\beta^{Y}_{1}\mathrm{AMENITY}_{is} + \beta^{Y}_{2,00}\Delta Z^{Y}_{is} + \Delta\beta^{Y}_{2} Z^{Y}_{is90} + \varepsilon^{Y}_{is} \qquad (9)$$

[2]Another advantage of using first differences over a fixed effects approach is that fixed effects models require the strong strict exogeneity assumption which is unlikely to apply in our setting (Wooldridge, 2001).

For all models (6, 7, 8, and 9), we adjust for both standard heteroskedasticity and any clustering of the standard errors based on the Bureau of Economic Analysis economic areas. Primo et al. (2007) show that not properly accounting for this correlation can lead researchers to overstate the statistical significance of coefficient estimates. We also consider the possibility of general spatial error correlation, spatial correlation of the dependent variables, and spatial spillovers of the explanatory variables and test all models using Moran's I and LM Error and LM Lag tests (results not shown). Overall, the results are qualitatively similar to those shown in Tables 2 to 7. Further, sensitivity analysis will test if the results are robust to the model specifications.

IV. Data

We have constructed a unique dataset that consists of observations for the counties in the eight states in the U.S. Great Lakes region – Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin. Counties within 100 miles of the Atlantic Ocean are excluded from this sample. As discussed in detail below, data are collected from a variety of sources, including the U.S. Census, the Bureau of Economic Analysis (BEA), the Department of Housing and Urban Development (HUD), the Environmental Protection Agency (EPA), the Department of Energy (DOE), the U.S. Geological Service (USGS), USDA-Economic Research Service (USDA-ERS), and others. ArcGIS is also used to construct a number of specialized variables using data from these sources. This dataset allows us to control both for access to lake amenities and the intervening effects of industrial disamenities while also controlling for other factors that would be expected to explain regional growth. **Table 1** shows the full list of variables and some descriptive statistics.

Dependent Variables

The analysis uses the following dependent variables:

1) Percent change in population, 1990 to 2000 and 2000 to 2007[3], using data from the BEA (Equation 6).
2) Percent change in employment, 1990 to 2000 and 2000 to 2007, using data from the BEA (Equation 7).

[3] We end the analysis in 2007 in order to pick up long-term trends and to avoid cyclical effects of the recession.

3) Percent change in college graduate share, 1990 to 2000 and 2000 to 2007, using data from the U.S. Census (Equation 8).[4]
4) Difference in Growth Rates = [Percent change in population, employment, or college-share growth, 2000-2007] – [Percent change in population, employment, or college-share growth, 1990-2000]; (Equation 9).

Explanatory Variables

The AMENITY variables can be grouped into two categories – natural amenities and industrial disamenities. Natural Amenities include measures related to the Great Lakes and other natural amenities that may important to households. The value of the Great Lakes is measured by 1) distance to the nearest Great Lake in kilometers and 2) a coastal measure that indicates whether or not a county is located on the coast of a Great Lake. Other natural amenities included in the model are measures of relative values of January temperature, July temperature, and topography.[5] We also create a measure of interior water area that does not include the water area in the Great Lakes. Additionally, we have a measure of the percent of the county that is in forest cover. These natural amenity data are time-invariant and are from USDA/ERS, USGS, or constructed using ArcGIS.[6] The Great Lakes region also has "lake-effect snow," with there being higher annual snowfalls in counties bordering the Great Lakes than in non-coastal counties (44. 5 versus 24.9 inches). Thus, in sensitivity analysis, we include average annual snowfall from the National Outdoor Recreation Supply Information System (NORSIS).

Industrial disamenities data include number of power plants, constructed using data from DOE's Energy Information Administration (EIA); and from the EPA, distance to the nearest federally-designated toxic waste "Superfund" site and measures of total air and water pollution (in pounds) released in the county (measures of industrialization) using Toxic Release Inventory (TRI) data. Because of high levels of multicollinearity among the disamenity measures, we create disamenity indices for both 1990 and 2000, which are comprised of the sum of the z-scores for the four disamenity measures in each year. This approach is similar to that used by McGranahan (1999) to construct his well-known index of natural

[4] After 2000, college graduate data are only available for all counties from the American Community Survey 5-year Estimates. Our 2007 college graduate share is an average from 2005 to 2009, rather than from 2007.
[5] These variables are measured using their z-scores. Source: www.ers.usda.gov/Data/NaturalAmenities/.
[6] All measures using ArcGIS are from the population weighted centroids of counties.

amenities. This allows us to assess the offsetting impact of disamenities in the models while avoiding the multicollinearity that arises when the measures are included individually.

In deciding what variables to include in the **X** vector, we follow the literature in proxying for the other forces that influence household and firm migration such as demographic composition, industry composition, urban proximity, and amenities (Deller et al., 2001; Glaeser et al., 1995; Partridge et al. 2008; 2009). Conditioning on other factors that affect household and firm migration is important to ensure that the results are not affected by omitted variable bias. All time-varying explanatory variables are from the initial time period in order to mitigate any endogeneity. Alternative model specifications are considered as robustness tests.

Because the attractiveness of a region is affected by access to urban amenities or urban agglomeration that may increase productivity, we control for urban access and agglomeration through a dummy variable for counties in metropolitan areas; measures of distance (in kilometers) to the nearest metropolitan area, and incremental distances to metro areas with 250,000, 500,000, and 2.5 million people (based on the 2000 Census), which are generated using ArcGIS; and population density, which is measured in 1990 and 2000, using U.S. Census data.[7] By including measures of proximity to cities of various sizes, we are controlling for whether a community is near a small metropolitan area like Springfield, Illinois, with about 200,000 people, or a large one like Chicago, with over 9 million people, which provides access to the full range of urban amenities and services for businesses.

The educational attainment of the population can increase the attractiveness of a region to firms due to productivity benefits and many endogenous growth theories rely on a pool of human capital skills to generate growth. However, for some areas with limited employment prospects, a higher initial share of educated individuals may actually be inversely related to growth. Finally, college graduates may be attracted to areas with higher levels of amenities. Partridge et al. (2008) found that the relationship

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[7] Measures are based on distance from the population weighted centroid of each county to the population weighted centroid of the metropolitan area. For example, if the county's nearest metropolitan area is just over 500,000 people and 50 kilometers (kms) away, then the nearest metropolitan area is 50 kms away and the incremental distance for the nearest metropolitan area with greater than 250,000 people and the incremental distance to a metropolitan area with greater than 500,000 people are both equal zero. Likewise, say a nonmetropolitan county is 100 kms from its nearest metropolitan area, 160 kms from the nearest metropolitan area with greater than 250,000 people, and 200kms from a metropolitan area with greater than 500,000 people (which is 3 million). Then the incremental distances are 100kms to the nearest metropolitan area, 60 incremental kms to a metropolitan area with greater than 250,000 people (160-100), 40 incremental kms to a metropolitan area with greater than 500,000 people (200-160), and 0 incremental kms to a metropolitan area with more than 2.5million people (200-200). See Partridge et al. (2009) for a similar discussion.

between college graduate share and growth was generally negative in nonmetropolitan counties in the Midwest; but that there is tremendous heterogeneity in the relationship between college graduates and growth. From the U.S. Census, for 1990 and 2000, we include measures of educational attainment, including percent of population 25 and older with only high school diplomas (or equivalent), those with some college, and college graduates (i.e., bachelors, graduate, professional, and doctorate degrees).

Other demographic measures from the U.S. Census, available for both 1990 and 2000, include racial composition, gender composition, age composition, and percent of the population that is married. As shown in much of the migration literature, the demographic composition of a region can affect its relative attractiveness to both people and firms. For example, young, single men may be more attracted to a place with a higher percentage of young, unmarried women. Similarly, firms would be more attracted to a place with working age people of both genders. Since people tend to be attracted to places with similar types of people, racial composition may affect migration.

To control for initial economic conditions, we include the initial percent of the population over 16 that is employed, which is a measure of the efficiency of the local labor market, and data on industrial composition. From BEA and EMSI[8] county-level industry employment data, we construct shares of county employment in various industries in 1990 and 2000. Specifically, we use initial percent of total employment in manufacturing, agriculture, and government; and percent of wage and salary employment in leisure companies (NAICS Sectors 71 and 72). These employment shares control for economic opportunities and the industrial mix. By including the share of leisure employment, we are controlling for whether there is a high level of employment in industries that are associated with a tourist destination.

The share of 1970 manufacturing employment, from the BEA, controls for historic industrial legacy effects that may prevent a county from taking advantage of lake-related amenity development. Industrial legacy effects include both abandoned factories and other abandoned industrial sites which are not fully accounted for in the disamenity index and a dependence on an industry composition of declining industries; both of which would be expected to contribute to lower growth.

In sensitivity analysis, we include the initial share of recreational homes from the U.S. Census, to control for areas that have a history of being tourist areas. Additionally, if retirees choose to convert these

[8] EMSI data has been used in many academic studies due to the care they take in deriving accurate employment measures even in sparsely populated counties (EMSI.com). See Dorfman et al. (2011) for more details of EMSI's employment estimating procedures.

summer homes into retirement homes, this may have long-term effects on population growth. However, we caution that recreational homes may be endogenous, as people may choose to buy recreational homes in places where they expect the economy to do well in order to improve the resale value.

The east-west effect is proxied by a dummy variable, East, that is equal to 1 if the nearest Great Lake is Erie, Huron, or Ontario. We also interact the east variable with distance to the nearest Great Lake and the coastal variable to test whether there is a difference in the effect of lake amenities in the eastern versus the western portions of the Great Lakes region after controlling for other factors.

Since we are interested in the Great Lakes as drivers of growth, ideally we would have good data on water quality. However, as noted by Gyourko et al. (1997), since water quality is monitored at the state level and the standards vary across states, consistent measures of water quality for the entire region are unavailable.

To avoid direct endogeneity, the explanatory variables are measured at the beginning of the period. For example, if the dependent variable measures a change from 1990 to 2000, the explanatory variables are from 1990.

V. Results and Discussion

Because of multicollinearity concerns, we first estimate several parsimonious models that only include the natural amenities measures, the disamenity index, and combinations of the state fixed effects, the East indicator dummy variable, and measures of urban proximity, to assess if there were any relationships between the variables of interest – proximity to amenities and disamenities and the "east" variables – and our growth measures. We then add demographic and industrial control variables as well as measures of spatial spillovers and other economic controls. When state fixed effects are included in the models, there is additional evidence of multicollinearity, although including them does not significantly change the results. Thus we report estimates without state fixed effects.

Additionally, including both the initial and changes in the explanatory variables when estimating changes in population, employment, and college graduate share growth between the decades [equation (9)] introduces multicollinearity into the models. Thus, we report only the models which include the beginning (1990) levels of time-varying explanatory variables in the results; which also minimizes endogeneity. Doing so does not change the key results.

Population Changes

As shown in **Table 2**, overall proximity to the Great Lakes does not seem to be a major driver of population growth. In the 1990s, being on the coast was associated with roughly 4% lower population growth than the rest of the region. This result holds up as we move from Model 1, which includes only controls for urban and natural amenities and disamenities and whether or not a county is in the east, through Model 3, which includes a full set of demographic and industrial controls. At the same time, however, there is a slightly positive relationship between being closer to one of the Great Lakes and population growth, roughly 0.2% for every 10 kilometers from one of the lakes. Since the population-weighted centroid of the average coastal county is 10 kilometers from a Great Lake, the average coastal county in the region has -3.8% lower population growth than other counties in the region. One possibility for this result may be that coastal counties have higher population densities; in 1990 coastal counties had an average of 174 people per square mile, while non-coastal counties had only 186 people per square mile, a statistically significant difference (t-statistic = 4.92). This suggests perhaps there are limits to growth along the coasts where population densities are high though many coastal counties are relatively sparsely populated with considerable room for more dense development. However, since our models control for population (or population density), the growth we observe is after accounting for that factor.

Another possible explanation for the negative coastal effect may be due to higher housing prices along the coast. While in 1990, coastal and non-coastal areas had statistically similar housing prices, by 2000, housing prices in coastal counties had jumped so that the average median housing value was $93,639 in coastal counties versus $85,690 in non-coastal counties (difference in means t-statistic =2.65). Thus, over the decade, rising housing prices may have discouraged people from wanting to live in coastal counties.

We also considered whether the amount of snowfall may be driving this negative coastal effect. However, controlling for snowfall does not affect our results in the 1990s nor is snowfall statistically related to population growth (results not shown).

Perhaps people in this region are just generally interested in having access to the lakes for recreational purposes, but may not care whether or not they directly live on the lake, consistent with a story that natural amenities can have significant distance effects. There is also the possibility that disamenities that are located directly on one of the lakes, like power plants, may keep people from wanting to live directly on the lake. Since we are only using county-level data, we may be unable to distinguish between on-lake disamenities and those further from the coast. Additionally, using county-level data means it also may be that we are not able to distinguish between those households that live exactly on the coast of one of the Great Lakes, or within a short distance of a lake, and those that live within a coastal county but farther from the lake.

Overall, eastern counties had lower total population growth in the 1990s. However, eastern coastal counties had slightly higher population growth than other counties in the eastern part of the region. At the same time, for counties in the eastern part of the region, there is a small positive relationship between being farther away from one of the Great Lakes and population growth. The net result is that, in the 1990s, it appears that the eastern part of the region saw almost no population growth effect due to lake amenities. An alternative explanation is that because regression provides the average effect, it may mask the positive gains of a few key coastal counties.

Table 2 also shows that after 2000 the correlation between proximity to one of the Great Lakes and population growth weakens considerably. Again, these results are robust to the inclusion of additional explanatory variables, in moving from Model 1 to Model 3. As expected from the lack of statistical difference between average eastern and western population growth in that decade (see **Table 1**), all else equal, both parts of the region experience similar levels of growth and the negative association between being in the east and total population change is smaller. This is also consistent with evidence that amenity-driven migration is declining in recent years. Yet, coastal counties (in the entire region) continue to be negatively associated with population growth. And, as shown in Model 3, after 2000, eastern coastal counties continue to see higher population growth (1%) than other eastern counties in the region. Interestingly, after 2000, when we control for snowfall, any negative impact on population growth from being on the coast disappears and there is a weak negative statistical relationship between snowfall and population growth (results not shown).

Looking closely at whether there is an offsetting effect of proximity to industrial and environmental disamenities, we see some evidence of a negative disamenity effect. In both decades, higher levels of the disamenity index are associated with statistically significant lower population growth. However, once we control for the industrial mix in Model 3 (in both decades), the statistical significance disappears. We initially were concerned that disamenities could be associated with employment opportunities, so we replaced the disamenity measure for 2000 with the measure for 1990 in the post-2000 models (results not shown). The results are qualitatively similar to those using the 2000 disamenity index and we conclude that the measure is not endogenous. This is further verified by the lack of correlation between changes in employment and the disamenities index; -0.16 in the 1990s and -0.02 after 2000.

Employment Changes

Next we consider employment changes. Overall, there is only a weak, negative relationship between proximity to the Great Lakes and employment growth.

In the 1990s, as **Table 3** shows, being on the coast of one of the Great Lakes was weakly associated with less employment growth. This is consistent with the lower population growth observed in those counties. Again, as expected, we also find evidence that, overall, being in the east was associated with lower 1990s employment growth. However, unlike with population growth, eastern coastal counties are not doing better than other eastern counties when it comes to job growth, and this result is robust from Model 1 to Model 3 as we add explanatory variables. Additionally, in Model 3, we observe a (weak) additional negative relationship between being in the east and closer to one of the Great Lakes and employment growth.

After 2000, as **Table 3** illustrates, for the broader region there appears to be no statistically significant relationship between proximity to the Great Lakes and job growth. And consistent with the lack of statistical difference between average eastern and western employment growth in that decade (see **Table 1**), all else equal, both parts of the region experience similar levels of growth.[9]

We also consider whether there is a relationship between disamenities and employment growth. In the 1990s, the disamenity index appears to be weakly negatively associated with employment growth. This suggests that job growth in the region is probably not due to gains from manufacturing and other businesses which might find proximity to power plants and other sources of pollution to be attractive or productivity enhancing. We see further evidence of this from the positive and statistically significant coefficient on the share of wage and salary leisure employment in the 1990s employment change equation.[10] However, after 2000, the statistically significant correlation between share of initial leisure employment and overall employment growth disappears and there is now a positive and statistically significant relationship between the level of disamenities and employment growth. This suggests that

[9] We also considered whether snowfall affects our employment results, since coastal counties have higher levels of annual snowfall. However, we find that snowfall has no effect on our results (results not shown).
[10] While not shown, the coefficient on the share of wage and salary leisure employment in Table 3, Model 2 (1990 to 2000) is 0.784 and is statistically significant at the 99% level.

jobs are being created in different industries after 2000, somewhat supportive of the notion that the lakes became less of an amenity post-2000.

College Graduate Share Growth

To explore whether those with high levels of human capital are more likely to be attracted to high levels of amenities, we consider the growth in the share of college graduates. As **Table 4** illustrates, in both decades, coastal counties were associated with higher levels of growth of college graduates, which is consistent with the theoretical models of Roback (1988) and Moretti (2004). Additionally, the statistically significant relationship between percent water (excluding the Great Lakes) and the growth in the share of college graduates provides further evidence that college graduates are attracted to natural amenities. For the 1990s, however, away from the coastal counties, being farther from one of the Great Lakes is statistically significant and positively associated with higher growth in college graduates. This suggests that there is a split among college graduates. Some relocate to areas immediately adjacent to one of the lakes and others locate where access to the Great Lakes is not a factor. For example, recreational amenities may draw college graduates and those in creative occupations to places like Traverse City, Michigan. However, the availability of jobs is likely the main driver in relocations to places like Columbus, Ohio, where proximity to Lake Erie, which is more than 100 miles away, is not likely a factor.

We also examined whether there is a difference between the east and west. In the 1990s, there is no statistically significant difference between the east and west in terms of growth of college graduates. But after 2000, the eastern counties actually seem to be doing better, overall, in terms of increasing their share of college graduates. And, in both decades, the eastern coastal counties appear to enjoy the same boost (or even more of one) in terms of attracting college graduates as their counterparts in the west. This suggests that the disamenity index is adequately controlling for industrialization effects and that the relatively poor performance of the eastern region is related to these disamenities. Finally, when we control for annual snowfall, we find no virtually no difference from our original results in either decade.

Differences between the 1990s and 2000s

In **Table 5**, we explore whether the attraction value of lake amenities is changing between the 1990s and the post-2000 period by looking at the difference across decades. This also allows us to difference out the unobservable fixed effects [see Equation (9)].

There is a positive change in the association between distance to the nearest Great Lake and population growth from the 1990s to the 2000s, suggesting that the value of being closer to the lake declined after 2000 (which is consistent with the results in **Table 2**). One explanation is that if amenities are normal or superior goods, then the sluggish economy post-2000 may have reduced the demand for lake-based amenities. Another possible reason is that the environmental quality of the lakes worsened after the late 1990s and this may explain the reversal of migration patterns post-2000.

We also difference across decades to see if there is a change in the value of proximity to the Great Lakes relative to employment growth between the 1990s and the post-2000. As shown in **Table 5**, there is evidence of a weak increasing coastal effect on employment growth across the decades, suggesting that perhaps there is an increasing productivity benefit from being on the coast.

Finally, we consider the difference in growth in college graduate shares across decades. Again, this allows us to difference out the fixed effects and assess whether the value of proximity to the lakes in terms of increasing college graduate share is changing across decades. The positive and statistically significant coefficient for the coastal variable suggests that amenity-based migration for the college graduate population is becoming more important post-2000. And, other natural amenities, as evidenced by the positive and statistically significant coefficient on non-Great Lakes water, also appear to be increasing in value to college graduates. This contrasts with the negative change related to lake amenities we observe for the total population, but is consistent with the positive change for total employment. This is also evidence that the total population changes, which are averages across the entire population, may be masking the heterogeneity in the effect of being closer to one of the lakes or on the coast. It is also consistent with a story that, after 2000, only the highly skilled were able to live near the lakes, possibly due to increasing housing prices. Additionally, these results suggest that perhaps it is the increase in high skilled workers in coastal counties that is driving the productivity improvements that have led to increases in employment. However, we caution that the low explanatory value of these models, as evidenced by the small values of the adjusted R-squared, suggests more analysis may be needed.

Sensitivity Analysis and the Role of Recreational Homes

Because of the role that recreational homes can play in economic growth in high-amenity areas (Deller et al., 1997), we re-estimated each of our core models but included the percentage of recreational homes in that county as a control (results not shown). While we are concerned that recreational homes may be endogenous and may be highly correlated with proximity to the lake, we find that there appears to be a positive and statistically significant relationship between the percentage of recreational homes and overall population growth in both decades. The result of including recreational homes in our models is that the coastal dummy variable in the population change between 1990 and 2000 model loses its statistical significance, although the coefficient remains large and negative. However, results for population change after 2000 remain the same. At the same time, there is no evidence of a statistical relationship between the percentage of recreational homes and either employment growth or growth in the share of college graduates in either decade. Additionally, including a control for recreational homes in our model leaves the other key results virtually unchanged.

VI. Conclusion and Future Research

With the economic recession and ongoing economic restructuring, there is interest in the Great Lakes region in whether the lakes themselves can be drivers of growth. There is an increased sense of urgency in finding new ways to generate growth, especially for the former Rustbelt cities and the entire eastern part of the region, which has experienced a decline in population since the 1970s.

To assess whether the Great Lakes are associated with growth in the region, we examine changes in population, employment, and the share of college graduates. Given the access to fresh water and recreational opportunities that the Great Lakes offer, could the region reinvent itself with amenity-driven growth? Or, will the industrial legacies of the Rust Belt create a repulsion effect that overwhelms the attraction of QOL-enhancing amenities? The evidence is mixed.

There is evidence that being in a county on one of the Great Lakes is associated with growth at the high-end of the human capital spectrum, as seen by the relationship with growth in the share of college graduates. This is consistent with work by Moretti (2004) and Roback (1988) that suggests that amenities are more important to those with higher incomes or higher human capital and by Kerr (2011) that shows that amenities are luxury goods. Additionally, Great Lakes coastal counties in the eastern part of the region, with their industrial legacy, seem to be doing just as well as their western counterparts in terms of increasing shares of college graduates, and this trend continues past 2000. It appears that amenity-based migration by those with higher levels of education is happening throughout the region and did not trail off after 2000.

At the same time, overall population changes in the Great Lakes region do not appear to be driven by a strong amenity effect. In the 1990s, there is some evidence that people may be interested in locating close enough to one of the lakes to enjoy their recreational benefits but not necessarily on one of the lakes. This is consistent with studies that show proximity benefits from natural amenities. It may also be that other factors such as housing prices affect exactly where they choose to live, and that higher rents near the lake may lead them to choose to be close enough to enjoy the benefits of the lakes, but just far enough away where they do not have to pay the amenity premium in their housing costs. But, between the 1990s and the 2000s, the relationship between proximity to the lakes and population growth declines. Since positive amenities are normal or superior goods, the housing crisis and the two recessions of the 2000s may have made households, in general, less concerned with amenities and disamenities. Alternatively, it could be that the decline in environmental quality of the lakes starting in the late 1990s has made the lakes less attractive after 2000.

One possibility for the relatively weak results for overall migration is that that, by using county-level data, we are not able to distinguish between those households that live directly on or within a short distance of one of the Great Lakes and those that live within a coastal county but farther from the lake. Thus, in future work we will use micro-level data at the household level to try to distinguish true coastal households from those who simply live "near" one of the lakes.

At first glance, it also appears that the Great Lakes do not seem to play much of a role in overall employment changes in the region, with almost no discernible relationship between proximity to the lakes and employment changes after 2000. However, when we look at whether the value of proximity to the lakes is changing between the decades, we see evidence that being on the coast is becoming more important to employment growth. Perhaps this is due to the increasing numbers of college graduates who are moving into the coastal counties thus creating productivity benefits for employers.

Finally, we note that both nationally and in this region, there is a dramatic decrease since 2000 in both population and employment growth. This could be because rising housing costs may be offsetting amenity benefits for the broader population and resulting in smaller disequilibrium adjustments toward equilibrium in terms of population and employment changes after 2000. In this region, if the higher housing prices mean that only the higher-skilled, higher-income workers and households can afford to live near the lakes, this could have important distributional or welfare effects not explored in this paper.

At the same time, if coastal areas in the Great Lakes region can attract high-skilled workers that could have tremendous benefits for the region in terms of transforming it into one that is economically diverse and includes higher-paying, higher-skilled jobs. Previous work has shown that as high-skilled labor enters a market, this can also attract new firms entering the region who demand this high-skilled labor. Through knowledge spillovers and productivity increases as well as bidding between firms, wages can increase (Deller et al., 2001; Partridge and Rickman, 2003b; Kim et al., 2005; Rosenthal and Strange, 2001; 2003). However, this strategy could also crowd out lower-skilled, lower-income workers from these areas.

There also could be tremendous heterogeneity in terms of the ability of specific communities to implement an economic development strategy focused on attracting high-skilled workers with lake amenities. It may be that a combination of both access to amenities and jobs in specific industries are important to attracting high-skilled workers; thus it would be interesting to investigate which types of jobs the college graduates are taking. Finally, we note that our results do not suggest that natural amenities in this region are more attractive than those in California, Florida, or the Mountain West. However, they do imply that there may be a way that communities in this region can capitalize on their natural amenities even if they cannot replicate the levels of growth seen in other high-amenity locations. Future work should also consider other measures of growth, such as the change in the share of self-employment or employment in specific industries or occupations.

The real and perceived quality of amenities varies throughout the region and changes over time. For example, there is evidence that many would-be tourists think of Lake Erie as dirty (Ohio Sea Grant, 2005) while there are positive perceptions of Lake Superior's water quality. Even when environmental restoration improves quality, changes in perceptions may take time. As the same time, water quality has declined for many parts of the region in recent years and this may or may not be known to potential in-migrants. Overall, this research suggests that for those counties and sub-regions close to the Great Lakes there may be economic benefits to preserving or restoring the quality of the lakes as a QOL-enhancing amenity.

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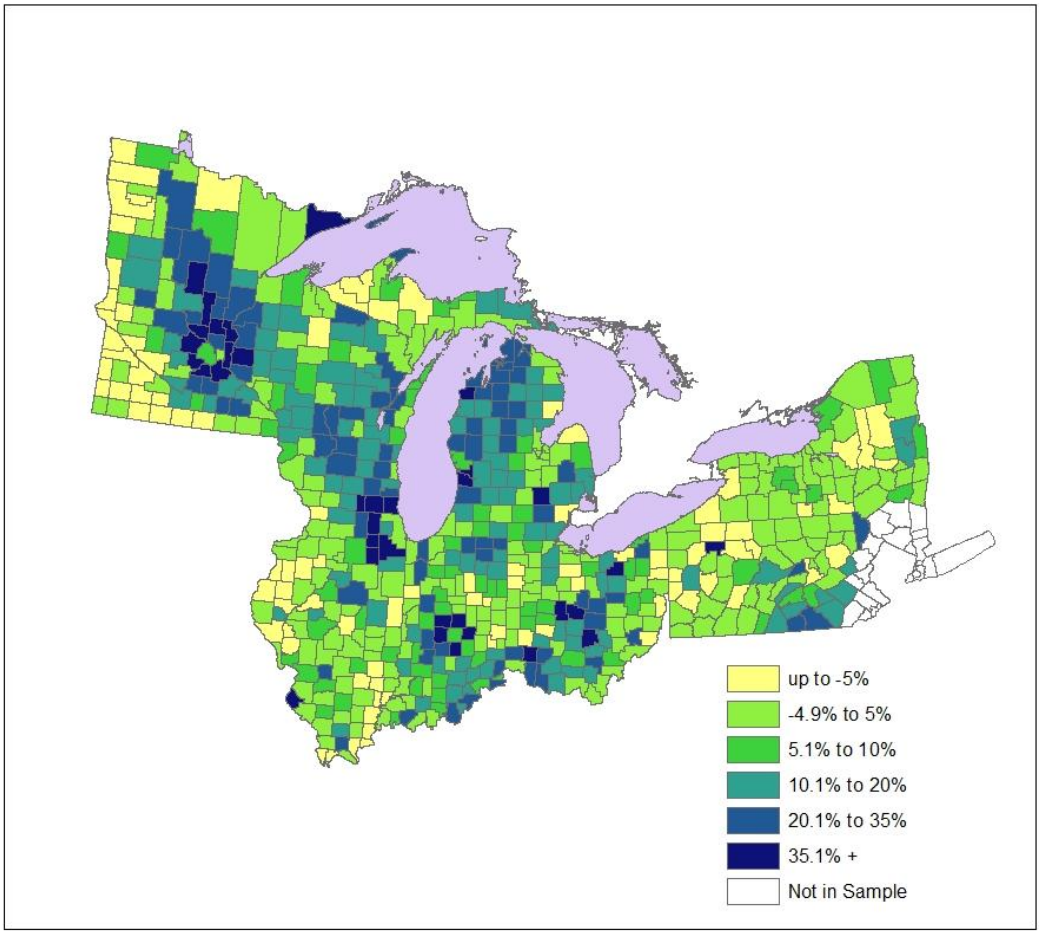

Figure 1. Great Lakes Region, County-Level Population Change, 1990 to 2007

	Eastern Great Lakes Counties (n=244)		Western Great Lakes Counties (n=384)		Difference between East and West?
	Mean	Std. Dev.	Mean	Std. Dev.	T-Statistic
Growth Variables: 1990 to 2000					
% Change in County-Level Population	5.56	8.43	8.56	10.93	3.65 ***
% Change in County-Level Employment	16.65	15.77	21.83	17.43	3.77 ***
% Change in County-Level Share of College Graduates	23.19	11.49	26.95	13.19	3.65 ***
Growth Variables: 2000 to 2007					
% Change in County-Level Population	0.67	5.91	1.59	8.40	1.48
% Change in County-Level Employment	2.46	10.84	1.97	10.79	-0.56
% Change in County-Level Share of College Graduates[1]	16.01	12.34	17.30	24.87	0.75

	Eastern Great Lakes		Western Great Lakes		Total	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Levels of Growth Variables						
Population, 1990	130,038	232,730	73,594	281,350	95,524	264,769
Population, 2000	134,368	233,992	80,807	298,300	101,618	276,147
Employment, 1990	68,655	138,619	41,420	175,403	52,002	162,533
Employment, 2000	76,987	151,941	49,241	191,841	60,021	177,796
% College Graduates, 1990	13.05	5.77	13.00	5.40	16.22	6.72
% College Graduates, 2000	15.96	6.86	16.39	6.62	13.02	5.54
Explanatory Variables (1990)						
Distance to Nearest Great Lake	136.94	93.68	199.56	134.05	175.23	123.74
Percent Forest Area	42.60	25.15	26.82	25.84	32.95	26.69
Topography Score	0.14	1.02	-0.53	0.61	-0.27	0.86
January Temperature - Z score	-0.57	0.32	-1.00	0.69	-0.83	0.62
July Temperature - Z score	0.47	0.39	-0.17	0.59	0.08	0.61
Percent water (not including Great Lakes)	-0.21	0.46	-0.01	0.69	-0.08	-0.62
Average Annual Snowfall	30.36	17.07	25.83	17.25	27.59	17.30
Distance to the nearest Superfund site	30.59	22.07	43.05	32.74	38.83	29.53
Number of power plants	1.52	3.07	0.85	1.49	1.03	2.20
total water emissions (tons)	38,805	223,023	27,469	273,389	32,322	258,697
total air emissions (tons)	1,277,166	2,170,466	832,704	2,443,207	997,886	2,366,926
Disamenity Index	0.02	2.14	-0.04	2.18	-0.02	-2.17
Distance to Nearest Metro	43.36	32.74	68.34	54.34	58.64	48.66
Incremental Distance to Metro > 250,000	20.13	30.72	40.88	56.21	32.82	48.97
Incremental Distance to Metro > 500,000	14.84	26.86	40.63	57.77	30.61	49.76
Incremental Distance to Metro > 2.5 million	67.18	85.18	17.22	35.72	36.63	64.69
% College Graduates	13.05	5.77	13.00	5.40	13.02	5.54
% some college	19.93	4.66	22.60	3.65	21.56	4.27
% High School graduates	40.76	5.91	38.89	4.84	39.62	5.35
% white	95.86	5.13	96.23	5.29	96.08	5.22
% married	61.24	4.32	62.59	4.52	62.07	4.49
% population female	51.15	1.13	50.83	1.25	50.95	1.22
population density (population per square mile)	228.29	408.91	139.72	427.51	174.13	422.27
% population under 18	25.20	2.27	25.66	2.26	25.48	2.27
% population over 65	13.61	2.65	14.88	3.36	14.39	3.16
% Population over 16 that is employed	55.62	6.24	57.77	6.75	56.94	6.64
% Manufacturing Employment 1970	27.08	10.47	19.06	11.72	22.18	11.90
% Recreational Homes	7.58	12.67	8.42	12.75	8.09	12.71
Percent of Nonfarm Proprietors Employment	16.39	4.19	17.36	4.56	16.98	4.44
Percent Wage and Salary Workers, Leisure	8.33	3.34	8.88	4.48	8.66	4.08
Percent Wage and Salary Workers, Manufacturing	24.02	10.69	20.45	11.37	21.84	11.24
Percent Wage and Salary Workers, Government	19.12	7.39	20.79	8.09	20.14	7.86
Percent Wage and Salary Workers, Agriculture	1.61	1.55	3.20	2.75	2.58	2.48

1 The share of college graduates in 2007 is actually theAmerican Community Survey 5-year estimate from 2005-2009.

Table 1. The Great Lakes Region, Descriptive Statistics

	1990 to 2000									2000 to 2007								
	Model 1			Model 2			Model 3			Model 1			Model 2			Model 3		
Distance to Nearest Great Lake	-0.021	*(0.007)*	***	-0.023	*(-4.38)*	***	-0.019	*(0.005)*	***	-0.011	*(0.007)*		-0.009	*(0.007)*		-0.010	*(0.006)*	
Great Lakes Coastal County	-4.077	*(1.382)*	***	-3.734	*(-2.58)*	**	-4.103	*(1.373)*	***	-2.588	*(1.382)*	*	-2.389	*(1.372)*	*	-2.531	*(1.459)*	*
Percent Forest Area	0.060	*(0.039)*		0.006	*(0.24)*		0.002	*(0.023)*		0.021	*(0.021)*		0.023	*(0.016)*		0.022	*(0.018)*	
Topography Score	-0.664	*(0.887)*		-0.049	*(-0.09)*		0.073	*(0.536)*		0.385	*(0.487)*		0.249	*(0.354)*		0.137	*(0.331)*	
January Temperature - Z score	-1.528	*(0.984)*		-1.402	*(-1.27)*		-1.295	*(1.148)*		-1.982	*(0.680)*	***	-1.006	*(0.524)*	*	-1.146	*(0.402)*	***
July Temperature - Z score	1.158	*(1.562)*		0.058	*(0.06)*		0.083	*(1.114)*		-1.148	*(1.091)*		-0.949	*(0.665)*		-1.008	*(0.594)*	*
Percent water (not including Great Lakes)	2.005	*(0.904)*	**	1.185	*(1.91)*	*	1.315	*(0.606)*	*	0.442	*(0.639)*		0.166	*(0.564)*		0.152	*(0.555)*	
Disamenity Index	-0.599	*(0.188)*	***	-0.154	*(-1.16)*		-0.054	*(0.126)*		-0.288	*(0.133)*	**	-0.073	*(0.076)*		-0.102	*(0.063)*	
Distance to Nearest Metro	0.006	*(0.019)*		0.017	*(1.49)*		0.002	*(0.011)*		-0.015	*(0.015)*		-0.007	*(0.009)*		-0.001	*(0.013)*	
Incremental Distance to Metro > 250,000	-0.051	*(0.015)*	***	-0.031	*(-3.94)*	***	-0.035	*(0.008)*	***	-0.044	*(0.009)*	***	-0.023	*(0.005)*	***	-0.019	*(0.006)*	***
Incremental Distance to Metro > 500,000	-0.058	*(0.010)*	***	-0.042	*(-5.28)*	***	-0.042	*(0.008)*	***	-0.038	*(0.005)*	***	-0.025	*(0.005)*	***	-0.024	*(0.005)*	***
Incremental Distance to Metro > 2.5 million	-0.034	*(0.010)*	***	-0.023	*(-3.63)*	***	-0.023	*(0.007)*	***	-0.021	*(0.006)*	***	-0.017	*(0.004)*	***	-0.017	*(0.005)*	***
Located within a Metro Area	5.528	*(1.383)*	***	3.355	*(3.81)*	***	3.118	*(0.668)*	***	5.432	*(1.405)*	***	2.468	*(0.810)*	***	1.993	*(0.607)*	***
East Control	-6.110	*(1.599)*	***	-9.557	*(-5.92)*	***	-8.984	*(1.691)*	***	-2.592	*(0.985)*	**	-3.949	*(1.665)*	**	-4.268	*(1.805)*	**
East x Distance to Nearest Great Lake				0.028		***	0.028	*(0.007)*	***				0.018	*(0.009)*	**	0.017	*(0.008)*	**
East x Coastal				3.892		**	3.864	*(1.761)*	**				3.278	*(1.334)*	**	3.552	*(1.596)*	**
Other Controls?																		
Demographic	N			Y			Y			N			Y			Y		
Industry	N			Y			Y			N			Y			Y		
State Fixed Effects	N			N			N			N			N			N		
Other Economic Controls	N			N			Y			N			N			Y		
Adjusted R^2	0.295			0.574			0.591			0.288			0.566			0.575		
Highest VIF	4.94			7.99			8.14			4.88			9.02			9.4		
Number of observations (n)	628			628			624			628			628			624		

(Values in italics and in parentheses are the clustered standard errors using BEA economic areas as clusters.)

*** Indicates significance at the 99% level; ** significance at the 95% level; and * significance at the 90% level.

Demographic includes initial (1990 or 2000) variables representing education levels (% college graduates, % some college, % high school graduates), population density, age (% under 18 and % over 65), race (% white), % married, and

Industry includes initial (1990 or 2000) % of population that was employed, % nonfarm proprietor employment, % manufacturing employment, % agriculture employment, % government employment, and % wage and salary leisure employment.

Other Economic Controls include 1970 manufacturing employment share and spatially-lagged 1990 employment share variables.

Table 2. Population Changes in the Great Lakes region

	1990 to 2000									2000 to 2007								
	Model 1			Model 2			Model 3			Model 1			Model 2			Model 3		
Distance to Nearest Great Lake	-0.012	*(0.013)*		-0.012	*(0.012)*		-0.004	*(0.010)*		-0.001	*(0.008)*		-0.004	*(0.008)*		-0.005	*(0.007)*	
Great Lakes Coastal County	-4.460	*(1.805)*	**	-3.273	*(1.987)*		-2.9[illegible]	[illegible]	*	-2.000	*(1.406)*		0.462	*(1.285)*		0.588	*(1.318)*	
Percent Forest Area	0.132	*(0.068)*	*	0.036	*(0.055)*		0.0[illegible]	[illegible]		0.021	*(0.025)*		0.009	*(0.028)*		0.013	*(0.029)*	
Topography Score	-1.691	*(1.477)*		-1.079	*(1.098)*		-1.241	*(1.018)*		1.742	*(0.638)*	***	0.921	*(0.583)*		0.860	*(0.658)*	
January Temperature - Z score	-2.949	*(1.451)*	**	-1.477	*(2.044)*		-1.703	*(1.931)*		-4.684	*(0.759)*	***	-3.212	*(0.787)*	***	-3.157	*(0.778)*	***
July Temperature - Z score	1.952	*(2.672)*		0.682	*(2.221)*		1.144	*(1.917)*		0.047	*(1.586)*		-0.319	*(1.374)*		-0.342	*(1.355)*	
Percent water (not including Great Lakes)	3.128	*(1.388)*	**	1.358	*(0.937)*		1.700	*(0.781)*	**	1.301	*(0.848)*		0.649	*(0.583)*		0.695	*(0.560)*	
Disamenity Index	-1.116	*(0.312)*	***	-0.393	*(0.208)*	*	-0.271	*(0.207)*		0.050	*(0.165)*		0.382	*(0.134)*	***	0.335	*(0.122)*	***
Distance to Nearest Metro	0.027	*(0.024)*		0.020	*(0.018)*		-0.005	*(0.019)*		-0.023	*(0.012)*	*	-0.019	*(0.009)*	**	-0.006	*(0.011)*	
Incremental Distance to Metro > 250,000	-0.055	*(0.018)*	***	-0.032	*(0.013)*	**	-0.046	*(0.012)*	***	-0.048	*(0.010)*	***	-0.025	*(0.009)*	***	-0.020	*(0.009)*	**
Incremental Distance to Metro > 500,000	-0.073	*(0.016)*	***	-0.051	*(0.016)*	***	-0.060	*(0.013)*	***	-0.042	*(0.007)*	***	-0.031	*(0.007)*	***	-0.028	*(0.008)*	***
Incremental Distance to Metro > 2.5 million	-0.061	*(0.016)*	***	-0.045	*(0.011)*	***	-0.053	*(0.011)*	***	-0.014	*(0.007)*	*	-0.009	*(0.008)*		-0.009	*(0.009)*	
Located within a Metro Area	7.581	*(1.723)*	***	4.436	*(1.602)*	***	4.249	*(1.252)*	***	6.139	*(1.511)*	***	3.225	*(0.875)*	***	2.819	*(0.916)*	***
East Control	-6.753	*(2.834)*	**	-9.205	*(2.595)*	***	-7.750	*(2.333)*	***	-1.869	*(1.296)*		-2.426	*(2.499)*		-3.424	*(2.396)*	
East x Distance to Nearest Great Lake				0.033	*(0.020)*		0.032	*(0.018)*	*				0.019	*(0.012)*		0.021	*(0.012)*	*
East x Coastal				2.040	*(2.464)*		1.730	*(2.260)*					0.780	*(1.738)*		1.320	*(1.660)*	
Other Controls?																		
Demographic	N			Y			Y			N			Y			Y		
Industry	N			Y			Y			N			Y			Y		
State Fixed Effects	N			N			N			N			N			N		
Other Economic Controls	N			N			Y			N			N			Y		
Adjusted R^2	0.188			0.432			0.439			0.176			0.424			0.433		
Highest VIF	4.94			7.99			8.14			4.88			9.02			9.4		
Number of observations (n)	628			628			624			628			628			624		

(Values in italics and in parentheses are the clustered standard errors using BEA economic areas as clusters.)

*** Indicates significance at the 99% level; ** significance at the 95% level; and * significance at the 90% level.

Demographic includes initial (1990 or 2000) variables representing education levels (% college graduates, % some college, % high school graduates), population density, age (% under 18 and % over 65), race (% white), % married, and % female.

Industry includes initial (1990 or 2000) % of population that was employed, % nonfarm proprietor employment, % manufacturing employment, % agriculture employment, % government employment, and % wage and salary leisure employment.

Other Economic Controls include 1970 manufacturing employment share and spatially-lagged 1990 employment share variables.

Table 3. Employment Changes in the Great Lakes region

	1990 to 2000			2000 to 2007[1]		
	Model 1	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
Distance to Nearest Great Lake	0.020 *(0.007)* ***	0.019 *(0.007)* **	0.018 *(0.007)* **	0.0227 *(0.015)*	0.0279 *(0.017)*	0.0231 *(0.019)*
Great Lakes Coastal County	4.172 *(1.412)* ***	4.814 *(1.730)* ***	5.517 *(2.006)* ***	4.5014 *(1.750)* **	5.2169 *(2.822)* *	6.1433 *(2.942)* **
Percent Forest Area	0.011 *(0.033)*	0.009 *(0.033)*	0.034 *(0.028)*	-0.0236 *(0.056)*	-0.0135 *(0.059)*	-0.0548 *(0.070)*
Topography Score	0.886 *(0.714)*	0.754 *(0.783)*	1.102 *(0.687)*	-1.1688 *(1.395)*	-1.0135 *(1.424)*	-0.2539 *(1.437)*
January Temperature - Z score	-2.449 *(1.105)* **	-2.416 *(1.075)* **	-0.753 *(1.593)*	4.2974 *(1.953)* **	4.1484 *(1.953)* **	2.7660 *(2.055)*
July Temperature - Z score	1.604 *(1.241)*	1.369 *(1.285)*	1.865 *(1.066)* *	-1.3420 *(2.761)*	-1.2582 *(2.743)*	-1.0847 *(2.759)*
Percent water (not including Great Lakes)	2.283 *(0.722)* ***	2.292 *(0.724)* ***	2.206 *(0.953)* **	2.7078 *(1.323)* **	2.6415 *(1.316)* *	2.8362 *(1.468)* *
Disamenity Index	-0.351 *(0.155)* **	-0.346 *(0.155)* **	-0.034 *(0.196)*	0.5664 *(0.415)*	0.5465 *(0.416)*	0.7135 *(0.473)*
Distance to Nearest Metro	0.014 *(0.017)*	0.015 *(0.017)*	0.018 *(0.017)*	0.0231 *(0.028)*	0.0176 *(0.027)*	0.0057 *(0.025)*
Incremental Distance to Metro > 250,000	-0.029 *(0.011)* **	-0.028 *(0.010)* ***	-0.018 *(0.012)*	-0.0009 *(0.013)*	-0.0039 *(0.013)*	-0.0178 *(0.014)*
Incremental Distance to Metro > 500,000	-0.015 *(0.013)*	-0.015 *(0.012)*	-0.012 *(0.012)*	0.0365 *(0.022)*	0.0354 *(0.022)*	0.0283 *(0.023)*
Incremental Distance to Metro > 2.5 million	-0.034 *(0.010)* ***	-0.032 *(0.009)* ***	-0.031 *(0.008)* ***	0.0111 *(0.010)*	0.0074 *(0.010)*	0.0110 *(0.014)*
Located within a Metro Area	4.735 *(1.192)* ***	4.677 *(1.203)* ***	7.510 *(1.406)* ***	-6.0471 *(2.273)* **	-6.0151 *(2.241)* ***	-0.0634 *(1.796)*
East Control	-2.523 *(1.434)* *	-2.831 *(2.655)*	-0.073 *(2.760)*	2.6094 *(1.741)*	5.6396 *(2.788)* **	6.8737 *(3.395)* *
East x Distance to Nearest Great Lake		0.005 *(0.018)*	-0.005 *(0.016)*		-0.0199 *(0.013)*	-0.0286 *(0.018)*
East x Coastal		-1.276 *(2.751)*	-3.864 *(3.273)*		-2.0398 *(3.254)*	-6.0573 *(3.698)*
Other Controls?						
Demographic	N	N	Y	N	N	Y
Industry	N	N	Y	N	N	Y
State Fixed Effects	N	N	N	N	N	N
Adjusted R^2	0.092	0.089	0.216	0.047	0.045	0.074
Highest VIF	4.94	6.44	7.99	4.88	6.51	9.02
Number of observations (n)	628	628	628	628	628	628

(Values in italics and in parentheses are the clustered standard errors using BEA economic areas as clusters.)

*** Indicates significance at the 99% level; ** significance at the 95% level; and * significance at the 90% level.

Demographic includes initial (1990 or 2000) variables representing education levels (% college graduates, % some college, % high school graduates), population density, age (% under 18 and % over 65), race (% white), % married, and % female.

Industry includes initial (1990 or 2000) % of population that was employed, % nonfarm proprietor employment, % manufacturing employment, % agriculture employment, % government employment, and % wage and salary leisure employment.

[1] The share of college graduates in 2007 is actually theAmerican Community Survey 5-year estimate from 2005-2009.

Table 4. Changes in Shares of College Graduates in the Great Lakes Region

	Population Change		Employment Change		Change in Share of College Graduates	
Distance to Nearest Great Lake	0.011	*(0.005)* **	0.014	*(0.014)*	0.015	*(0.015)*
Great Lakes Coastal County	1.185	*(0.992)*	3.453	*(1.984)* *	3.683	*(1.881)* *
Percent Forest Area	-0.023	*(0.022)*	-0.075	*(0.068)*	-0.078	*(0.073)*
Topography Score	0.790	*(0.404)* *	2.822	*(1.307)* **	-0.284	*(1.608)*
January Temperature - Z score	-0.490	*(0.702)*	-1.874	*(1.708)*	4.025	*(1.761)* **
July Temperature - Z score	-0.430	*(0.916)*	-0.001	*(3.178)*	0.588	*(2.519)*
Percent water (not including Great Lakes)	-0.890	*(0.527)* *	-0.317	*(1.105)*	3.048	*(1.211)* **
Distance to Nearest Metro	-0.024	*(0.010)* **	-0.041	*(0.024)* *	0.007	*(0.022)*
Incremental Distance to Metro > 250,000	0.001	*(0.008)*	0.001	*(0.014)*	-0.016	*(0.015)*
Incremental Distance to Metro > 500,000	0.010	*(0.006)*	0.018	*(0.018)*	0.028	*(0.024)*
Incremental Distance to Metro > 2.5 million	0.012	*(0.006)* *	0.045	*(0.014)* ***	0.016	*(0.012)*
Located within a Metro Area	0.088	*(0.705)*	-0.647	*(1.886)*	-1.496	*(1.908)*
Other Controls?						
Demographic	Y		Y		Y	
Industry	Y		Y		Y	
Adjusted R^2	0.300		0.189		0.062	
Highest VIF	5.08		5.08		5.08	
Number of observations (n)	628		628		628	

(Values in italics and in parentheses are the clustered standard errors using BEA economic areas as clusters.)

[a] Difference between Population, Employment, and College Graduate Share growth from 2000 to 2007 and 1990 to 2000

*** Indicates significance at the 99% level; ** significance at the 95% level; and * significance at the 90% level.

Demographic includes 1990 variables representing education levels (% college graduates, % some college, % high school graduates), population density, age (% under 18 and % over 65), race (% white), % married, and % female.

Industry includes 1990 % of population that was employed, % nonfarm proprietor employment, % manufacturing employment, % agriculture employment, % government employment, and % wage and salary leisure employment.

Table 5. Differences between the 2000s and the 1990s[a] in how Amenities and Disamenities Affect Growth