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Does Public Lands Policy Affect Local Wage Growth?

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Abstract: We quantify the effects on wage growth of management practices applied on public lands in the Northern Forest region of the United States. A central objective is to determine if the management of public lands for preservationist uses results in lower average wages. This is a frequent claim made by critics of land preservation who argue that preservationist management, by prohibiting resource extraction, causes the composition of employment to shift from high-wage jobs in resource-based manufacturing to low-wage jobs in the service sector. A model of simultaneous employment and net migration growth is estimated with data on non-metropolitan counties over the period 1990 to 1999 and applied in a recursive relationship to wage growth. In earlier studies, models of this type have typically been specified in levels. We provide time-series evidence that supports a preference for growth rates as the form for such models. Exogenous variables in our model include the 1990 shares of the county land base that are publicly owned and managed for preservationist (non-extractive) uses and multiple (including extractive) uses. We find that wage growth rates are not significantly affected by the shares of land under either management regime. As well, recent declines in national forest timber sales are found to have no effect on wage growth.

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I. INTRODUCTION

Over the past three decades, public lands in the United States have been increasingly managed for non-commodity outputs such as wildlife habitat, wilderness recreation, and environmental benefits such as watershed protection. In many cases, this represents a marked shift away from historical commodity-oriented uses of these lands. There appears to be widespread public support for this increased emphasis on preservationist uses of public lands. For example, in January, 2001, the U.S. Forest Service announced the Roadless Rule for National Forests, which banned road building and most commercial logging on 58 million acres of national forest land. During the formulation of the Roadless Rule, more than 1.6 million public comments were received, 96% of which expressed support for the rule. The principal rationale for preservationist management is to ensure the provision of non-commodity outputs that would otherwise be underprovided in a private land market. Yet, even if the aggregate net benefit of public land preservation is positive, the benefits and costs of land preservation may not be evenly distributed across segments of the population. In particular, a common charge is that the costs of public land preservation are disproportionately borne by rural residents whose ability to capture the benefits from high-wage jobs is diminished when restrictions are placed on timber harvesting and other commercial uses of the land.

The management of public lands for preservationist uses can potentially impact employment through a number of channels. Preservationist lands may have a direct effect on employment by decreasing jobs in resource extraction industries and increasing tourism-related jobs. In addition, land preservation may have an indirect effect on employment if it attracts amenity-seeking migrants to the local area or causes current residents to leave in search of employment opportunities elsewhere. Previous studies have examined the simultaneous effects of public land preservation on population and employment. Duffy-Deno (1998) applies the Carlino and Mills (1987) model to study the impact of federal wilderness areas on population and employment levels in the Rocky Mountain West. Lewis *et al*. (2002) apply a variation of Greenwood and Hunt's (1984) model to analyze the effects of all public conservation lands[1] on net migration and employment growth rates in the Northern Forest region. Neither study finds significant effects of public land preservation on employment levels or growth rates.[2]

These earlier studies use aggregate (county-level) data and measure employment as the number of full- and part-time jobs. While they find no effect on total employment, these studies do not address the question of whether public land management changes the composition of employment.[3] Of particular interest is whether preservationist lands cause a shift from high-wage jobs in resource-based manufacturing to low-wage jobs in the service sector. This is a frequent claim made by opponents of land preservation,[4] who contend that preservationist lands result in the replacement of high-paying jobs with the proverbial "burger-flipper" jobs. It is difficult to test directly for the effects of preservationist lands on the composition of employment because sufficiently detailed sectoral employment figures are rarely disclosed for rural counties. An alternative approach is to examine the effects of preservationist lands on wages. If land preservation causes a shift from high- to low-wage jobs, one should find a negative effect of preservationist lands on wage growth as average wage levels in the county are decreased, all else equal. In the studies cited above, wages are not explicitly modeled.

The objective of this paper is to analyze the impact of public land management on wage growth rates in the Northern Forest region. We extend the model of Lewis *et al*. (2002) to include, in addition to simultaneous equations for net migration and employment growth, a third equation for wage growth. The model is estimated with county data for the period 1990 to 1999, and two strategies are employed to quantify management practices on public lands. First, we simply include variables measuring the lagged (1990) shares of total county land under preservationist and multiple-use management. Second, we divide the multiple-use variable into the shares of county land in state and national forests and include an additional variable measuring recent changes in public timber sales. During the 1990s, there were considerable declines in timber sales from national forests in the region, providing us with a "natural experiment" that identifies the wage growth effects of the adoption of preservationist management. Our model structure allows us to test for direct and indirect effects of public land management on wage growth. In the first case, we test if land preservation has a direct negative effect on wage growth, a finding that would be consistent with the impacts on the composition of employment discussed above. In the second case, we investigate the wage growth impacts of public land management through its effect on net migration and employment growth.

An important distinction is made between our analysis and the earlier study by Duffy-Deno (1998). The jointly endogenous variables in our empirical model are measured in growth rate form. Employment and wages are both measured directly as growth rates, and the migration rate variable is a population flow component expressed as a rate. The importance of modeling the growth rate forms of these variables relates to the concept of stationarity. As is well known (Granger and Newbold, 1977; Davidson, 2000), estimating models formulated in terms of nonstationary variables leads to inconsistent estimates, invalid inferences based on classical test statistic distributions, and spurious results. To provide justification for the growth rate specification, we analyze annual data on state-level employment and population for the period 1950-2000 for the states in our study. Levels and log-levels of employment and population are shown to be nonstationary in almost all cases. These are the measurements used in Duffy-Deno (1998) and in other studies modeled on Carlino and Mills (1987). However, growth rates of population and employment are found to be stationary for every state in our study.

The next section provides an overview of the study region and a brief historical review of public land management in the region. In Section III, we present the econometric model of net migration, employment and wage growth and, in Section IV, our estimation results. Section V presents discussion and conclusions.

II. PUBLIC CONSERVATION LANDS IN THE NORTHERN FOREST REGION

The Northern Forest region stretches from northern Minnesota to Maine and is one of the largest forested regions in the United States. For this study, the Northern Forest region is defined by 92 counties in the northern Lakes States region, northeastern New York, and northern New England (Figure 1).[5] In all of the counties, a large share of the land base is forested, and wood products production is the dominant manufacturing industry. Forest products employment accounts for 11 percent of total employment regionwide and as much as 71 percent of total employment in a single county.[6] We include only non-metropolitan counties—those counties that do not contain a city qualifying as a

Metropolitan Statistical Area (MSA)—in order to focus on employment that is largely based on the forest resource. Six counties (Penobscot, ME, Franklin, VT, Herkimer and Warren, NY, Douglas, WI, and St. Louis, MN) that contain small MSAs are also included because they have population densities and other characteristics similar to non-metropolitan counties.

For many years, there has been significant pressure brought by conservation and environmental interests to increase the amount of public conservation land in the Northern Forest region. Although the region is sparsely populated, with only about one percent of the U.S. population living in the region, it is easily accessed from major metropolitan areas to the south (e.g., Boston, New York, Detroit, Chicago, Minneapolis). Almost 40 percent of the U.S. population lives in a Northern Forest state or a state bordering a Northern Forest state, and existing conservation lands within the region (e.g., Acadia National Park in Maine, the White Mountain National Forest in New Hampshire) have some of the highest visitation rates in the country. Since most of the land in the region is privately owned (78 percent) and much of it is intensively used for commodity production, there is strong support for the designation of additional conservation lands. Environmental groups are promoting the creation of a large national park in northern Maine and biodiversity reserve systems in New England and the Lake States region (Kennedy and Sant 2000). In recent years, voters in Maine and Michigan approved ballot initiatives providing funding for the acquisition of conservation lands and the federal government has funded land purchases in the region through the Land and Water Conservation Fund.

While most land in the region is privately-owned, there is great variation at the state and county levels in the areas of land in public conservation uses.[7] Only about five percent of Maine's land within the Northern Forest region is in public conservation uses, compared to almost 37 percent in Michigan. The variation is even greater at the county level, ranging from zero to 82 percent. There is also considerable variation in the management practices applied on public conservation lands in the region. As noted above, public conservation lands include lands managed for preservationist and multiple uses. For the purposes of this study, preservationist lands include national and state parks, wilderness areas and wildlife refuges. Commercial resource extraction is largely prohibited on these lands. Multiple-use lands include state forests and non-wilderness portions of national forests. Commercial resource extraction, including timber harvesting, is permitted on multiple-use lands, though these lands also provide for some forms of recreation. Approximately 30 percent of the public conservation land in the region is managed for preservationist uses and 70 percent is under multiple-use management. At the county level, the share of the total land base under preservationist management ranges from zero to as much as 71 percent. For multiple-use management, the range is zero to 55 percent.

As in other parts of the U.S., public lands in the Northern Forest region are increasingly being managed for preservationist uses instead of traditional commodity-oriented uses.[8] Most of the large tracts of public conservation land in the region were established prior to World War II. However, the transfer of land from private owners to the government did not always coincide with changes in management practices. While timber-harvesting restrictions were applied immediately on many preservationist lands (e.g., the Adirondack Forest Preserve and Acadia National Park), similar management practices were not adopted on public forest lands until much later. In particular, the Weeks Act of 1911 that established many of the national forests in the region required the land to be managed for timber and watershed protection, but made no provisions for other non-timber benefits such as recreation and wildlife.

After World War II, timber harvesting on national forests increased dramatically in response to the post-war housing boom. At the same time, there was increasing pressure on public land management agencies to increase non-timber outputs from public forests. The U.S. Congress passed the Multiple-Use Sustained-Yield (MUSY) Act in 1960 and the National Forest Management Act (NFMA) in 1976, which mandated that, in addition to timber, the national forests be managed for benefits such as outdoor recreation and wildlife habitat. However, for several decades after the passage of the MUSY Act, the national forests continued to be managed primarily for timber production (Alverson *et al*., 1994). By the late 1980s, management plans required under the NFMA were completed for national forests in the region and land preservation became a dominant management objective. Beginning in the early 1990s, national forest timber sales dropped sharply.[9] Between the 1980s and 1990s, average annual sales declined by 42 percent on northeastern forests and 22 percent on Lake States forests. These changes in national forest harvest levels were determined in response to policies promulgated at the national level and, thus, can be considered exogenous to local economic conditions.[10] As such, the observed declines in national forest timber sales provide a “natural experiment” allowing us to identify the effects on local wage growth rates of the adoption of preservationist management.

III. AN ECONOMETRIC MODEL OF NET MIGRATION, EMPLOYMENT AND WAGE GROWTH IN THE NORTHERN FOREST REGION

Model Structure

We conduct an econometric analysis of the effects of public conservation lands on net migration, employment and wage growth in the Northern Forest region. Following Greenwood and Hunt (1984) and Greenwood *et al*. (1986), we specify the system of simultaneous equations,

$$
\begin{aligned}
NM_{i,90-99} &= f_1(EG_{i,90-99}, PD_{i,90}, WG_{i,81-90}, \mathbf{A}_{i,90}) \\
EG_{i,90-99} &= f_2(NM_{i,90-99}, ED_{i,90}, WG_{i,81-90}, \mathbf{B}_{i,90}) \\
WG_{i,90-99} &= f_3(NM_{i,90-99}, EG_{i,90-99}, WG_{i,81-90}, \mathbf{C}_{i,90})
\end{aligned} \qquad [1]
$$

where the two endogenous variables, $EG_{i,90-99}$ and $NM_{i,90-99}$, are employment growth and net migration rates, respectively, in county *i* over the period 1990 to 1999. $WG_{i,90-99}$ is the growth rate in the average real wage in county *i* over the same period, $PD_{i,90}$ and $ED_{i,90}$ are lagged population and employment densities, and $WG_{i,81-90}$ is lagged (1981 to 1990) wage growth. $\mathbf{A}_{i,90}$, $\mathbf{B}_{i,90}$ and $\mathbf{C}_{i,90}$ are vectors of additional lagged exogenous variables that include our measures of management practices on public lands. In the first version (Model I), we include the lagged (1990) shares of total land in county *i* under preservationist ($PR_{i,90}$) and multiple-use ($MU_{i,90}$) management. In the second version (Model II), $MU_{i,90}$ is disaggregated into the lagged shares of national forest ($NF_{i,90}$) and state forest ($SF_{i,90}$) land, and we include a variable measuring changes in national forest timber sales between the 1980s and 1990s (CS_i).

The equation system in [1] captures the simultaneous nature of net migration, employment and wage growth. Under conditions of econometric identification and consistent estimation (as discussed below), causation runs from the righthand side variables to the left hand side variable *in each equation*. In this descriptive model of the time-series structure of local net migration, employment, and wage growth rates, we expect the following qualitative relationships in each equation among endogenous variables, *ceteris paribus*, based on local labor market supply-demand conditions.

Positive employment growth increases the number of available jobs and attracts migrants to a county. At the same time, positive net migration increases the number of people in a county, which positively affects employment by increasing demand for goods and services and providing a larger workforce. Such shifts in a region's labor supply and demand curves affect wages in the region, with the ultimate effect determined by the relative magnitude of these shifts, local demand and supply elasticities, and the responsiveness of local wages to these changes (Greenwood and Hunt 1984).

Holding net migration constant, we expect employment growth to raise wages and, therefore, to produce positive wage growth. On the other hand, higher net migration is expected to lower wage growth, *ceteris paribus*. Wage growth itself should be positively related to contemporaneous net migration and negatively related to contemporaeous employment growth, *ceteris paribus*. We attempted to endogenize wage growth rates but the results did not support this contemporaneous specification.[11] Given this result, we specified lagged wage growth to capture the time-series process between wage growth and employment growth. This specification produces empirical results (see below) that are consistent with our expectations. We use this lagged wage growth specification symmetrically across all three equations. This contrasts slightly with Greenwood and Hunt (1984) and Greenwood *et al*. (1986) where lagged wage growth is omitted from the employment growth rate equation.

Our specific interest is in how public land management affects wage growth. As discussed above, management practices may directly affect wage growth by influencing the composition of employment. We model these direct effects on wage growth by including $PR_{i,90}$ and $MU_{i,90}$ (or $NF_{i,90}$, $SF_{i,90}$, and CS_i) in the third equation of [1]. Public land management may also influence wages indirectly through their effect on migration. For many people, public conservation lands are an amenity because they provide recreational opportunities and may act to limit further land development in their community. In this case, conservation lands have a positive effect on net migration, which may further influence wages through the labor supply and induced local demand effects described above. Accordingly, we include $PR_{i,90}$ and $MU_{i,90}$ in the net migration equation. Conservation lands, and particularly those managed for preservationist uses, may further influence employment growth, potentially reducing jobs in resource extraction industries and increasing jobs in tourism-related sectors. Such changes in employment can affect wages directly as well through their effect on net migration. $PR_{i,90}$ and $MU_{i,90}$ are included in the employment growth equation. This specification covers all channels through which public conservation lands could impact wage growth in our model.

Because conservation lands are viewed as an amenity by households and may, or may not, be unproductive from a firm's point of view, we control for other major consumption and production amenities to better isolate any effects of public land management. Because our counties are similar in their climatic amenities, we include population and employment densities to capture potential scale-related consumption and production amenities. These density measures also can be viewed as possibly helping to control for the effects of long-past conservation decisions.[12] However, we believe that the natural experiment employed below is much better suited to identifying effects of "new" versus "old" conservation decisions.

The principal goal of the econometric estimation is to obtain consistent and precise estimates of the parameters on the public land management variables. In a study of local economic conditions and amenities, the goal of consistency is served by including as many potentially relevant exogenous regressors in [1] as possible so that omitted variable bias in the parameter estimates of interest is mitigated.[13] Another role of the exogenous regressors is to achieve an identified system of equations. These additional exogenous variables measure factors that make an area more attractive to firms considering expansion or relocation and to potential migrants, as well as factors that may affect a region's wages. Following Clark and Murphy (1996), the additional variables in vector **A** measure amenities other than those provided by public lands, fiscal conditions, and economic opportunities beyond employment growth. Additional variables in **B** measure local business and fiscal conditions, and variables in **C** measure fiscal conditions, economic conditions and other factors likely to affect wages.

A number of features of the Northern Forest region facilitate the proposed analysis. Given our use of cross-sectional data, the role of the exogenous variables is to control for differences across counties that explain spatial variation in net migration, employment and wage growth. As noted above, there are large differences across counties in shares of land managed for preservationist and multiple uses, yet the region is relatively homogeneous in terms of land cover, forest species, population densities, climate, proximity to major urban areas, and manufacturing activities. Thus, we find large variation in the exogenous variables of interest but little variation in a number of factors that, otherwise, we would need to model explicitly.

Empirical Model

For estimation, we used a linear specification of [1],

$$
\begin{aligned}
NM_{i,90-99} &= \beta_0 + \beta_1 EG_{i,90-99} + \beta_2 PD_{i,90} + \beta_3 WG_{i,81-90} + \sum\nolimits_j \beta_j A_{ji,90} + \mu_{i,90-99} \\
EG_{i,90-99} &= \alpha_0 + \alpha_1 NM_{i,90-99} + \alpha_2 ED_{i,90} + \alpha_3 WG_{i,81-90} + \sum\nolimits_j \alpha_j B_{ji,90} + \varepsilon_{i,90-99} \qquad [2] \\
WG_{i,90-99} &= \gamma_0 + \gamma_1 NM_{i,90-99} + \gamma_2 EG_{i,90-99} + \gamma_3 WG_{i,81-90} + \sum\nolimits_j \gamma_j C_{ji,90} + \delta_{i,90-99}
\end{aligned}
$$

i=1,…,92, where **α**, **β** and **γ** are vectors of unobserved parameters and $\varepsilon_{i,90-99}$, $\mu_{i,90-99}$ and $\delta_{i,90-99}$ are assumed to be spherical disturbances with zero means. Variable definitions and data sources are reported in Table 1. *EG* is defined as the percentage change in total (full- and part-time) employment in county *i* between 1990 and 1999. *NM* is the percentage change in total county population net of natural changes due to births and deaths. *WG* is the percentage change in the average real (1990=100) wage in county *i* over the indicated period. For the period 1990 to 1999, *WG* ranged –0.15 to 0.33, with a mean value of 0.08. *PD* and *ED* equal total population and total employment in county *i*, respectively, divided by the total land area of the county.

In addition to the public land management variables discussed above, the additional lagged exogenous variables in the net migration equation (elements of **A**) measure the attractiveness of the county to potential migrants and current residents. The first group of variables, in addition to *PD* and *ED*, are included to capture access and amenities. Community stability is a potential amenity, which we measure as the percentage of people who own their own homes (*HO*). The availability of transportation infrastructure may enhance the attractiveness of the county by increasing accessibility and is measured by interstate highway mile density (*IH*). The income of a county, measured by median family income (*IN*), proxies for a number of factors including the range of consumer and cultural offerings and the extent of social problems stemming from poverty.[14] Finally, large water bodies are an amenity to many people and we include a dummy variable indicating whether or not the county has shoreline on either the Atlantic Ocean or one of the Great Lakes (*SH*).

A group of fiscal variables are used to measure government taxation and spending. We hypothesize that individuals prefer living in counties with the greatest difference between the provision of services by the government and the taxes paid to provide these goods. This is measured as the ratio of local government expenditures to local taxes (*ET*). People may have preferences for categories of government-provided goods and services (e.g., education). The percentage of government expenditures on education (*EE*), police protection (*PP*), and health and hospitals (*HH*) are used to account for the mix of local government spending. *A priori*, the effect of government expenditures on police protection is uncertain since large expenditures may indicate high or low rates of crime.

Counties with better economic opportunities are more likely to attract net migrants. Since economic opportunities are often greater in larger population areas, we account for potential spillover effects from urban areas with the dummy variable *UA* indicating adjacency to a metropolitan county. As well, *CT* is a dummy variable indicating the presence of a city within the county with a population greater than 25,000.

The employment and wage growth equations have the same set of additional lagged exogenous variables (elements of **B** and **C**). The first group of variables measures local business conditions. Work-force quality is measured by the percentage of county residents older than 25 years who graduated from high school (*HG*) and the share of local government expenditures on education (*EE*). The unemployment rate (*UE*) is measured as the percentage of the workforce unemployed in 1990 and is used to proxy for general conditions in the local labor market. Accessibility to markets is an important component of costs for some firms and is measured in our model by interstate highway mile density (*IH*). *IH* may also signify greater access to jobs for employees and directly affect wage growth.

In the Northern Forest region, forest products manufacturing is the dominant resource-based industry, the principal source of employment in some counties, as well as the highest-wage employer in some counties. To measure the dependence of the local economy on the forest products industry, we include the share of total county employment in forestry, paper and allied products, lumber and wood products, and furniture and fixtures (*FP*). Ski resorts are found throughout the Northern Forest region and may influence local business conditions, including the possibility of attracting low-paying tourism-related businesses. *ES* is a dummy variable indicating the presence of one or more destination ski resorts in the county.[15]

Local business conditions may also be influenced by spillover effects from urban areas and the presence of a relatively large city within the county that provides services for surrounding communities. We include *UA* and *CT* (defined above) in the employment and wage growth equations. Finally, to account for income injected into the local economy from external sources, we include a variable measuring the percentage of personal income from dividends (*DV*). *DV* could also affect attachment to the labor market and affect wage growth directly.

Fiscal conditions may have a direct effect on employment and wage growth. To capture the relative tax burden in the county, we include a variable measuring the ratio of local government expenditures to local taxes (*ET*). *ET* is also an important proxy for the size of the local public sector and includes payments to counties and towns from the state government, which are often an important component of local expenditures. Income tax policies, regulations, and other factors specific to individual states may also affect employment and wage growth. A set of state-level dummy variables is included in the net migration, employment, and wage growth equations to control for these fixed effects. The dummies may be interpreted as measuring differences relative to Minnesota, the omitted category.

Variable Measurement Issues

Observations of the area of preservationist and multiple-use lands by county and the year 1990 are available for federal lands managed by the U.S. Forest Service, the U.S. Fish and Wildlife Service, and the National Park Service. Corresponding data on state lands is available for Minnesota, New Hampshire, and Wisconsin. County-level data for 1990 are not available for Maine, Michigan, New York, and Vermont; however, there are county data for years ranging from 1996 to 1999. Statewide increases in public land area were only 2 percent in Maine between 1990 and 1999, 1.5 percent in Michigan, and less than 3 percent in New York. We use 1999 values as proxies for the 1990 values. The total area of state-owned public lands in Vermont increased approximately 24 percent over this time period. We form county-level estimates for 1990 by reducing the more recent county measures of state-owned public land by 24 percent. We note that excluding the Vermont counties from the sample has little effect on either the signs or statistical significance of the estimated coefficients.

In Model II, we include a variable measuring the percentage change in national forest timber sales in each county (*CS*). We measure changes in sales rather than changes in harvests because the former better captures the timing of the shift in national forest management practices. Purchasers of national forest timber are allowed to delay harvest up to five years past the time of sale. As with sales, national forest timber harvests declined in the early 1990s, but the data provide a less clear signal of the shift in management practices. Time-series data on national forest timber sales are available at the state, but not the county, level. We apportion state-level sales growth to each county based on the county's share of total national forest land in the state. *CS* is the percentage change in total sales between the 1981 to 1989 period and the 1990 to 1998 period. Apportioning state-level sales to counties does not introduce measurement error for counties in Maine, New Hampshire, and Vermont since these states have only one national forest. Michigan, Minnesota, and Wisconsin each have two national forests within the region. In these cases, measurement error would induce spatial dependence in the error terms since the direction of the bias is the same for all counties straddled by a national forest. The results of tests for spatial autocorrelation, discussed below, provide some evidence that this measurement error is not significant.

Data on interstate highway miles in 1999 were obtained from the U.S. Department of Transportation. There were no additions to the interstate highway system in our set of counties between 1990 and 1999; therefore, 1999 values are identical to 1990 values. Only 1992 values of the government tax and expenditure variables (*ET*, *EE*, *PP*, *HH*) were available.

We test alternative measures of population and employment data for stationarity (Table 2). We must rely on state data, instead of county data, because the tests that we employ are large sample tests, and a sufficiently long time series of observations is only available for state data. The state data on population and employment are obtained from the Bureau of Economic Analysis and Bureau of Labor Statistics, respectively. In both cases, we utilize annual observations from 1950-2000 for the states in our study.

For each state, we conduct an Augmented Dickey-Fuller (ADF) Unit Root test for population and employment measured in actual levels, log-levels, first differences in levels (i.e., delta levels), and first differences in log-levels (i.e., approximate growth rates for the range of relatively low growth rates observed in these data). Constant terms and deterministic trends are specified as appropriate (see notes to Table 2). The test is considered complete when a Breusch-Godfrey Lagrange Multiplier test for autocorrelation in the residuals of the ADF equation fails to reject the null hypothesis of no autocorrelation up to the fourth order. Sufficient lags are specified in the ADF test to achieve this measure of white noise residuals. If the test rejects the null of a unit root[16], therefore implying that the series is stationary, the numerical value of the ADF test statistic is bolded in Table 2.

The results are consistent with our expectations. The population series are found to be stationary in only 2 of 7 cases for levels and none of the cases for log-levels. Similar results are obtained for employment levels. Matters improve substantially when first differences are tested, and growth rates (i.e., log-differences) are stationary for all states used in our study.

These results provide justification for the growth rate formulation of the endogenous variables in our study, and suggest that previous studies using levels or log-levels (e.g., Carlino and Mills, 1987; Duffy-Deno, 1998) may not provide as reliable estimates. This conclusion holds in spite of the fact that our study, and earlier ones, rely primarily on cross-sectional data. The reason is that all of the studies have a time-series component to them because they employ lagged data values. Any nonstationarity in the time series component results in unreliable estimates of timing parameters such as the speeds of adjustment to equilibrium levels estimated by Carlino and Mills (1987) and Duffy-Deno (1998).[17] These problems spillover to other parameter estimates because the estimation method obtains the values of all parameters in an interrelated manner (i.e., by solving the system of normal equations). It should be noted that our specification of beginning-of-period population and employment densities relates to their expected roles as proxies for household and producer amenities related to density. They are not part of the dynamic component of our model as the levels of employment and population are in previous studies.

IV. ESTIMATION RESULTS

The equation system in [2] is estimated using three-stage least squares (3SLS). 3SLS is a consistent estimator for systems of simultaneous equations and is more precise than two-stage least squares because it accounts for cross-equation correlation of the error terms. Heteroskedasticity is often present in studies with cross-sectional data and we use White's (1980) test to evaluate the null hypothesis of homoskedasticity (in each equation) against the alternative that the errors have a general heteroskedastic structure. We fail to reject the null at the 5 percent level for each of the model equations. Our use of some observations for years after 1990 raises the possibility that these variables are endogenous. We use Hausman's (1978) specification test to test for the endogeneity of each regressor, using the remaining set of variables as instruments. We fail to reject the null hypothesis that the least squares and instrumental variables estimates are the same, indicating that the regressors are exogenous.

Given our use of cross-sectional spatially-referenced data, we also test for spatial autocorrelation of the residuals. Since we model only within-county effects of conservation lands, a potential source of spatial autocorrelation is cross-county effects of conservation lands on net migration, employment, and wage growth. For the three sets of residuals, we compute Moran's *I* statistic using a "rook" measure of proximity that indicates if counties share a common border (Bailey and Gattrell, 1995). Moran's *I* ranges in value from +1 (strong positive autocorrelation) to –1 (strong negative autocorrelation) in most applications, and is approximately equal to zero if the pattern is random. The computed values are small (less than 0.05 in absolute value) for each equation and one to five spatial lags. By assuming that *I* has an approximately normal sampling distribution, we can formally test the null hypothesis of no spatial autocorrelation, and we fail to reject the null at the five percent level for each equation and spatial lag.

The full set of estimation results for Model 1 are reported in Table 3. The estimated equations explain approximately 47, 37, and 25 percent of the variation in net migration, employment and wage growth rates, respectively. The coefficients on the endogenous variables (*EG* and *NM*) are significantly different from zero at the 5 percent level and indicate the interdependence of employment and net migration growth. The coefficient estimates reveal that, all else equal, a one percentage point increase in net migration rates yields approximately a 1.5 percentage point increase in employment growth, and a seven percentage point increase in employment growth yields roughly a one percentage point increase in the net migration rate. These findings are qualitatively consistent with those in previous regional economics studies (e.g., Greenwood *et al*., 1986; Carlino and Mills 1987) and support the notion that migration is more stimulative of job creation than job creation is of migration. The coefficient on employment growth is also positive and significantly different from zero in the wage growth equation. A five percentage point increase in employment growth yields roughly a one percentage point increase in the wage growth rate.

In the employment growth equation, seven of the coefficient estimates (*FP*, *EE*, *ET*, *UA*, and three state dummies) are significantly different from zero at the 10 percent level or higher. Employment growth was lower, all else equal, in counties with a higher percentage of forest products employment (*FP*). In some counties as much as 70 percent of total employment is in forest products and, at least over the period 1990 to 1999, fewer jobs were created in counties highly dependent on this industry. Lewis *et al*. (2002) test whether this negative relationship between job trends and relative size of the forest products industry is due to conservation land effects operating indirectly through this industry and find evidence that this is not the case.

Educational spending is found to have a significant effect on employment growth. Counties with a higher share of total expenditures allocated to education (*EE*) experienced higher job growth, all else equal. As well, counties with higher public sector expenditures relative to taxes (*ET*) had higher employment growth, perhaps reflecting the local effects of state government payments. Employment growth is also significantly higher in counties adjacent to urban counties (*UA*), implying some spillover effects from urban to rural areas. Finally, three of the coefficients on the state dummies are negative and significantly different from zero, indicating systematically higher employment growth in Northern Forest counties in Minnesota compared to those in Maine, Wisconsin, and Vermont.

The remaining variables in the employment equation did not have a significant effect on the rate of employment growth during the period analyzed. Of particular interest, the shares of the county land base under preservationist (*PR*) and multiple use (*MU*) management did not have significant effects on employment growth. It should be noted that the estimates of the coefficients on the exogenous variables reported in Table 3 measure the direct effects of these variables on employment growth, net migration, and wage growth. The exogenous variables may also have indirect effects through the endogenous employment growth and net migration variables, and below we derive the "solved structure" effects of public conservation lands on employment growth, net migration, and wage growth.

In the net migration equation, six of the coefficients on the exogenous variables (*PD*, *MU*, *HO*, *ET*, *WG* and *HH*) are significantly different from zero at the 10 percent level. In particular, the sign on the multiple-use variable (*MU*) is positive, indicating that counties with more multiple-use lands in 1990 experienced higher net migration over the following nine-year period. The magnitude of the coefficient suggests that, all else equal, counties whose multiple-use share is eight percentage points higher experienced a one percentage point higher net migration rate during this nine year period. The coefficient on preservationist lands (*PR*) is also positive, but not significantly different from zero.

The negative sign on the expenditure-to-tax ratio variable (*ET*) is contrary to expectations, and points out the difficulties of constructing tax measures. A shortcoming of this variable is that it cannot capture the relative tax burdens on local businesses and residents (or the relative expenditures)[18]. In some counties with high levels of taxes, residents may face low tax rates if a large proportion of taxes are collected from businesses. Such a county may be attractive to potential migrants, even though expenditures relative to total taxes may be relatively low. Also, a county might have high taxes if it anticipates high population and employment growth in the future together with greater demand for public services.

The other significant variables have expected signs and suggest that migrants are attracted to counties with higher percentages of people who own their own homes (*HO*) and higher government expenditures on health and hospitals (*HH*). Net migration rates are also higher in counties with larger population densities (*PD*). The remaining coefficient estimates are not significantly different from zero at the 10 percent level, indicating that the corresponding variables are not important in explaining cross-county variation in rates of net migration.

In the wage growth equation, seven of the coefficients on exogenous variables (*WG*, *UA* and the dummy variables for Maine, New Hampshire, Vermont, New York, and Wisconsin) are significantly different from zero at the 10 percent level. The coefficient on lagged wage growth (*WG*) is negative, indicating that counties with higher wage growth during the 1980s tended to experience lower wage growth during the 1990s. *UA* is negative, implying that rural counties sharing a border with a metropolitan county had lower wage growth over this period, all else equal. Positive signs on the five state dummy variables indicate higher wage growth in the Northern Forest portions of these states compared to Minnesota. The coefficients on the land management variables (*PR* and *MU*) are negative but not significantly different from zero (the asymptotic *t*-ratios are -0.50 and -0.29, respectively).

Because net migration and employment growth are positively related, increases in public conservation lands (*PR* and *MU*) indirectly affect employment growth through their effect on net migration. Likewise, the net migration rate is indirectly affected by conservation lands through changes in employment growth. The "solved structure" effects of *PR*, for example, may be derived from the equation system in [2] as $dEG/dPR = (\hat{\alpha}_1\hat{\beta}_{PR} + \hat{\alpha}_{PR})/(1-\hat{\alpha}_1\hat{\beta}_1)$ and $dNM/dPR = (\hat{\alpha}_{PR}\hat{\beta}_1 + \hat{\beta}_{PR})/(1-\hat{\alpha}_1\hat{\beta}_1)$ where $\hat{\beta}_{PR}$ and $\hat{\alpha}_{PR}$ are the estimated coefficients on the *PR* variable. These expressions measure the effects of preservationist lands after all adjustments in the endogenous variables are complete. The solved structure effect of preservationist lands on wage growth incorporates these solved structure effects on employment growth and net migration and is given by $dWG / dPR = \hat{\gamma}_1 dNM / dPR + \hat{\gamma}_2 dEG / dPR + \hat{\gamma}_{PR}$.

The solved structure effect of multiple-use land (*MU*) on net migration is positive and significantly different from zero at the 5 percent level (Table 4, Model I).[19] As with the direct effect, this result indicates that an eight percentage point increase in the county share of multiple-use land yields a one percentage point increase in the net migration rate, all else equal. The solved structure effects of multiple-use lands on employment and wage growth are not significantly different from zero, nor are any of the effects of preservationist lands (*PR*).

The results for Model II are almost identical to those in Table 3 and so we report only the direct and solved structure effects of *PR*, *NF*, *SF*, and *CS* on net migration, employment and wage growth in Table 4.[20] As noted above, many conservation lands in the region were designated long before 1990, implying that the Model 1 results do not yield insights into the wage effects of *new* conservation lands or changes in management practices on existing public lands, issues of significant policy interest.[21] However, the changes in national forest management in the early 1990s provide a natural experiment that allows us to examine this issue. We exploit the variation in national forest sales reductions—declines were larger on northeastern national forests than Lake States forests—to identify the effects of the adoption of preservationist management. The results reported in Table 4 reveal that changes in timber sales (*CS*) had no significant effect on net migration, employment or wage growth. On the other hand, the solved structure effects of national and state forest shares on the net migration rate are positive and significantly different from zero at the 5 percent level. None of the land management variables in Model II were found to have a significant effect on wage growth.

V. DISCUSSION AND CONCLUSIONS

The first set of results (Model I) reveals that wage growth rates in Northern Forest counties between 1990 and 1999 did not vary systematically with the county shares of land under preservationist and multiple-use management in 1990. The direct and solved structure effects of *PR* and *MU* on wage growth are not significantly different from zero at any reasonable confidence level (Table 4). The absence of a direct effect of preservationist lands on the growth in the average wage suggests that preservationist lands did not cause a shift from high- to low-wage jobs, contradicting the claim often made by opponents of preservationist management. In addition, the insignificance of the solved structure effect indicates a lack of influence on wages coming through changes in net migration and employment growth. Viewed together, the insignificant effects of *PR* and *MU* suggest that wages are unaffected by either the presence of public conservation lands[22] or by the management practices applied on these lands.

In contrast, multiple-use lands (*MU*) are found to have a positive effect on the net migration rate, while the effect of the preservationist share (*PR*) is found to be insignificant. Lewis *et al*. (2002) explain that multiple-use lands in the Northern Forest region typically offer a broader range of day-use activities attractive to potential migrants than do preservationist lands which tend to offer multiple-day wilderness experiences that people are unlikely to participate in regularly. Neither multiple-use (*MU*) or preservationist (*PR*) lands are found to significantly affect employment growth.

Model II employs a "natural experiment" to further clarify these results. We find that declines in national forest timber sales in the early 1990s do not have a significant effect on net migration, employment or wage growth. Since the adoption of preservationist management involves a similar decline in timber production, we interpret this result as evidence that the establishment of *new* preservationist lands and the adoption of preservationist management on existing public lands do not impact wages over the range of timber reductions that are observed in our sample.[23] This is an important extension to Lewis *et al*. (2002) in that we can now conclude that if reductions in national forest timber harvests are causing a shift in the composition of employment (e.g. manufacturing to tourism), this is not being translated into wage growth.

In summary, the results of this paper provide no evidence that existing public conservation lands are systematically associated with low wage growth in the Northern Forest region. Our model also allows us to test whether timber harvest declines negatively impact regional wage growth rates. Results suggest no effects on wage growth (within the range of our data) from the adoption of preservationist management on national forest lands. In addition, this study adds to a growing literature on the role of area-specific amenities in regional development (Knapp and Graves, 1989; Treyz *et al*. 1993; McGranahan, 1999; Deller *et al*., 2001; Lewis *et al*., 2002). Our model structure highlights the importance of analyzing the economic effects of conservation lands in a model which incorporates not only direct impacts on employment and wages, but also indirect impacts through the amenity effect on migration. This modeling approach allows for a more complete view of the simultaneous relationships between population, employment and wages than will be provided by simple input-output or economic base models.

While stakeholders in the Northern Forest region continue the debate over whether to increase the area of public conservation lands and the extent of preservationist management on existing public lands, the results of our analysis suggest that the current emphasis on labor market effects is misplaced. There are many factors to consider in evaluating the costs and benefits of changes in public lands policy. For instance, the recreational and ecological benefits of preservationist lands would be a key input to the policy process. In addition, an important consideration is the way in which preservationist lands might transform the character of rural communities. However, the results of this study provide no evidence that negative impacts on employment and wages should be the primary factor driving the decision process. By the same token, we find no evidence in support of the conclusion that public land management can be effectively used as a tool for promoting job or wage growth in rural communities, though it may have relatively small effects on rates of population growth.

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Table 1. Variable Definitions and Data Sources

Variable	Description (Year)	Data Source
EG	% Change in Employment ('90 - '99)	County Business Patterns
NM	Net Migration Rate ('90 - '99)	USA Counties
ED	Employment Per Sq. Mi. ('90)	City & County Data Book,
PD	Population Per Sq. Mi. ('90)	City & County Data Book,
$WG_{81\text{-}90}$	Real Wage Growth ('81-'90)	Bureau of Economic Analysis
$WG_{90\text{-}99}$	Real Wage Growth ('90-'99)	Bureau of Economic Analysis
PR	Percentage of Total County Land in Preservationist Uses ('90)	State/Federal Land Management Agencies
MU	Percentage of Total County Land under Multiple-Use Management ('90)	State/Federal Land Management Agencies
SF	Percentage of Total County Land in State Forest ('90)	State Land Management Agencies
NF	Percentage of Total County Land in National Forest ('90)	U.S. Forest Service
CS	Percentage Change in National Forest Timber Sales (81-89 to 90-98)	U.S. Forest Service
HG	Percentage of People > 25 who graduated from High School ('90)	City & County Data Book
UE	Unemployment Rate ('90)	City & County Data Book
IH	Interstate Highway Miles Per Sq. Mi. ('99)	U.S. Dept. of Transportation
FP	Percentage of County Employment in Forest Products ('90)	County Business Patterns
SK	Dummy (1= Destination Ski Area in Northeast, 0 = no)	Ski Magazine
UA	Dummy (1= Adjacent to Urban, 0 = no)	City & County Data Book
CT	Dummy (1= City > 25K, 0 = none)	City & County Data Book
DV	Percentage of Personal Income from Dividends ('90)	Regional Economic Information System
ET	Ratio of Local Gov't Expenditures to Local Taxes ('92)	USA Counties
EE	Percentage of Gov't Expenditures on Education ('92)	USA Counties
PP	Percentage of Gov't Expenditures on Police Protection ('92)	USA Counties
HH	Percentage of Gov't Expenditures on Health and Hospitals ('92)	USA Counties
HO	Percentage of people who own their own homes ('90)	City & County Data Book
IN	Median Household Income ('90) (in Thousands of Dollars)	City & County Data Book
SH	Dummy (1=Adjacent Shoreline, 0 = no)	

Table 3. Estimation Results for the Employment, Net Migration and Wage Growth Model (Model I)

	Migration		*Employment*		*Wages*	
Variable	*Coefficient*	*t-stat*	*Coefficient*	*t-stat*	*Coefficient*	*t-stat*
Intercept	-0.140	-0.87	0.274	0.45	-0.069	-0.38
Net Migration (NM)			1.507**	2.11	0.106	0.53
Emp. Growth (EG)	0.135**	1.95			0.207***	3.04
Multiple-Use Land (MU)	0.124**	2.55	-0.090	-0.46	-0.013	-0.29
Preservationist Land (PR)	0.118	1.35	-0.271	-0.82	-0.039	-0.50
Lag Wage Growth (WG)	0.101	1.35	-0.362	-1.21	-0.126*	-1.68
Population Density (PD)	0.001***	2.93				
Emp. Density (ED)			-0.004	-1.30		
High Sch. Grad Rate (HG)			-0.010	-1.50	0.001	0.37
Unemployment Rate (UE)			-0.007	-0.64	0.002	0.68
Highway Density (IH)	-0.178	-0.56	1.214	0.91	-0.212	-0.74
Forest Prod. Emp. (FP)			-0.474**	-2.21	-0.057	-0.84
Destination Ski Area (SK)			0.070	1.02	-0.005	-0.26
Adj. to Metro County (UA)	-0.025	-1.57	0.120**	2.26	-0.026*	-1.79
City > 25,000 Pop. (CT)	0.022	0.75	-0.008	-0.07	0.012	0.42
Dividend Income (DV)			0.817	1.18	-0.005	-0.03
Expend. to Tax Ratio (ET)	-0.033***	-4.82	0.057*	1.80	0.003	0.33
Expend. on Education (EE)	-0.135	-0.93	1.357***	4.25	-0.128	-1.10
Expend. on Police (PP)	-0.166	-1.00				
Expend. on Health (HH)	0.215**	2.01				
Home Ownership (HO)	0.005***	3.34				
Median Income (IN)	-5.77E-06	-1.62				
Shoreline (SH)	0.012	0.81				
Maine	-0.049	-0.92	-0.259*	-1.77	0.078*	1.98
New Hampshire	-0.037	-0.71	-0.225	-1.22	0.108**	2.26
Vermont	0.004	0.06	-0.450***	-2.76	0.128**	2.57
New York	-0.067	-1.00	-0.244	-1.33	0.100**	2.00
Michigan	-0.065	-1.43	-0.194	-1.65	0.044	1.35
Wisconsin	0.039	1.08	-0.292***	-3.36	0.104***	3.53
Adj R^2	0.472		0.372		0.254	
F Value	4.87		3.56		2.47	
Prob>F	0.0001		.0001		.0025	
White	91.43		90.3		91.69	
White Prob>Chi	0.556		0.589		0.5843	
#Obs	92		92		92	

*Significance at the 10% level; **Significance at the 5% level; ***Significance at the 1% level

Table 4. Effects of Public Land Management on Net Migration, Employment and Wage Growth

Variable	----Migration ----		---Employment---		-------Wages--------	
	Direct	Solved	Direct	Solved	Direct	Solved
Model I						
Preservationist	0.12	0.10	-0.28	-0.12	-0.04	-0.05
Lands (*PR*)	(1.35)	(1.09)	(-0.82)	(-0.33)	(-0.50)	(-0.56)
Multiple-Use	0.12**	0.14***	-0.09	0.12	-0.01	0.03
Lands (*MU*)	(2.55)	(2.85)	(-0.46)	(0.61)	(-0.29)	(0.51)
Model II						
Preservationist	0.14	0.12	-0.37	-0.20	-0.05	-0.07
Lands (*PR*)	(1.62)	(1.21)	(-1.10)	(-0.57)	(-0.57)	(-0.77)
State Forest	0.17**	0.16**	-0.27	-0.05	-0.03	-0.01
Lands (*SF*)	(2.47)	(2.19)	(-1.01)	(-0.15)	(-0.38)	(-0.19)
National Forest	0.09	0.12**	0.09	0.27	-0.002	0.07
Lands (*NF*)	(1.44)	(2.06)	(0.40)	(1.11)	(-0.03)	(1.06)
Change in National	-0.06	-0.03	0.24	0.19	0.02	0.05
Forest Sales (*CS*)	(-0.71)	(-0.40)	(0.71)	(0.54)	(0.23)	(0.58)

t-statistics are in parentheses
* Significance at the 10% level
** Significance at the 5% level
*** Significance at the 1% level

Figure 1. The Northern Forest Region

[1] We use the term "public conservation lands" to refer to the broader class of publicly-owned lands managed for both preservationist and multiple uses. These categories are discussed in more detail in the next section.

[2] Other studies of the impacts of conservation lands on migration decisions include Clark and Hunter (1992) and Rudzitis and Johansen (1992). Deller *et al*. (2001) study population, employment, and income in a reduced-form model, and include an amenity index as an exogenous variable. The index measures characteristics of preservationist lands (e.g., acres of National Park Service lands), but also includes many features of private lands (e.g., acres of cropland, pasture, and range land). The amenity index is found to have a positive and significant effect on population and employment growth.

[3] Duffy-Deno (1998) also examines the impact of wilderness areas on employment in the resource-based sector alone, and finds no significant effects.

[4] See, for example, the article "Park Opponents Denounce Restore Study" (Bangor Daily News, December 14, 2001) in which a critic of a proposal for a national park and preserve in northern Maine claims that, "the positions created would be primarily low-paying service jobs and would not make up for the loss of high-paying, forestry-related occupations."

[5] We selected the counties in our region based on survey unit definitions used by the U.S. Forest Service. Survey units are county groupings that the Forest Service defines for use in conducting forest inventories. Survey units are relatively homogeneous in terms of land-use patterns and characteristics of the forest resource. We include counties in the Northern Pine and Aspen-Birch units (MN), the Northwest and Northeast units (WI), the Western and Eastern Upper Peninsula units (MI), and the Western, St. Lawrence, and Eastern Adirondack units (NY). We include counties in all of the Vermont, New Hampshire, and Maine survey units, with the exception of metropolitan counties (see below).

[6] Even in northeastern Minnesota where one might expect mining to be a relatively important source of manufacturing employment, forest products is still the dominant manufacturing industry. The exception is Lake county, Minnesota, where mining accounts for a greater share of manufacturing employment. We included a dummy variable for Lake county in the empirical model discussed below but found the corresponding coefficient to be insignificant.

[7] In this study, we consider only federal- and state-owned conservation lands. In most states, municipal governments are not significant owners of conservation lands. In Minnesota and Wisconsin, municipal governments are responsible for managing tax-forfeited lands, however, there is no indication that these lands provide conservation-related benefits and we exclude them from our analysis. We also exclude conservation lands managed by private land trusts. While there has been considerable growth in land trusts during the 1990s, according to the Land Trust Alliance they still manage less than 1 percent of all conservation lands in the region.

[8] For more details on the history of public land management in the region, see Lewis *et al*. (2002) and Lewis and Plantinga (2001).

[9] In the case of state forests, we find no evidence of a similar shift towards preservation management. State forest harvests remained at historic levels throughout the 1990's.

[10] While local conditions (e.g., characteristics of the timber resource) are certainly an important determinant of the *levels* of national forest timber harvests, we are concerned with *changes* in timber sales between the 1980s and 1990s. For the reasons noted, changes in timber sales are largely exogenous to local conditions.

[11] Three-stage leasts squares estimates of a model with contemporaneous wage growth produced significant positive effects of wage growth on employment growth. All other endogenous variable coefficients were satisfactorily signed. Given the problem in the employment growth rate equation, we decided to rely on the recursive specification with respect to wage rate growth. The qualitative and quantitative estimated effects of the land management variables are consistent across the endogenous and the recursive specifications. Therefore, the recursive specification both makes sense for our descriptive model and does not alter our conclusions regarding the effects of public land management on migration rates, employment growth, or wage growth rates.

[12] As mentioned above, preservationist management was adopted on some public conservation lands well before 1990. In these cases, the model in [1] does not capture initial changes in employment, net migration, and wage growth rates associated with the designation of these lands. For example, suppose that many decades ago a large tract of conservation land was established in a county, and that the associated diversion of commercial forest to preservationist uses reduced wood products employment. By 1990, employment adjustments would be complete, and the initial impact on jobs would not be reflected in recent growth rate data. However, the effects of the preservationist land should still be present in the *levels* of employment and population. The county discussed above would have a lower level of employment, all else equal, than a county with no preservationist land. Accordingly, we include measures of lagged employment and population density ($PD_{i,90}$ and $ED_{i,90}$) in [1] to "absorb" these earlier effects of land preservation, and ensure that our model isolates the impacts of public land management on growth in employment and population during the 1990s.

[13] It is especially important to be sensitive to such omitted variable bias in a study that involves local economic conditions and amenities (Hunt, 1993).

[14] There is evidence that willingness-to-pay for cultural goods rises with income (see, for example, Thompson *et al*., 2002). If there is an efficient market for cultural amenities, then cultural offerings in a given area will be positively correlated with median family income in the area.

[15] *ES* applies to destination resorts in the northeastern states. Destination resorts are those ski areas ranked in the top 60 by Ski magazine. A referee suggested that net migration rates may also be influenced by the presence of a ski resort. However, the coefficient on *ES* was found to be insignificant when included in the net migration equation and there were no detectible changes in the other coefficient estimates.

[16] Note that the MacKinnon critical values for the rejection of the null of a unit root vary, *inter alia*, with the number of lags specified in the test. Thus, two numerical test values that are similar may lead to rejection of the null in one case and not in the other.

[17] One well-known result of estimating dynamics with nonstationary data is that the adjustment periods are overstated. Duffy-Deno (p. 114, fn. 5) points out the rather long

adjustment lags obtained by Carlino and Mills; and his own results imply very long adjustment lags as well. The results reported by Carlino and Mills imply that after 50 years 50 percent (42 percent) of the adjustment to equilibrium employment (population) still remains to be made. After 100 years, 25 percent (15 percent) of the adjustment to equilibrium employment (population) remains. Duffy-Deno's results imply that after 50 years 66 percent of the adjustments to both population and employment remain; and after 100 years, 43 percent of the adjustments remain. These estimates are based on actual levels in both studies. When Duffy-Deno changes to log-levels, the adjustment period falls substantially for employment to 18 percent remaining after 50 years and 3 percent remaining after 100 years. However, the adjustment for population lengthens to 95 percent of the adjustment to equilibrium remaining to be made after 50 years and 90 percent remaining after 100 years. Clearly, these are very long estimated adjustment periods, and may reflect the use of nonstationary time-series components in the two data samples.

[18] The tax burden on households varies somewhat across the states in our study. For example, estimates by the Tax Foundation reveal that in 1990 Wisconsin households had the highest state and local tax burden, at 11.4% of income, wheras New Hampshire households had the lowest at 8.2%.

[19] Standard errors for the solved structure effects are estimated using the delta method (see Greene, 1993).

[20] All results not reported in the paper are available from the authors upon request.

[21] Some effects from the initial period when conservation lands were designated could be observed as late as the 1990s if such effects require a separate mediating factor to express themselves. For example, if designation raises the supply of natural inputs useful for producing tourism services, but the demand for tourism is expressed later when incomes grow sufficiently to increase tourism demand substantially, then a long lag between designation and the observed effect can occur. Similarly, advances in computer technology that increase opportunities for telecommuting might increase migration to counties with more public conservation lands, or amenity-oriented, footloose firms may follow labor to such areas.

[22] The same result is obtained if *PR* and *MU* are combined into a single variable.

[23] Stronger conclusions could be drawn from a similar analysis using time-series data covering periods during which preservationist lands were actually designated. Unfortunately, long-term historical data on the area of public conservation lands, and many other variables needed for the analysis, are unavailable.