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Public Conservation Land and Economic Growth in the Northern Forest Region

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PUBLIC CONSERVATION LAND AND ECONOMIC GROWTH

IN THE NORTHERN FOREST REGION

By David James Lewis

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An Abstract of the Thesis Presented
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Environmental issues frequently revolve around a perceived tradeoff between the economy and the environment. In the Northern Forest region, one of the most important environmental policy issues of recent years has been the ownership of vast stretches of undeveloped forestland. Specifically, the possibility of increasing public conservation ownership on these lands has emerged. Opponents of conservation lands often argue that employment will decline significantly when land is diverted from commodity-oriented uses such as forest products production. Proponents of conservation lands frequently cite the amenity benefits of conservation lands and the potential to diversify and stimulate the economy by designating more land into conservation uses. Empirical evidence is rarely offered from either side.

To evaluate this issue, I estimate a model of simultaneous migration and employment growth using data on the 92 non-metropolitan counties comprising the Northern Forest region. Growth in migration and employment are measured over the period 1990 to 1997 and the set of exogenous variables includes the 1990 share of county land in public conservation uses. I find that net migration rates were systematically higher in counties with more conservation lands, but the effects are

relatively small. Public conservation lands were found to have no systematic effects on employment growth over the 1990 to 1997 period.

Two extensions are also considered. I examine the separate effects of preservationist and multiple-use lands. I also identify a “natural experiment” involving changing national forest management that allows me to estimate the effects of diverting private forestland to public conservation uses. My central conclusion is that existing National Forest lands have a positive, but small, effect on employment and migration in the Northern Forest region, while State Forest lands have a positive, but small, effect on migration. I also conclude that, over the range of my data, employment and migration are unlikely to be affected by timber harvest reductions resulting from the establishment of new conservation lands.

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INTRODUCTION

Stretching from eastern-most Maine to northern Minnesota, the Northern Forest is one of the largest contiguously forested expanses in the United States. This forest occupies a broad transition zone between temperate and boreal forests and supports an unusually diverse natural ecosystem. It also supports a healthy rural economy, and its lands are in demand for recreational uses by both local residents as well as the many millions of people who live in nearby urban areas. Land ownership in this region is far different from in forested areas in the western United States. In comparison to the Rocky Mountain region, which has approximately 47 % of the land owned by the federal government, the Northern Forest has only about 22 % of the land in public ownership. As a result, many important public values are derived from privately owned land in the Northern Forest region.

As predicted by Krutilla (1967), the demand for recreation and other non-commodity uses of forestland has continued to grow over time. Combined with population increases, particularly in the urban centers of the Northeast and the upper Midwest, there is heightened interest in the possibility of increasing the amount of conservation land in the Northern Forest region. This has ignited a fierce debate about traditional private property ownership and the appropriateness of placing more land in publicly owned conservation uses. Proponents of conservation land cite the benefits of increased public access to recreation and the public values associated with wilderness preservation. Opponents often argue that local economies will be hurt when land is diverted from traditional commodity-oriented uses, particularly wood-products production.

To date, there has been no comprehensive analysis of the local economic impacts of conservation lands in the Northern Forest. This paper studies employment and population growth in a group of 92 non-metropolitan counties in Maine, New Hampshire, Vermont, the Adirondack region of New York, the Upper Peninsula of Michigan, and northern Wisconsin and Minnesota. My particular interest is in determining the effect that publicly owned conservation land has had on county-level population and employment growth. I estimate the effects using a model of simultaneous migration and employment growth (Greenwood and Hunt 1984; Greenwood et al. 1986). The model treats conservation land as an amenity determining human migration and thus indirectly influencing employment. I also model the role of conservation land as a direct inhibitor or enhancer of county employment growth.

The management of public lands may also determine the economic effects of these lands on local economies. In this study, I distinguish between publicly owned preservationist lands and multiple-use lands.[1] Preservationist lands are not managed for timber production, and may include lands managed as national parks, state parks, wilderness areas, and wildlife refuges. Preservationist lands may have a more adverse effect on natural resource-based employment because they are closed to commercial extraction. On the other hand, these lands could have a more favorable effect on employment in other sectors of the economy (e.g., tourism) as their amenity values may be higher. Multiple-use lands are managed for many different commercial and non-commercial uses and include lands managed as national and state forests. These lands

[1] My goal is to distinguish between public lands that are not managed for commodity production and those that are managed for commodity production and other uses, such as recreation.

should have different effects on resource-based employment than preservationist lands because they are not closed to resource extraction.

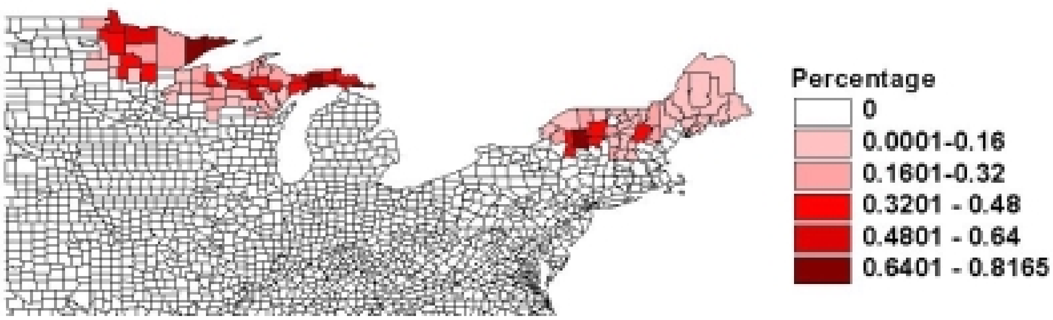
I also identify and explore a solution to a "timing" problem that has not been acknowledged in earlier studies (e.g., Duffy-Deno 1998). In most cases, public conservation lands were established long before the period for which I have data. Accordingly, I may not expect the effects of these conservation lands to be fully reflected in recent employment growth rates, unless some sort of structural change had taken place in the economy whereby conservation lands took on an added attractiveness. This "timing" problem has implications for the interpretations of my results. In particular, a finding that public conservation lands have no effect on recent job growth rates does not support the conclusion that the establishment of *new* conservation lands does not impact employment. In order to measure these effects, I model recent changes in management practices on national forests. Declines in national forest timber sales during the early 1990s provides a "natural experiment" that identifies the migration and employment effects of diverting commercial forest land to conservation uses.

Knapp and Graves (1989) argue that a region's economic future is increasingly determined by its amenities. This study analyzes the amenity effects of all state and federal conservation land, as opposed to only specific management categories (Clark and Hunter 1992; Rudzitsis and Johansen 1992; Duffy-Deno 1998). Increasing amounts of conservation funding in the Northern Forest has been available in the last few years. State programs, such as the Land for Maine's Future Fund, and federal programs, such as the Forest Legacy Fund and the Land and Water Conservation Fund, are likely to ensure a steady stream of funding for conservation initiatives in the future. This study will provide critical information to policy makers and will help to resolve the question of whether conservation land helps or hurts local economies.

CONSERVATION LAND IN THE NORTHERN FOREST REGION

The Northern Forest region (Figure 1) is home to some of this country's most important publicly owned conservation lands, including Baxter State Park in Maine, the White Mountain National Forest in New Hampshire, the Adirondack State Park in New York, the Apostle Islands in Wisconsin, and the Boundary Waters Canoe Area Wilderness in

Figure 1. Conservation Lands (% of county) in the Northern Forest region



Minnesota. The Northern Forest has a broad variety of public lands, including lands managed by the federal, state, and municipal governments. As well, private land trusts have become increasingly important owners of conservation lands in recent years. In this study, I consider only state and federally owned conservation land. In most states in the region, municipal governments are not a significant owner of conservation lands.[2] According to the Land Trust Alliance, land owned by land trusts represents less than 1% of the total area of public land in the Northern Forest region.

The federal government is a primary public landowner in the region. Federal lands include national forests (managed by the U.S. Forest Service), national parks

(National Park Service) and national wildlife refuges (U.S. Fish & Wildlife Service). In most states, the department of natural resources (or equivalent) is the primary manager of state-owned conservation lands, although fish and wildlife agencies are also important owners in most states. As indicated in Table 1 and Figure 1, the amount of public conservation land varies significantly by state. The upper Peninsula of Michigan has the highest percentage of total land in conservation uses (37%), while Maine has the lowest (5.4%). The breakdown of federal and state ownership also varies significantly across the region, with the Adirondack region of New York having the most state ownership (100%), and New Hampshire having the most federal ownership (87%).

The management of public conservation lands also differs significantly across the region (Table 2). The upper Peninsula of Michigan has the highest percentage in multiple-use (92%), while the Adirondack region of New York has the highest percentage of preservationist lands (92%). Overall, there is more land under multiple-use management than preservationist management. Conservation land management also varies considerably among counties in the region. Some counties have practically no public conservation land, whereas in some counties more than 50% of the land is in multiple-use or preservationist uses.

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[2] In Wisconsin and Minnesota, municipal governments are responsible for managing tax-forfeited lands, however, I have no information on whether these lands provide conservation benefits. Including these lands in my analysis had no effect on the results.

Table 1. Public Conservation Lands in the Northern Forest region, 1990

State	Total (acres)	Conservation Land (acres)	Percent Conservation	Percent Federal	Percent State
ME	18,290,560	986,932	5.40%	15.00%	85.00%
MI	10,163,200	3,755,273	36.95%	45.83%	54.17%
MN	19,304,320	6,420,810	33.26%	40.18%	59.82%
NH	3,900,800	813,788	20.86%	86.52%	13.48%
NY	8,771,200	2,610,742	29.76%	0.00%	100.00%
VT	5,575,040	575,492	10.32%	60.18%	39.82%
WI	13,630,720	2,185,361	16.03%	72.58%	27.42%

Table 2. Management of Public Conservation Lands in the Northern Forest Region, 1990

	Total Conservation (state)		Multiple-Use (county)		Preservationist (county)	
State	Multiple-Use	Preservationist	Minimum	Maximum	Minimum	Maximum
ME	2.99%	2.41%	0.11%	6.48%	0.32%	9.26%
MI	33.95%	3.00%	2.16%	54.74%	0.00%	13.44%
MN	26.17%	7.09%	3.74%	54.98%	0.26%	28.52%
NH	17.02%	3.84%	0.60%	30.40%	0.03%	3.31%
NY	2.26%	27.51%	0.00%	9.99%	2.71%	71.49%
VT	7.00%	3.32%	0.00%	28.78%	0.76%	6.29%
WI	13.54%	2.50%	0.00%	50.25%	0.03%	11.65%

A variety of historical factors led to the designation of conservation lands in the Northern Forest region. During the late 19th and early 20th century, the region suffered through an era of extreme forest degradation due to over-harvesting and large-scale fires (Barlowe 1983; Cubbage et al. 1993; Irland 1999). This period was also an active time for the establishment of major new tracts of public land in the region. The 2.5 million acres of public land in the Adirondack Park, most of which is in preservationist uses, was created in the late 1800s.[3] Schneider (1997) argues that the impetus for the park was water conservation—the Adirondack Mountains are the source of much of the water for

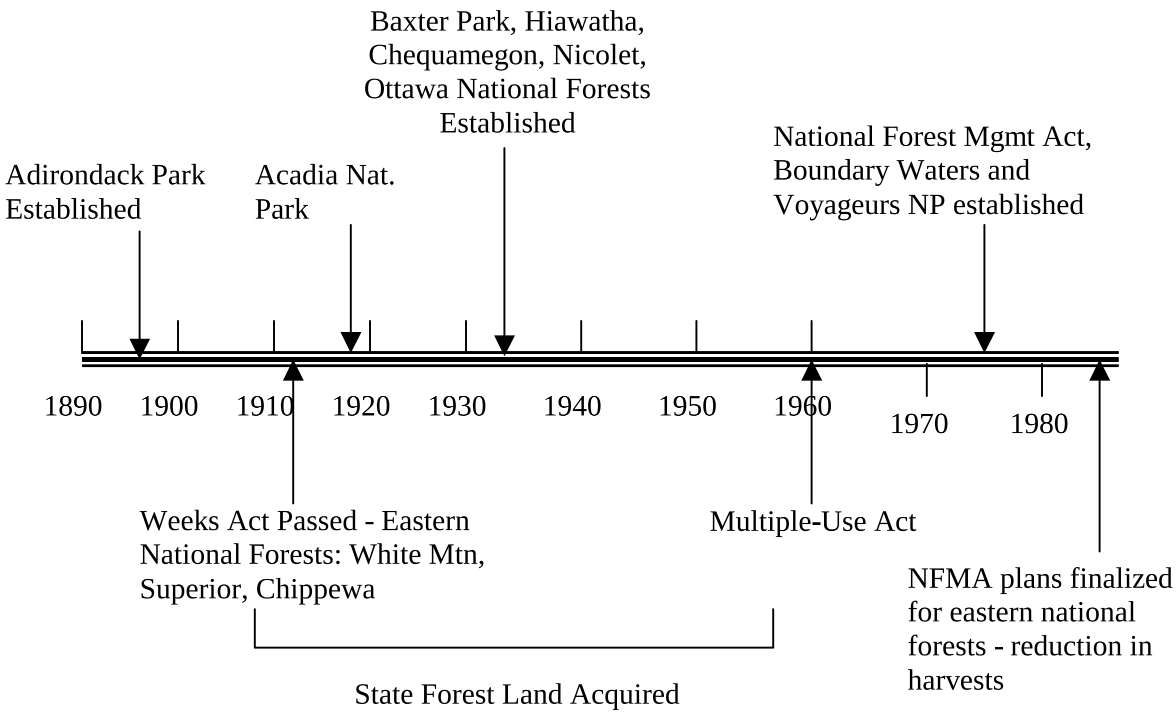
[3] The total area of the Adirondack Park is 6 million acres, although only 2 ½ million acres are publicly owned. The rest is privately owned, but subject to strict land-use regulations.

several major cities outside of the Adirondack region. The 3 million acre Superior National Forest in Minnesota was designated by Theodore Roosevelt in 1909, while the Weeks Act of 1911 established the White Mountain National Forest in New Hampshire and the Chippewa National Forest in Minnesota. President Franklin Roosevelt established the Chequamegon and Nicolet National Forests in northern Wisconsin and the Hiawatha National Forest in Michigan in the early 1930s. The Green Mountain National Forest in Vermont was also established in the early 1930s. Private individuals donated Maine's two most famous parcels of conservation land. Governor Percival Baxter purchased the land for the 200,000 acre Baxter State Park over a 30-year period starting in 1930, while a group of wealthy landowners, including the Rockefeller family, donated Acadia National Park in 1929. Most state forest lands were acquired during the first half of the 20th century as well.

In the region, the transfer of land from private owners to the government has not always coincided with immediate changes in management practices. While timber harvesting restrictions were applied immediately to many preservationist lands (e.g., Adirondack Forest Preserve and Acadia National Park), changes were much more gradual on the national and state forest lands. The Weeks Act that created many of the national forests in the region carried with it no conservation mandate; rather it specified that the national forests were to be managed for a steady supply of timber as well as to protect watersheds. No specific guidelines were given for the provision of non-timber benefits such as recreation and wildlife, nor were restrictions placed on timber harvesting.

Nonetheless, little timber harvesting took place on public forests prior to the 1950s due to earlier over-harvesting that left a depleted forest stock and economic disruptions caused by wars and the Great Depression (Shands and Healey 1977; Barlowe 1983; Irland 1999).

Figure 2. Conservation Land Timeline for the Northern Forest Region



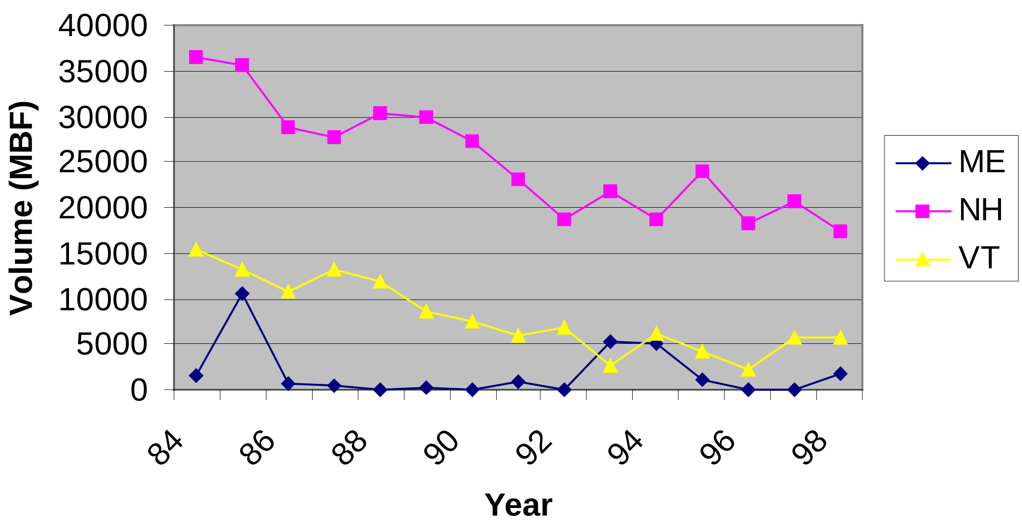
The housing boom of the early 1950s increased the demand for wood products, and the national and state forests responded (Cubbage et al. 1993). Timber harvests on national forests more than doubled during the 1950s and, by and large, the principle management goal of the national forests was timber production. However, a dramatic increase in tourism in national forests during the 1950's helped set the stage for later battles over public forest management. In 1960, Congress passed the Multiple-Use Sustained-Yield Act (MUSY). MUSY mandated that national forests provide a variety of benefits in addition to timber, including outdoor recreation, watershed protection, and wildlife and fish habitat. Shands and Healy (1977) argue that the MUSY Act is so broadly conceived as to be open to almost any interpretation and, in practice, fails to acknowledge aesthetic and environmental benefits. Alverson et al. (1994) argue that the Forest Service interpreted MUSY to justify its continuing practice of managing the national forests for timber production.

The environmental movement of the 1960s and 1970s brought continued pressure for changes in public land management (Barlowe 1983; Cubbage et al. 1993; Irland 1999). Legislation enacted after MUSY, including the National Environmental Policy Act (NEPA) of 1969 and the Endangered Species Act (ESA) of 1973 had a number of implications for national forest policy (Cubbage et al. 1993). In addition to NEPA and the ESA, the famous Monongahela National Forest court case prompted Congress to pass the National Forest Management Act (NFMA) of 1976. NFMA defined specific conservation objectives for the national forests and also required the Forest Service to provide for public participation in the development of management plans for each national forest. Section 6 of the Act gives specific land management guidelines, including timber-harvesting restrictions and the requirement to provide a "diversity of plant and animal communities."

Despite the passage of NFMA in 1976, management plans for the nine national forests in the region were not implemented until the end of the 1980s. Because of intense criticism leveled at the Forest Service during the first round of planning in the mid 1980s, the Agency reformulated its multiple-use policies to better take account of environmental concerns (Alverson et al. 1994). The resulting initiative was referred to as New Perspectives in Forestry, and later re-labeled Ecosystem Management. One result of the NFMA plans is that national forest timber harvests declined during the 1990s by more than two-thirds and are now at pre-1950 levels. As well, the use of clear-cuts has declined by almost 80 % nationwide. These recent trends signal a major shift in national forest management from timber-dominated uses to more conservation-oriented uses.

In the Northern Forest Region, timber sales began to decline in the late 1980's for the New England national forests, and in the early 1990's for the Great Lakes national forests. Between the 1980's and 1990's timber sales declined by 41% in the New England forests and by 22% in the Great Lakes forests.[4] Figure 3 presents a graph of timber sales on New England national forests, while figure 4 presents a graph of timber sales on Great Lakes forests.

Figure 3 – Timber Sales on New England National Forests

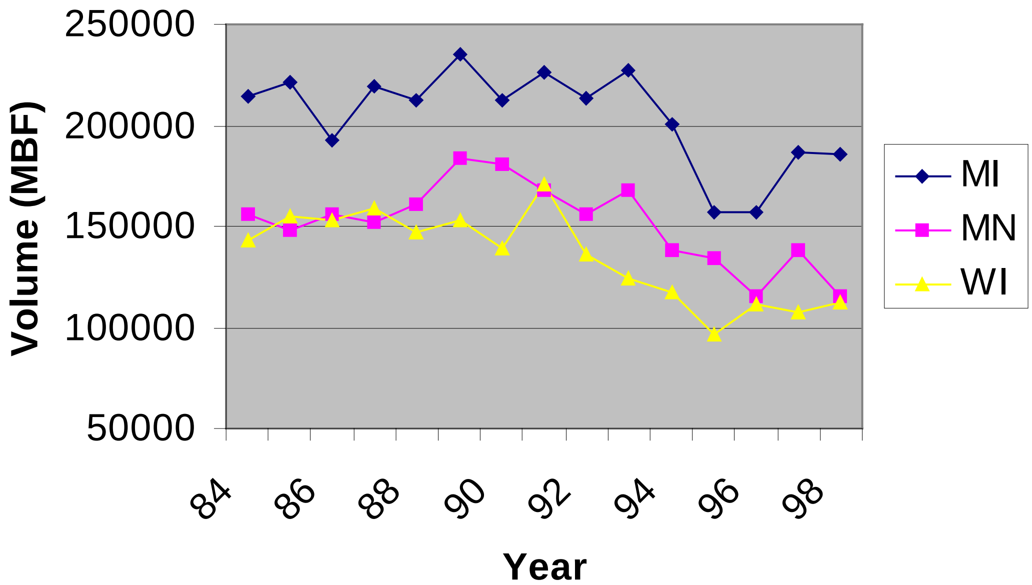


In sum, the early 1990s was a turning point for conservation management on national forests. Prior to this time, management practices on national forests were similar

[4] To arrive at these figures, I compute the average annual sales between 1984 and the last year before sales declined sharply (1987 in Maine, 1993 in Michigan, 1993 in Minnesota, 1989 in New Hampshire, 1988 in Vermont, 1991 in Wisconsin). I exclude data for the early 1980s because sales dropped off due to the nationwide recession. The average annual sales for the 1990s decade is calculated from year when sales declined through 1998.

to those on private lands, despite the fact that these lands were in public ownership. As the decade of the1990s began, much more weight was given to non-timber outputs of the forest, and conservation became a prominent objective of national forest management. In contrast, conservation management had been adopted much earlier in national parks, state parks, and wilderness areas, in most cases at the time when the lands were transferred

Figure 4 – Timber Sales on Great Lakes National Forests



from private to public ownership. There is no information indicating that state forest lands have undergone a similar shift in policy, as their harvest levels have not changed drastically during the 1990s. As discussed below, the timing of conservation management on public lands has important implications for the specification of my empirical model and the interpretation of my results. In this regard, national forest lands correspond roughly to lands on which increased conservation practices were adopted around 1990 and preservationist lands had been managed for conservation uses for at least 15 years prior to 1990. State forest lands are assumed to provide some conservation benefits less than that offered from preservationist lands, but since timber management has not changed in a similar fashion to national forests, the interpretation of the timing of conservation management will be similar to that of preservationist lands.

LITERATURE REVIEW

Amenities and Regional Development

The role of amenities in determining regional development has received much attention by regional economists in recent years (Roback 1982, 1988; Carlino and Mills 1987; Knapp and Graves 1989; Greenwood and Hunt 1989; Clark and Hunter 1992; Muser and Graves 1995; Duffy-Deno 1998; McGranahan 1999). A common assumption in such models is that human migration between regions is often caused by amenity differentials. If amenities are location-specific and considered normal or superior goods, then rising income levels leads to an increasing demand for amenities (Knapp and Graves 1989). Likewise, time-varying amenity differentials may also lead to migration between regions.

The study of human migration as a determinant of employment growth has also received a substantial literature in recent years (Greenwood and Hunt 1984; Greenwood, Hunt and McDowell 1986; Carlino and Mills 1987; Clark and Murphy 1996; Duffy-Deno 1998). Migrants may create jobs for themselves as well as for current residents (Greenwood and Hunt 1984). The relative attractiveness of people to jobs, or jobs to people has been analyzed in simultaneous models of migration/population and employment growth (Greenwood et al. 1986; Carlino and Mills 1987; Clark and Murphy 1996), with results pointing towards the former (people to jobs) as the dominant process.

Implications from these papers are that amenities may not only have direct effects on employment, but they may also have indirect effects through migration.

Spatial General Equilibrium

The classic paper in the spatial general equilibrium literature is by Jennifer Roback (1982). The paper focuses on the role of the land and labor markets in allocating workers to areas with different amenity levels. The theoretical foundation is built on a simple model of households and firms. Household utility is assumed to be a function of commodities consumed, land and amenities. The firm's cost function is assumed to be a function of wages, rents and amenities. Amenities are assumed to shift either the firm's cost function or the household's utility function.

Roback's solution for spatial general equilibrium indicates that the value of wages and rents in a region depends on the region's location-specific amenities, the value of indirect utility in equilibrium and the price of tradable goods. Indirect utility along with prices are assumed constant across regions. Therefore, amenity differentials are assumed to be the primary determinant of both wage and rent differentials. Roback specifies both consumption and production amenities. Roback argues that production amenities can be either productive (lack of snow storms) or unproductive (clean air). Higher levels of unproductive amenities will shift wages down, while the shift on rents is ambiguous. This is due to firms preferring low amenity areas and households preferring high amenity areas. Higher levels of productive amenities will shift rents down, while the shift on wages is ambiguous. The ultimate effect of amenities on area wages and rents depends on whether the consumption or production amenity dominates. In Roback's condition for spatial general equilibrium, households and firms have no incentive to move.

Beeson and Eberts (1989) take Roback's (1982) framework and estimate the relative importance of amenity and productivity differences in determining wage differentials across regions. The paper is aimed at analyzing both labor supply and demand in determining wage differentials. Major findings include the result that productivity contributes to 60% of the wage differential, while amenities contribute to 40%. However, Beeson and Eberts do find that the relative importance of these factors varies across cities. In some cities, amenity differentials are found to be the dominant cause of wage differentials. The findings here point to the importance of both labor supply and labor demand in determining wage differentials. Their calculations are based on the assumption of spatial general equilibrium.

Greenwood, Hunt, Rickman and Treyz (1991) empirically test the existence of equilibrium. They note that equilibrium in wages and rents assumes regional markets are to be efficient, with regional prices quickly responding to exogenous changes induced by disequilibrium shocks. They argue that if markets are not efficient, the assumption of equilibrium will lead to biased estimates of amenity valuations based on wage and rent differentials.

Greenwood et al. derive a net migration equation as a function of expected income and amenities. They econometrically estimate a value for the equilibrium level of expected income by state, along with lower and upper bounds. They use these values to determine that most U.S. states were in an equilibrium condition in 1980, with only a small portion of states in disequilibrium. They conclude that errors generated by estimating compensating differentials based on the assumption of equilibrium may be assumed to be relatively minor.

These three papers present a useful framework for thinking about household and firm location. The equilibrium approach emphasizes the consumption amenity motive and assumes that migration and local market processes are relatively efficient (Hunt 1993). The other implication of an equilibrium assumption is that economic opportunities such as wages and job growth are not important factors in household migration, a notion challenged by disequilibrium theorists. Hunt (1993) sums up the challenge by stating that disequilibrium theory suggests that local markets are not efficient and that spatial differentials in economic opportunities reflect utility differentials and are long-lived. Therefore, economic opportunities drive migration. Empirical evidence of the importance of economic opportunities is presented in Greenwood and Hunt (1984), Carlino and Mills (1987), Greenwood and Hunt (1989) and Clark and Hunter (1992) among others.

The degree to which a researcher assumes equilibrium is equal to the degree to which he believes local markets operate efficiently. Efficient markets have a relatively quick speed-of-adjustment to disequilibrating shocks. While equilibrium and disequilibrium theorists debate the relative importance of economic opportunities versus amenities in determining household location, the combined literature points to both variables as important factors. Spatial general equilibrium is best thought of as the final destination of household and firm movement, regardless of whether or not the system is in equilibrium. Indeed, whether households and firms are headed to, or already in a form of equilibrium or disequilibrium, the inclusion of amenities in regional development models is paramount when considering long-run location.

Households

The effect of amenities on households has been analyzed on migration (Knapp and Graves 1989; Greenwood and Hunt 1989; Clark and Hunter 1992; Treyz, Rickman, Hunt and Greenwood 1993; Graves and Mueser 1995), and on population growth (McGranahan 1999). As noted above, amenities have also been analyzed in a context of explaining wage differentials between regions (Roback 1982; Roback 1988; Beeson and Eberts 1989; Beeson 1991). All studies have determined amenities to be an important factor in explaining population, employment and wages, although they differ on the relative extent.

Knapp and Graves (1989) explore the role of location-specific amenities in human migration decisions. They stress that regional development models must focus on amenities as critical elements in determining economic growth. The paper is exploratory in nature and analyzes prior demand-side and supply-side approaches in regional economic models, in addition to assumptions of spatial general equilibrium.

In reviewing past demand-side models, Knapp and Graves note that a common assumption across papers was that labor supply is assumed to be perfectly elastic, and that increased labor demand was the impetus for household migration. Knapp and Graves point out that in-migration is often modeled as a function of wages and unemployment, where unemployment is used as a proxy for the probability of receiving employment. Supply-side models are analyzed by noting the assumption that the outflow of labor from low-wage to high-wage areas explains migration. Labor demand is assumed to be perfectly elastic and migration due to wage differentials is the important determinant of regional development.

Knapp and Graves also analyze the valuation of location-specific amenities through compensating wage and rent differentials. The hedonic technique is commonly used and assumes spatial general equilibrium (SGE) across regions. SGE assumes efficiency in local labor and land markets and points towards amenity differentials as the impetus for household migration. This assumption allows researchers to value amenities because they are argued to be fully capitalized into either the land or labor markets. An SGE assumption contradicts supply-side models because one would not always expect migration toward high-wage areas (since the high-wage may proxy for undesirable characteristics). SGE assumptions may also explain negative coefficients on income variables in migration equations. Knapp and Graves note many empirical contradictions to demand-side models with several studies showing high migration into areas of low income or high-unemployment, findings that may be understood with SGE assumptions.

Knapp and Graves conclude that location specific amenities may influence productivity, firm location decisions and the demand for labor. Therefore, amenities are justifiably used in both supply-driven and demand-driven models. Knapp and Graves also suggest that in the early stages of development of an amenity-rich site, low wages may reflect the presence of the amenity relatively more than rents, while the full value of the amenity is not reflected in general due to the presence of disequilibrium. It is also argued that increasing spatial uniformity of production advantages may imply a structural change in the motivation for ongoing regional development. If household migration decisions are increasingly influenced by demands for location-specific amenities, then the paper concludes amenities will continue to play an increasing role in models of regional development.

Greenwood and Hunt (1989) explore the role of jobs versus amenities in metropolitan migration models. They offer a challenge to some of Knapp and Graves' (1989) conclusions in terms of the relative importance of amenities to employment in determining migration. Their main finding is that employment opportunities are far more important in explaining metropolitan migration than location-specific amenities, at least in a direct sense. They claim that prior migration models which estimate the relatively large importance of amenities, failed to take employment growth into account, and thus may have spurious results.

Greenwood and Hunt specify a net migration equation covering individual years from 1958 – 1975 for 57 U.S. metropolitan areas. Major findings include the fact that employment growth is always a positive and significantly different from zero determinant of migration, whereas amenities are infrequently significant. The time-series nature of their data set allows them to conclude that no obvious temporal pattern is evident suggesting the importance of amenities growing with generally rising real incomes. Greenwood and Hunt conclude that while amenities may be somewhat important determinants of migration, the inclusion of an employment growth variable is necessary to avoid spurious results.

Clark and Hunter (1992) analyze the impact of economic opportunities, amenities and fiscal factors on age-specific household migration rates. Their model extends prior migration models by including a more encompassing definition of economic opportunities and amenities. The paper investigates U.S. county net migration between 1970 and 1980 and seeks to answer Greenwood and Hunt (1989) in addressing the issue of amenities in determining migration. Major findings include the result that all three categories (economic opportunities, amenities, fiscal factors) are important determinants of migration.

Clark and Hunter's definition of amenities/disamenities is wide-ranging and includes variables such as crime rates, poverty, climate, state parks, major sports teams and cultural opportunities such as museums and theatres. The study is also distinguished by its explicit examination of age-specific households. They find that economic opportunities are most influential in determining the migration patterns of young males, while amenities are more significant in determining the movements of older residents. The following policy prescription is offered:

> The impact of the baby-boom cohort on county migration patterns can be expected to be substantial, and amenities will play an increasing role in the future. Consequently, policy makers may be able to at least partially offset the deterrent effect of a poor mix of climatic amenities through the development of cultural and recreational amenities. (p. 363)

Clark and Hunter conclude that economic opportunities, amenities and fiscal opportunities are all critical components in determining household migration.

Treyz et al. (1993) estimate a stock-flow model of migration and equilibrium population. The model specifies economic opportunities and amenity differentials as determinants of migration. The model is specified so as to estimate the speed at which net migration re-establishes stock equilibrium. Results indicate that the process is stable and is significantly related to stock equilibrium changes induced by amenity differentials, employment opportunities, wages and industry composition. Again, results point towards the inclusion of amenities as significant determinants of household movement.

Mueser and Graves (1995) develop a model of migration to examine the explanatory role of economic opportunity and amenities. They argue that the problem needs to be considered from an equilibrium standpoint so as to avoid ad-hoc model structures. They point out that disequilibrium models such as Greenwood and Hunt (1984), are unable to place observed migration patterns within a context of the long-run spatial population distribution.

Mueser and Graves analyze data from 1950 – 1980 and conclude that there is no "final" answer to the question of causal impact on migration, and that the relative importance of factors varies over time. Their results suggest that while employment opportunities may strongly affect migration in one period, amenity variables may strongly affect migration in the next period. They stress that incorporating compensating differentials in land and labor markets is necessary when analyzing migration models, and that modeling the role of employment growth on migration without taking these differentials into account may be suspect. Mueser and Graves conclude that systematic migration trends observed over several decades appear to have been tied to household preferences for amenities, in conjunction with changes in income that shifts the relative importance of such factors.

While most of the previous papers reviewed were based on urban growth, McGranahan (1999) analyzes the role of natural amenities in determining rural population change. A natural amenities index is explicitly derived which consists of climate, topography and lake area variables. Major findings include the result that 1970 – 1996 population change was highest in rural counties with the highest rating on the natural amenities index, as well as the finding that employment change is also higher in counties with more natural amenities.

McGranahan notes that most counties with high population growth and high natural amenity scores were found in the western and southwestern portions of the U.S. Although recreation-oriented counties are found to correlate somewhat with natural amenity counties, they are not found to be as popular a place to live year-round as counties scoring high on the natural amenity index. This is primarily due to the index's bias towards warm climates. Although employment growth is found to be higher in natural amenity counties, it is not clear whether this is being driven by the amenity-induced population growth or other factors related to the amenities.

These six papers all represent the fundamental importance of using amenity variables in models of household location. While equilibrium theorists (Knapp and Graves 1989) stress that amenities are the most important factor in determining household migration, disequilibrium theorists challenged this notion (Greenwood and Hunt 1989) and suggested that employment growth was more important. After a series of back and forth papers, Mueser and Graves (1995) summed up the issue by stating that there is no "final" answer as to the importance of employment opportunities or amenities in determining migration. Instead, they suggest that the relative importance of factors varies over time. Indeed, even the disequilibrium theorists (Hunt 1993) indicate that while employment opportunities are important, disequilibrium models that fail to specify amenity factors may be misspecified. McGranahan's (1999) paper concluded that natural amenities were indeed a very important factor in the regional development of rural economies. The literature suggests that amenities and employment opportunities are both important to household location and that the relative importance is an empirical question that may vary both spatially and temporally.

Firms

Perhaps the first mention of amenity-driven firm location was by Perloff and Wingo (1964). They present a history of natural resource endowment and economic growth in the United States. Distinct periods of American history are analyzed in the context of the spatial attractiveness of distinct regions. They note that early American regional growth was largely driven by the natural resource endowments of specific regions in determining regional productivity advantages. Specifically, this included productive agricultural lands, forest lands and mineral deposits.

Perloff and Wingo also argue that the mid-twentieth century was the beginning of the "services" and "amenity resources" era in the United States. An important development in this period was the growth in the number and significance of industries whose ties to resource inputs and national market centers are relatively weak. These industries tend to be labor-oriented and differ from others in the sense that they have an unusually wide range of locational alternatives available to them. Typical requirements for such firms include either unskilled or semi-skilled labor such as apparel, or highly technical labor, such as research and development firms. Perloff and Wingo note that such firms are attracted to regions offering high amenity levels. They also argue that with rising incomes in the United States, it seems fairly certain that the direct influence of amenities on regional growth will increase with time.

Roback's (1982) classic paper on spatial general equilibrium analyzed the effect of productive and unproductive amenities on firms. In her model, a firm's production function is dependent on land, labor and amenity vectors. Likewise, she assumes a firm's cost function is dependent on wages, rents and amenities. Amenities are classified as either unproductive (clean air) or productive (lack of snow storms). The first derivative of the firm's cost function is negative with respect to unproductive amenities.

When the firm's cost function is analyzed in an SGE format with household's utility function, the effect of an amenity on the point of equilibrium is determined by its effect on households (labor supply) and firms (labor demand). So, amenities affect both the utility of households and the productivity of firms. Beeson and Eberts (1989) estimate the relative importance of amenity and productivity differences in determining wage differentials. They find that the productivity share accounts for 60%, while the amenity share accounts for 40%. The conclusion is that both factors appear to play comparable roles in determining interregional wage differentials, and thus spatial general equilibrium between firms and households.

McGranahan (1999) analyzes the affects of natural amenities on employment in rural counties of the continental United States. He notes that employment change in rural counties over a recent twenty-five year span has been highly related to natural amenities. McGranahan points out that the amenity effect on employment change is strong, but weaker than the amenity effect on population change. Whether the amenities are directly affecting a firm's cost function is not specifically analyzed, although the high significance of amenities on population growth in his paper brings up a simultaneous issue not addressed.

Perloff and Wingo (1964) argue that the United States begins a time period of amenity-driven firm location in the mid-twentieth century. Roback (1982) and Beeson and Eberts (1989) bring up an important issue of understanding the direct effects amenities may have on a firm's cost function. Roback's underlying theory implies the direct importance an amenity may have on a firm's cost function, and likewise a firm's location decision. Whether the amenity has a positive or negative effect on firms depends on whether the amenity is "productive" or "unproductive." Given the important impact amenities may have on a household's utility function, it is also important to analyze the effect that a household's location decision may have on a firm's location decision. This is addressed in the next section, which analyzes the literature on simultaneous models of population and employment.

Simultaneous Models

The long-standing debate between equilibrium and disequilibrium regional economists highlights the importance of considering both economic opportunities and amenities in models of household migration. But, there is also a substantial literature that suggests the importance of population in determining regional employment (Greenwood and Hunt 1984; Greenwood et al. 1986; Carlino and Mills 1987; Clark and Murphy 1996). Indeed, population and employment can be treated as endogenous, with the resulting simultaneous model reflecting a more complete regional economic growth system.

Greenwood and Hunt (1984) analyzed human migration and employment growth in a simultaneous framework. The study is empirical in nature and analyzes growth rates for each of 171 U.S. regions. The time-series data covers the years 1958 to 1975. Their primary emphasis was on the 57 major metropolitan areas and they demonstrate that incremental employment opportunities are more attractive to migrants if the opportunities occur in the amenity-rich southern and western portions of the country.

Greenwood and Hunt argue that migration to cities has been a self-reinforcing and cumulative phenomenon. They note the following underlying factors to this relationship: 1)differential levels of human capital between migrants and current residents, 2)the migrant's own physical and financial capital, 3)non-labor income of migrants, 4)migrant-caused incremental investment, 5)changing local demand for goods due to migration, 6)migrant contributed scale and agglomeration economies. Greenwood and Hunt argue that each of these factors would shift the local labor demand schedule as well as result in additional employment growth above and beyond the migrant's own direct contribution. Likewise, they note that outward migration may result in the opposite effect.

Empirical findings include the result that an average of 0.451 employed net migrants are directly attracted by one additional job. The paper notes that areas in the south and west attract about one more employed migrant per 10 extra jobs than those areas in the northeast and north central U.S. They also find that for two-thirds of the nation's major metropolitan areas, one more employed migrant results in one more job. For the remaining one-third, the migration of one more employed migrant leads to creation of approximately 1.26 more jobs. While Greenwood and Hunt do not explicitly include amenities as independent variables, the finding that employment growth in the amenity-rich southern and western regions have stronger attractions to migrants than in the northeast and north central regions implies the importance of amenities in regional development models.

Greenwood, Hunt and McDowell (1986) extend the Greenwood and Hunt (1984) paper. The study is most concerned with determining the linkages between net employment migration and employment growth. The paper is also empirical in nature and utilizes the same 1958-1975 time-series data set, although they include amenity variables explicitly into their econometric equations where Greenwood and Hunt (1984) did not. The main finding is that in an average year, two extra jobs attract one extra migrant and one additional net migrant has a direct effect of almost 1.4 additional jobs. This finding gives support to the notion that jobs follow people in an average year.

Greenwood et al. (1986) note that the time period of their data (1958 – 1975) was generally one of economic stability, but that there were periods (1963 – 1968) of sustained national growth. In order to determine the effect of national growth on regional growth, they econometrically established that migrants have a significant tendency to respond positively to incremental employment opportunities during periods of national expansion. Greenwood et al. (1986) interpret this finding to suggest that job-determined migration is not fixed or changing along a trend line, but rather it behaves in cyclical fashion. The authors also explore the effects of national expansion in the context of migrant-determined job growth and find that migrants have a lesser impact on jobs during national expansionary periods than during contractionary periods.

Carlino and Mills (1987) analyze the determinants of population and employment densities for about 3,000 counties in the U.S. The study is similar to Greenwood and Hunt (1984) in that it is simultaneous in nature, but the focus is on determining the levels of population and employment rather than growth rates. Model specification assumes that population and employment depend on various economic and amenity factors. The model is also designed to estimate the speed-of-adjustment of population and employment to an equilibrium state.

Major findings include the results that population and employment were strongly significant determinants of each other, as well as the result that speed-of-adjustment to equilibrium was extremely slow. Results also imply that jobs follow people more than people follow jobs. Carlino and Mills find that amenities (particularly climate) are important determinants of both population and employment. They also find that public policy variables, such as taxes, exert little impact on population or employment. The paper concludes with the following policy prescription:

> Since population and employment growth are interrelated, one policy prescription for local economic development officials is to formulate strategies to retain or attract population and employment will follow. (p. 52)

Clark and Murphy (1996) repeat the analysis of Carlino and Mills (1987) using the time period from 1981 to 1989. A partial adjustment disequililbrium model is specified and a large set of exogenous variables is included to estimate the effects of amenities, business and fiscal conditions, demography, employment structure and relative location on population and employment. The model differs from Carlino and Mills (1987) in that the amenity, fiscal and location-oriented variables are greatly expanded. They also estimate an employment model by sector, and include manufacturing, construction, service, trade and finance, insurance and real estate.

Major findings from Clark and Murphy include the result that changes in population density are sensitive to changes in amenities, a finding consistent with other papers cited earlier. Policy variables related to government spending had minor impacts on population, while population density is found to have a larger influence on employment density than employment density has on population density. Again, this points to the relative importance of population induced employment growth consistent with Greenwood et al. (1986) and Carlino and Mills (1987). Clark and Murphy conclude that public policy variables are more effective at influencing employment than population, because amenity levels drive population growth.

Results from these four papers highlight the fundamental importance of modeling population and employment in a simultaneous framework. Consistent with the long-standing debate about equilibrium versus disequilibrium in regional models, all four papers find that both economic opportunities and amenities are important determinants of household migration. Another consistent finding across papers is the relative importance of population in determining employment. Indeed, all four papers weigh in on the jobs follow people or people follow jobs debate with a resounding conclusion of the former as the dominant process. This finding highlights the importance of the simultaneous model structure as well as the importance of considering endogenous population when analyzing employment growth in regional models.

Conservation Land as an Amenity

Public conservation land is owned publicly and managed to some degree for environmental purposes. People who value the services offered by these lands may consider conservation land an amenity. Specifically, people who value the recreational, wildlife or other environmental benefits offered by these lands may base their location decisions partly on the amount of conservation land offered in a specific region. The amenity power of various types of conservation land has a relatively small literature (Power 1991; Rudzitis and Johansen 1991; Power 1996; Duffy-Deno 1998). However, all studies have found conservation lands to offer some degree of amenity services to local residents and migrants.

Power (1991) analyzes the economic health of counties surrounding the Greater Yellowstone ecosystem in the states of Montana, Wyoming and Idaho. Specifically, he analyzes the relative importance of extractive industries and service-related industries in determining local economic activity. The paper is exploratory in nature and focuses on a descriptive analysis of the economic structure in the region. He concludes that contrary to popular belief, recreation-related economic activity is more important to the local economy than resource-extraction related activity. This suggests that amenities supplied from nearby conservation lands such as Yellowstone National Park, are attracting both permanent residents and temporary visitors. In this sense, Power concludes that conservation lands are a crucial element to any economic development in the region.

Rudzitis and Johansen (1991) summarize results from survey research to find out what the attitudes of the public are towards the management of federally designated wilderness. Federal wilderness can be designated on national forests, parks, wildlife refuges or lands administered by the federal Bureau of Land Management. Wilderness is the most restrictive form of land management, with preservation being the key goal in these lands. Results from the survey indicate that wilderness is an important reason why 53% of the people moved to or live in the area and 81% felt that wilderness areas are important to their counties. In regards to migrants, 60% of the migrants cite the presence of nearby wilderness as an important reason why they moved to the area, while 45% of the residents say that is why they stay in the area. Rudzitis and Johansen conclude by emphasizing that a new set of values that emphasizes the benefits of natural environments seems to be prevalent in the U.S., as these benefits seem to be playing an increasing role in determining local economic activity.

Thomas Power's 1996 book *Lost Landscapes and Failed Economies* enlarges the scope of his earlier paper (Power 1991) to present a more thorough analysis of the role of environmental protection in local economies. He presents a case where efforts to place land into conservation uses is being portrayed as threatening the local economies of entire regions. The book seeks to analyze popular perceptions of local economies as being entirely tied to the multiplier effect offered by big resource-extractive industries. Power asserts that these claims about local economies are incomplete, distracting and misleading. He presents a new way of thinking about local economic activity that is focused on the amenities that may be offered to rural economies from environmental protection, particularly conservation lands. In a sense, Power is advocating the consideration of the economics literature on amenity-induced regional development (Knapp and Graves 1989; Clark and Hunter 1992; Mueser and Graves 1995). Power's conclusions are that environmental protection efforts can be an important part of regional economic development, and that claims of widespread devastation due to protection efforts are unfounded.

Duffy-Deno (1998) utilizes the model introduced by Carlino and Mills (1987) to analyze the effects of federal wilderness on county-level population and employment density in the Rocky Mountain region of the United States. The model is a simultaneous model of population and employment density including a variable for the share of county land in wilderness exogenously determining both population and employment density. Duffy-Deno's empirical results show no evidence that wilderness is directly or indirectly associated with population or employment density growth between 1980 and 1990. He does find that population density is higher in counties with more land owned by the

National Park Service, implying that Parks are considered a local amenity. However, Duffy-Deno fails to calculate reduced form effects of wilderness, results of which might lead to different conclusions. This seems to be a particularly serious problem considering wilderness is used as an explanatory variable in both the population and employment equations.

One other problem not identified by Duffy-Deno is one of timing. While many of the wilderness lands included in his study were designated during the 1960's, he makes no note of how they would still affect population and employment growth in the 1980's. There may be an issue of timing related to how economies react under the *presence* of wilderness as well as how they react to the *designation* of new wilderness. Due to a good deal of land being designated wilderness in the 1960's, it seems that Duffy-Deno's study focuses on the presence of wilderness. However, given that most wilderness lands in the west have never been utilized commercially, a wilderness designation may mean that lands change management in name only.

Each of the four studies cited in this section presents evidence of conservation land being considered a local amenity to households. Power's work (1991; 1996) is descriptive in nature, Rudzitis and Johansen (1991) is survey oriented, and Duffy-Deno (1998) presents an econometric model based on the regional economics literature cited earlier. Although Power's work is descriptive in nature, his hypothesis of the positive role of environmental protection in regional economic development should be considered seriously. The hypothesis is well grounded in previous regional economics work regarding amenity-induced regional development and his theory is supported by survey evidence presented in Rudzitis and Johansen (1991). Duffy-Deno (1998) presents econometric evidence of the positive effect of national parks on population, but his study is concerned only with the effect of the presence of conservation lands on population and employment. He also fails to calculate reduced form effects, which may have implications on his findings. None of these studies present evidence of an economy's response to the designation of new conservation lands, although they all give some indication of the amenity effect new conservation lands may have on population.

MODEL STRUCTURE

The basis for my study is a model of net migration and employment growth. Following Greenwood and Hunt (1984) and Greenwood et al. (1986), behavioral equations are specified for net migration (NM) and employment (CE) growth rates,

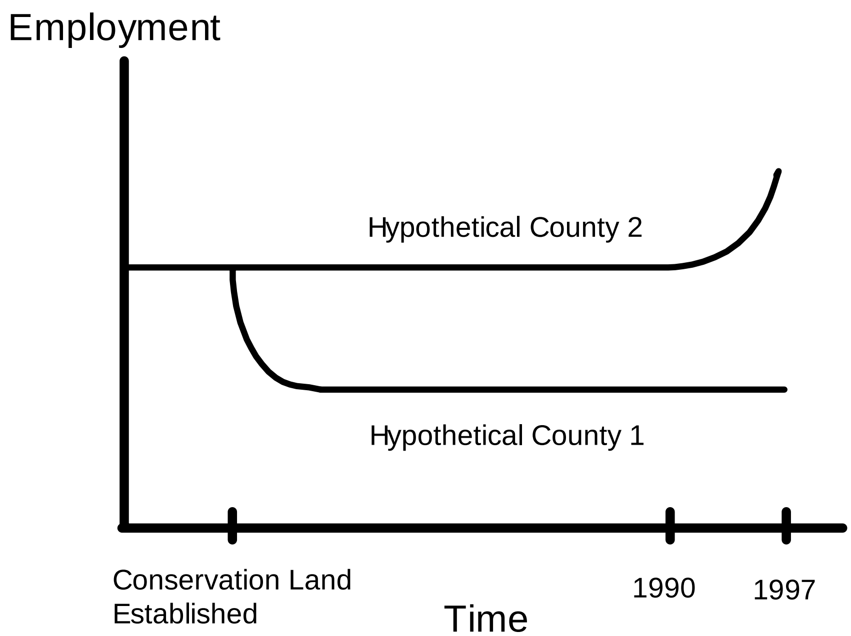
$$NM_{i,90\text{-}97} = f_1(CE_{i,90\text{-}97}, A_{i,90}) \quad (1)$$

$$CE_{i,90\text{-}97} = f_2(NM_{i,90\text{-}97}, B_{i,90}) \quad (2)$$

where i indexes counties and NM and CE are measured over the period 1990 to 1997. Equations (1) and (2) capture the simultaneous nature of migration and employment. Positive net migration increases the number of people in a county and this has a positive effect on employment by increasing local consumer demand and providing a larger workforce. At the same time, positive employment growth increases the number of jobs available and attracts new migrants to the county. Net migration and employment are also affected by exogenous factors that make an area more attractive to potential migrants and to firms considering expansion or relocation. A and B are vectors of lagged (1990) exogenous variables that include the percentage of the county's land base designated as publicly owned conservation land.

Conservation practices were adopted on preservationist lands well before 1990. In these cases, the growth rate model does not capture initial changes in net migration and employment associated with the designation of these lands. Consider a hypothetical county (County 1 in Figure 5) in which a large tract of conservation land was established at the turn of the century (e.g., a New York county containing a portion of the Adirondack Park).

Figure 5. Timing of Conservation Management on Public Lands



If the county had a large number of wood products firms, one might expect a loss in employment in response to the designation of conservation land. By 1990, however, the adjustment would be complete, and the initial impact on jobs would not be reflected in employment growth data for 1990 to 1997. The effects of conservation land should still be present in the *levels* of population and employment. The county discussed above, for instance, would have a lower level of employment, all else equal, than a county with no conservation land. Vectors A and B include measures of 1990 population and employment levels, respectively. These variables "absorb" the earlier effects of conservation land and ensure that my model isolates the effects of conservation land on growth in employment and population in the 1990s.

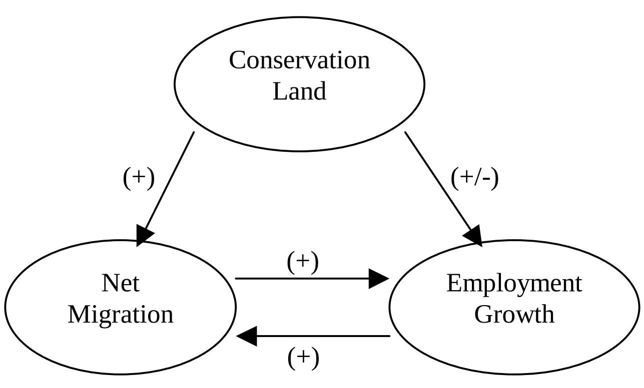
In the case of national forest lands, I would expect the effects of conservation lands to be reflected in recent population and employment growth data since the adoption of increased conservation practices occurred around 1990. This case is represented by County 2 in Figure 5. At the time the conservation land is established, there is no change in employment because conservation management has yet to be adopted on these lands. When these practices are adopted in 1990, there are corresponding changes in employment. In the case depicted in Figure 5, employment increases due to an increase in tourism-related business.

The remaining variables in A measure the attractiveness of an area to potential migrants and current residents. Following Clark and Murphy (1996), vector A contains the following categories of variables: amenities, fiscal conditions, economic opportunities, and local characteristics. Location-specific amenities, including those provided by conservation lands, indicate the quality of life for local residents. Fiscal conditions include the tax burden on residents of the county in addition to the level of government services. Economic opportunities are determined by factors such as the diversity of the local economy and injections of income from external sources. Finally, local characteristics include fixed effects that explain variation in population and employment not controlled for by the other variables.

Vector B contains measures of determinants of employment growth and employment levels and includes the following categories of variables: local business conditions, fiscal conditions, and local characteristics. Local business conditions include characteristics of the labor force, the unemployment rate, the quality of public infrastructure, and diversity of the local economy. Fiscal conditions include tax rates and government expenditures. Lastly, I control for local characteristics that may promote or reduce employment, including the presence of conservation lands.

My specific interest in this study is the effect of conservation land on migration and employment growth, and Figure 6 illustrates different pathways through which these effects can be transmitted. Conservation land is considered by many people to be an amenity, since it increases recreational opportunities and may prevent land development considered undesirable by current residents. In this way, conservation land contributes directly and positively to net migration. Conservation land may also directly affect employment growth, negatively by removing land from commercial uses or positively by

Figure 6. Expected Effects of Conservation Lands on Net Migration and Employment Growth



attracting new businesses to an area. Power (1996) suggests that conservation land enhances the attractiveness of the surrounding area as a place to do business. Roback

(1982) argues that, all else equal, high levels of amenities might entice some people to accept lower wages, leading to a higher-quality, lower-cost labor force. As shown in Figure 4, conservation land may also affect net migration and employment growth indirectly through its direct effects on employment and population, respectively.

EMPIRICAL MODEL

Model Specification

For my empirical application, the model summarized by (1) and (2) is specified as,

$$NM_{i,90-97} = \alpha_0 + \alpha_1 CE_{i,90-97} + \sum_{j=2}^{J} \alpha_j a_{ji,90} + \varepsilon_{1i,90-97} \quad (3)$$

$$CE_{i,90-97} = \beta_0 + \beta_1 NM_{i,90-97} + \sum_{k=2}^{K} \beta_k b_{ki,90} + \varepsilon_{2i,90-97} \quad (4)$$

for i=1,…,92. $NM_{i,90-97}$ is the rate of net migration (net movement in population less natural changes due to births and deaths) in county I between 1990 and 1997 and $CE_{i,90-97}$ is the employment growth rate in county I between 1990 and 1997. The independent variables ($a_{ji,90}$ and $b_{ji,90}$) are lagged in order to ensure exogeneity, $\varepsilon_{1i,90-97}$ and $\varepsilon_{2i,90-97}$ are error terms, and the αs and βs are parameters. The data set includes 86 non-metropolitan counties that make up the Northern Forest region. I include all counties without a city large enough to qualify as a metropolitan statistical area (MSA). I also include an additional six counties that do contain an MSA, but have low population densities that are comparable to the other counties. These are Penobscot (ME), Franklin (VT), Herkimer and Warren (NY), Douglas (WI), and St. Louis (MN).

Exogenous Variables in the Net Migration Equation

The independent variables in (3) measure the attractiveness of the county to potential migrants and current residents. Amenity variables include the percentage of total county land in public conservation uses (TCO). TCO combines multiple-use and preservationist lands; however, I examine also the effects of these management categories separately. Community stability is another potential amenity, which I measure as the percentage of people who own their own homes (PH). Ease of transportation may enhance the attractiveness of the county and is measured by interstate highway mile density (IH). The income of a county, measured by median family income (I), proxies for a number of factors, including the range of consumer and cultural offerings and the extent of social problems stemming from poverty. Finally, large water bodies are an amenity to many people and I include a dummy variable indicating whether or not the county borders either the Atlantic Ocean or one of the Great Lakes (SH).

I include a set of fiscal variables measuring government taxation and spending. I hypothesize that individuals prefer living in counties with the greatest difference between the provision of goods by the government and the taxes paid to provide these goods. This is measured as the ratio of local government expenditures to local taxes (TR) and includes payments to counties and towns from the state government, which are often an important component of local expenditures. People may have preferences for categories of government-provided goods and services (e.g., education). The percentage of government expenditures on education (PE), police protection (PP), and health and hospitals (PM) 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, I account for potential spillover effects from urban areas. UA is a dummy variable indicating whether or not the county is adjacent to a metropolitan county (i.e., a county with a metropolitan statistical area). As well, CT is a dummy variable that accounts for the presence of a city within the county with a population greater than 25,000.

For reasons discussed earlier, I include the 1990 population level, measured as population density per square mile (PDL). As well, I include a set of state dummy variables to control for differences in local characteristics such as state regulations and state income taxes (Minnesota is the omitted category). Although most migration models include weather variables, I do not include them in my models due to a lack of climate variability in the region. The Northern Forest region is generally cold in the winter and mild to warm in the summer.

Exogenous Variables in the Employment Growth Equation

In (4), determinants of employment growth and employment levels include local business conditions such as the availability of a high-quality, low-cost work force. Work-force quality is measured by the percentage of county residents who graduated from high school (HS) and the share of local government expenditures on education (PE). The cost of the work force is measured by the unemployment rate (UE). Accessibility to markets is an important component of costs for some firms and is measured in my model by interstate highway mile density (IH). All of these variables are expected to have a positive direct effect on employment growth.

The diversity of the local economy may also be an important determinant of business conditions since communities largely dependent on a single industry may be less resilient to economic downturns. In the Northern Forest region, forest products manufacturing is the dominant resource-based industry and the principal source of employment in some counties. To measure dependence of the local economy on the forest products industry, I include the share of total county employment in forestry, paper and allied products, lumber and wood products, and furniture and fixtures (PF). Ski resorts are found throughout the Northern Forest region and may influence local business conditions. ES is a dummy variable indicating the presence of one or more destination ski resorts in the county.[5] Local business conditions may also be determined by spillovers effects from urban areas, relatively large cities within the county, the presence of a destination ski resort, and outside income sources. As in the net migration equation, I include UA and CT in the employment equation. Finally, to account for income injected into the local economy from external sources, I include the percentage of personal income from investments (PD).

Fiscal conditions may affect employment growth and levels, and as in the net migration equation, I include a variable measuring the ratio of local government expenditures to local taxes (TR). Local characteristics affecting employment include the presence of conservation lands (TCO) (see above) and state regulations and income taxes.

[5] Destination resorts are those ski areas ranked in the top 60 by Ski magazine. ES applies only to destination resorts in the northeastern states (ME, NH, VT, NY) and not those in the Midwest. In my judgment, resorts in the Northeast offer much better skiing than those in the Midwest. Admittedly, my definition of ES reflects my personal bias toward higher mountains and better snow conditions.

A set of state dummy variables is included in (4) to control for these fixed effects. Lastly, employment density per square mile (EDL) is included in the growth-rate specification to control for pre-1990 changes in employment.

Exogenous Variables to Measure Increasing Conservation Management on National Forest Lands

I will also estimate the effects of increased conservation management on national forest lands. As noted earlier, national forest policy changed significantly in the early 1990s, with one result being lower timber sales from these lands. I use the change in timber sales (NFT) as a proxy for increasing conservation management. National Forest timber sales data is included at the state level for the years 1983 to 1996. Changes in national forest timber sales are estimated at the county level by weighting the change in sales between the1983 to 1989 period and the 1990 to 1996 period by the share of state-level national forest land located in the county.

To control for the other conservation land types included in TCO, I also include a variable for state forests (SF) and preservationist lands (PR). State forests are managed for multiple uses, including timber harvesting. While these lands offer some conservation benefits similar to those found on national forest lands and preservationist lands, there have been no significant policy changes regarding conservation management on these lands. Therefore, I do not use a timber harvest proxy to measure changing conservation management for state forests.

DATA SOURCES AND MEASUREMENT ISSUES

Variable definitions and data sources are presented in Table 3 and summary statistics are provided in Table 4. GIS maps of the net migration rates are presented in figure 5, while maps of the employment growth rates are presented in figure 6. Data on the area of conservation land is available by county and the year 1990 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 conservation lands is available for Minnesota, New Hampshire, and Wisconsin. County-level conservation land 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% in Maine between 1990 and 1999, 1.5% in Michigan, and less than 3% in New York. I use these values as proxies for the 1990 values. The total area of state-owned public lands in Vermont increased approximately 24% over this time period. I form county-level estimates for 1990 by reducing the more recent county measures of state-owned public land by 24%. In light of these measurement issues, I conducted Hausman specification tests, the results of which indicate that the conservation land variable (TCO) and the national forest timber variable (NFT) are not endogenous (see Appendix 1).

Figure 7 – Net Migration Rates in the Northern Forest Region

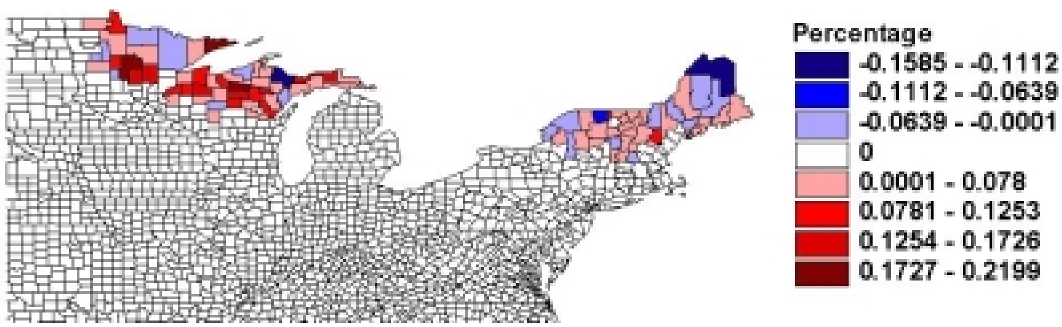
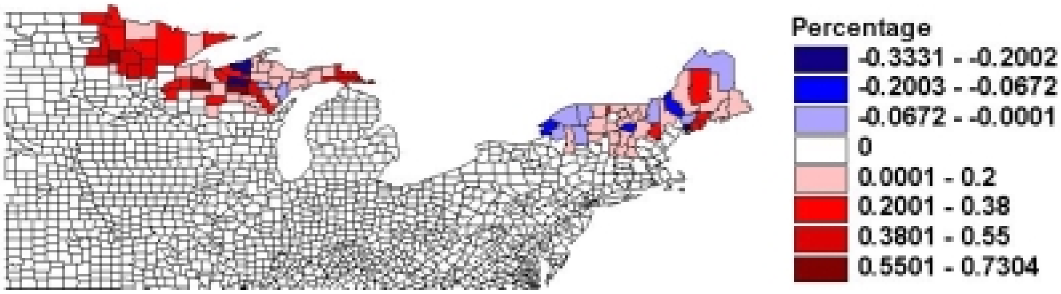


Figure 8 – Employment Growth Rates in the Northern Forest Region



Data on interstate highway miles in 1999 were obtained from the U.S. Department of Transportation. There were no additions between 1990 and 1999 to the interstate highway system in my set of counties; therefore, 1999 values are identical to 1990 values. All government tax and expenditure variables (TR, PE, PP, PM) are from Census of Governments (1992) and reflect 1992 values. Hausman specification tests indicate that these variables are not endogenous (Appendix 1). Finally, key data sources for the other variables are USA Counties, County Business Patterns, and the City & County Data Book, all publications of the U.S. Bureau of the Census. The Regional Economic Information System is a product of the U.S. Bureau of Economic Analysis.

Table 3. Variable Descriptions and Data Sources

Variable	Description (Year)	Data Source
NM	Net Migration Rate (‘90 – ‘97)	USA Counties
CE	% Change in Employment (‘90 – ‘97)	County Business Patterns
PDL	Population Density per sq. mi. (‘90)	City & County Data Book,
EDL	Employment Density per sq. mi. (‘90)	City & County Data Book,
TCO	Percentage of Total County Land in Conservation (‘90,’99)	State/Federal Land Mgmt. Agencies
MU	Percentage of Total County Land in Multiple-Use Conservation (’90,’99)	State/Federal Land Mgmt. Agencies
PR	Percentage of Total County Land in Preservationist Uses (’90,’99)	State/Federal Land Mgmt. Agencies
NF	Percentage of Total County Land in National Forest (’90)	US Forest Service
SF	Percentage of Total County Land in State Forests (’90, ’99)	State Land Mgmt. Agencies
NFT	Percentage Decline in National Forest Timber Sales in County (’83-’89) to (’90-’96)	US Forest Service – Cut and Sold Reports
PH	Percentage of people who own their own homes (‘90)	City & County Data Book
TR	Ratio of Local Gov’t Expenditures to Local Taxes (‘92)	USA Counties
PE	Percentage of Gov’t Expenditures on Education (‘92)`	USA Counties
PP	Percentage of Gov’t Expenditures on Police Protection (‘92)	USA Counties
PM	Percentage of Gov’t Expenditures on Health and Hospitals (‘92)	USA Counties
I	Median Household Income (‘90) (Thousands of Dollars)	City & County Data Book
PD	Percentage of Personal Income from Dividends (‘90)	Regional Economic Information System
SC	Percentage of People > 25 who graduated from High School (‘90)	City & County Data Book
UE	Unemployment Rate (‘90)	City & County Data Book
PF	Percentage of County Employment in Forest Products (‘90)	County Business Patterns
IH	Interstate Highway Miles per Sq. Mi. (‘99)	U.S. Dept. of Transportation
CT	Dummy (1= City > 25K, 0= none)	City & County Data Book
UA	Dummy (1= Adjacent to Urban, 0= no)	City & County Data Book
ES	Dummy (1= Destination Ski Area in northeast, 0= no)	Ski Magazine
SH	Dummy (1=Shoreline presence, 0=no)	
States	State Dummy variables	

Table 4. Summary Statistics for Variables Used in this Study

	Mean	St Dev	Min	Max
Net Migration Rate (NM)	0.036	0.064	-0.158	0.22
Job Growth Rate (CE)	0.157	0.182	-0.333	0.73
Pop Dens (PDL)	32.7	28.7	2.7	133.5
Emp Dens (EDL)	10.0	11.4	0.4	66.7
% Cons. Land (TCO)	0.205	0.192	0	0.816
% Multiple-Use Cons (MU)	0.149	0.167	0	0.55
% Preservationist (PR)	0.057	0.107	0	0.715
% Nat Forest Land (NF)	0.073	0.119	0	0.502
% State Forest Land (SF)	0.078	0.121	0	0.549
Change in NF Timber (NFT)	-0.015	0.047	-0.302	0
% Income Dividend (PD)	0.057	0.045	0.124	0.373
% Own Home (PH)	75.428	5.122	59.3	84.5
Local Gov Exp / Taxes (TR)	3.042	1.458	0.949	8.187
Median Income (I)	23.52	3880	16307	31948
% High School Grad (SC)	75.249	4.489	64.1	84.9
Unemployment Rate (UE)	8.325	2.445	3.3	19.8
Int. Hwy Mile Density (IH)	0.011	0.023	0	0.09
% Jobs in Forest Prod (PF)	0.105	0.113	0	0.708
% Gov Exp on Educ (PE)	0.502	0.112	0.242	0.744
% Gov Exp on Police (PP)	0.033	0.031	0.004	0.302
% Gov Exp on Medical (PM)	0.056	0.082	0.001	0.515

ESTIMATION / STATISTICAL TESTING

Procedures / Testing

The equation system (3)-(4) was estimated using a three-stage least squares (3SLS) procedure. 3SLS is a consistent estimator for systems of simultaneous equations and is more efficient than generalized least squares because it accounts for cross-equation correlation of the error terms. Heteroskedasticity is often present in studies with cross-sectional data and I use White's (1980) test to evaluate the null hypothesis of homoskedasticity against the alternative that the errors have a general heteroskedastic structure. I failed to reject the null at the 5% level for each of the model equations, as reported in tables below.

Given my use of cross-sectional data, I also test for spatial autocorrelation of the residuals. A potential source of spatial autocorrelation is cross-county effects of conservation lands on employment and net migration growth, since I model only within-county effects of conservation lands. I first test for spatial variation of the mean of the estimated error terms (1st order effects) using a spatial averaging variable,

$$\mu_i = \frac{\sum_j w_{ij}\hat{e}_i}{\sum_j w_{ij}}$$

where w_{ij} takes the value 1 if the *i*th observational unit borders the *j*th unit and is 0 otherwise, and $\hat{e}_i$ is the estimated residual for the *i*th unit. Results are plotted in GIS maps in Appendix 3. Spatial averages typically yield a smoother picture of spatial variation than a map of raw data and serve to highlight broad regional trends (Bailey and Gattrell 1995). There are no first order effects found in the residuals.

To explore spatial autocorrelation amongst the residuals (2nd order effects), I compute Moran's *I* statistic,

$$I^{(k)} = \frac{n \sum_{i=1}^{n}\sum_{j=1}^{n} \hat{e}_i \hat{e}_j w_{ij}^{(k)}}{\sum_{i=1}^{n} \hat{e}_i^2 \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}^{(k)}}$$

where *n* is the number of observations, $w_{ij}^{(k)}$ takes the value 1 if the *i*th observational unit borders the *j*th unit at the *k*th spatial lag and is 0 otherwise, and $\hat{e}_i$ is the estimated residual for the *i*th unit. Moran's *I* ranges in value from +1, (strong positive autocorrelation) to –1 (strong negative autocorrelation), and a 0 value indicates no spatial autocorrelation. The computed values are small (less than 0.05 in absolute value) for each equation and one through five spatial lags. With a null hypothesis of no spatial autocorrelation, I fail to reject the null at the 5% level for each equation and spatial lag (see Appendix 3 for full description).

Estimation Results

The 3SLS estimates of (3) and (4) indicate that the equations explain approximately 50 % and 32 % of the variation in net migration and employment growth rates, respectively (Table 5). The coefficients on CE and NM are significantly different from zero at the 5% level and indicate the interdependence of migration and employment growth. The coefficient estimates reveal that a 5 % increase in job growth yields roughly a 1 % increase in net migration rates, and that a 1 % increase in net migration rates yields approximately a 1 % increase in job growth rates. These findings are consistent with those in previous regional economics studies (e.g., Greenwood et al. 1986; Carlino and Mills 1987) and support the notion that migration stimulates job creation, rather than the other way around.

In the net migration equation, five of the coefficients on the exogenous variables (PDL, TCO, PH, TR, and PM) are significantly different from zero at the 5% level. Of particular interest is the positive sign on the TCO variable, indicating that counties with more conservation land in 1990 experienced higher net migration over the following seven-year period. One explanation is that people view conservation land as an amenity, and conservation land has the effect of attracting or retaining people in a county. The magnitude of the coefficient suggests that, all else equal, counties with a 10% greater share of conservation land (i.e., TCO is higher, in absolute terms, by 0.10) experience 1% higher net migration rates (i.e., NM is higher, in absolute terms, by 0.01). Comparative statics results discussed later in this publication should also be interpreted in terms of absolute changes.

The negative sign on the expenditure-to-tax ratio variable (TR) 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). 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 effects and suggest that migrants are attracted to counties with higher percentages of people who own their own home (PH) and higher government expenditures on health and hospitals (PM). Net migration rates are also higher in counties with larger population densities (PDL). The remaining coefficient estimates are not significantly different from zero at the 5% level, indicating that the corresponding variables are not important in explaining cross-county variation in rates of net migration. These variables include interstate highway miles (IH), income (I), expendures on education (PE) and police (PP), adjacency to a metropolitan county (UA), a relative large city (CT), and the shoreline dummy (SH). As well, none of the coefficients for the state dummies are significantly different from zero, indicating no shift in the intercept term relative to the omitted state (Minnesota).

Table 5. Estimation Results for Net Migration and Employment Growth Rate Equations

	Net Migration		*Employment*	
	Coefficient	*t-stat*	*Coefficient*	*t-stat*
Intercept	-0.291	-2.12	0.241	0.60
Net Migration (NM)			1.05**	1.98
Employment Change (CE)	0.189**	2.32		
Pop Dens / Sq. Mi. (PDL)	0.0008**	2.60		
Emp Dens / Sq.Mi. (EDL)			-0.0020	-0.99
Conservation Land (% of county) (TCO)	0.098***	2.65	-0.050	-0.44
% of People Who Own Home (PH)	0.005***	4.15		
Interstate Hwy Mile / Sq. Mi. (IH)	0.033	0.13	-0.108	-0.12
Median Family Income (I)	-0.0035	-1.39		
% of People Grad from High Sch. (SC)			-0.002	-0.36
Unemployment Rate (UE)			0.003	0.39
% of Income from Dividends (PD)			0.139	0.32
% of Emp. In Forest Products (PF)			-0.296**	-2.12
Gov Expend / Taxes (TR)	-0.019***	-2.77	-0.004	-0.19
Percent of Expend. On Education (PE)	-0.031	-0.38	0.363*	1.77
Percent of Expend. On Police (PP)	-0.148	-1.05		
Percent of Expend. On Medical (PM)	0.168**	2.06		
Adjacent to Metropolitan County (UA)	-0.017	-1.61	0.026	0.78
City > 25k in County (CT)	0.024	1.05	-0.023	-0.32
Destination Ski Area (ES)			0.026	0.57
Maine	-0.025	-0.59	-0.221**	-2.41
New Hampshire	-0.004	-0.10	-0.222*	-1.92
Vermont	0.021	0.43	-0.307***	-3.04
New York	-0.012	-0.26	-0.272***	-2.79
Michigan	-0.047	-1.29	-0.161**	-2.18
Wisconsin	0.036	1.41	-0.137**	-2.44
Shoreline (SH)	0.011	0.91		
Adj R^2	0.497		0.324	
F Value	5.728		3.291	
Prob>F	0.0001		0.0001	
White	92		92	
	0.451		0.451	

Note: Since I anticipate positive coefficients on the endogenous variables (NM and CE), confidence intervals for these coefficients are based on a one-tailed test; all others are based on a two-tailed test.
* Significant at the 10% level
** Significant at the 5% level
*** Significant the 1% level

In the employment growth equation, eight of the coefficient estimates on the exogenous variables (PF, PE, and the six state dummies) are significantly different from zero at the 10% level or higher. Employment growth was lower, all else equal, in counties with a higher percentage of forest products employment (PF). As indicated in Table 4, in some counties as much as 70% of all employment is in forest products. At least over the period 1990 to 1997, fewer jobs were created in counties highly dependent on this industry. Educational spending is also found to have a significant effect on employment growth. Counties with a higher share of total expenditures allocated to education (PE) experienced higher job growth, all else equal. Finally, all of the coefficients on the state dummies are negative and significantly different from zero, indicating systematically lower employment growth in the counties of Maine, Michigan, New Hampshire, New York, Vermont, and Wisconsin compared to the counties of Minnesota.

The remaining variables in vector B did not have a significant effect on the rate of employment growth during the period analyzed. These variables include the 1990 employment density (EDL), interstate highway miles (IH), high school graduation rate (SC), unemployment rate (UE), income from dividends (PD), the ratio of government expenditures to taxes (TR), adjacency to a metropolitan county (UA), presence of a relatively large city (CT), and presence of a destination ski resort (ES). In addition, the percentage of the county in conservation land (TCO) did not have a significant effect on employment growth. It should be noted, however, that the coefficients in the employment growth equation measure direct effects of the exogenous variables on employment. As I will discuss in more detail, conservation land indirectly affects employment growth through its effect on population growth.

Effects of Conservation Land on Migration and Employment (Model I)

In examining the direct effects of conservation land (and other exogenous variables) on net migration and employment growth, I found that conservation land has a direct and positive effect on net migration rates, but no significant direct effect on employment growth. Since net migration and employment growth are determined simultaneously in my systems of equations, I can also measure indirect effects of conservation land. For instance, since employment growth depends positively on net migration, I can determine how conservation land affects employment growth by increasing net migration rates. Moreover, I can determine the total (reduced-form) effect of conservation lands. Derivations and the procedure used to compute standard errors of the indirect and total effects are reported in Appendix 2.

The indirect effect of conservation land on employment growth is positive and significantly different from zero at the 10% level (Table 6). In this case, conservation

Table 6. Effects of Conservation Lands on Net Migration and Employment Growth

	Net Migration	Employment
Direct	0.098**	-0.050
	(2.65)	(-0.44)
Indirect	-0.009	0.103*
	(-0.44)	(1.64)
Total	0.111**	0.067
	(2.60)	(0.55)

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

lands increase net migration to a county, which increases employment growth. The magnitude of the estimate indicates that a 10% (absolute) increase in the county share of conservation land yields a 1% (absolute) increase in the employment growth rate, all else equal. The indirect effect of conservation land on net migration is not significantly different from zero; however, the total (reduced-form) effect is significant at the 5% level. The estimate indicates that the total effect of an approximate 10% increase in the county share of conservation land is a 1 % increase in net migration rates, all else equal. The total effect of conservation land on employment growth is not significantly different from zero.

Effects of Multiple-Use and Preservationist Lands (Model II)

I also investigate the different effects of preservationist and multiple-use lands on net migration and employment growth. As stated earlier, the equation system (3)-(4) is estimated with 3SLS, except that the total conservation land variable (TCO) is split into the percentage of total land in preservation uses (PR) and multiple-uses (MU). This will be referred to as model II. The results are very similar to those for the original model, so I focus only on the estimates of the coefficients on PR and MU.

Between 1990 and 1997, neither preservationist nor multiple-use lands had a significant effect on employment growth (Table 7). This result is consistent with the finding reported above that conservation lands as a whole had no effect on employment growth (Table 5). In contrast, in the net migration equation, the coefficient on the multiple-use variable (MU) is positive and significantly different from zero at the 5% level. The coefficient on the preservationist land variable (PR) is also positive, but not significantly different from zero. These results indicate that the positive (direct) effect of conservation lands on net migration (Table 5) is attributable to multiple-use lands rather than preservationist lands.

Table 7. Estimation Results for Net Migration and Employment Growth Rate Equations with Multiple-Use and Preservationist Land Variables

	Net Migration		*Employment*	
	Coefficient	t-stat	Coefficient	t-stat
Intercept	-0.301	-2.19	0.272	0.67
Net Migration (NM)			0.915**	1.71
Employment Change (CE)	0.177**	2.15		
Pop Dens / Sq. Mi. (PDL)	0.001**	2.57		
Emp Dens / Sq.Mi. (EDL)			-0.002	-1.11
Multiple-Use Land (MU)	0.106**	2.62	0.010	0.08
Preservationist Land (PR)	0.071	1.05	-0.202	-0.96
% of People Who Own Home (PH)	0.006***	4.31		
Interstate Hwy Mile / Sq. Mi. (IH)	0.049	0.20	-0.084	-0.10
Median Family Income (I)	-0.003591	-1.41		
% of People Grad from High Sch. (SC)			-0.002	-0.40
Unemployment Rate (UE)			0.002	0.32
% of Income from Dividends (PD)			0.251	0.56
% of Emp. In Forest Products (PF)			-0.312**	-2.22
Gov Expend / Taxes (TR)	-0.019**	-2.84	-0.007	-0.35
Percent of Expend. On Education (PE)	-0.032	-0.39	0.332	1.62
Percent of Expend. On Police (PP)	-0.169	-1.19		
Percent of Expend. On Medical (PM)	0.167**	2.03		
Adjacent to Metropolitan County (UA)	-0.016	-1.50	0.030	0.87
City > 25k in County (CT)	0.022	0.94	-0.038	-0.51
Destination Ski Area (ES)			0.021	0.45
Maine	-0.028	-0.66	-0.222**	-2.45
New Hampshire	-0.006	-0.13	-0.239**	-2.07
Vermont	0.019	0.39	-0.309***	-3.11
New York	-0.007	-0.15	-0.239**	-2.29
Michigan	-0.053	-1.43	-0.180**	-2.39
Wisconsin	0.034	1.34	-0.139**	-2.49
Shoreline (SH)	0.013	1.11		
Adj R^2	0.50		0.32	
F Value	5.48		3.16	
Prob>F	0.0001		0.0002	
White	92		92	
Prob>χ^2	0.451		0.451	

Note: Since I anticipate positive coefficients on the endogenous variables (NM and CE), confidence intervals for these coefficients are based on a one-tailed test; all others are based on a two-tailed test.
* Significant at the 10% level
** Significant at the 5% level
*** Significant the 1% level

Table 8. Effects of Multiple-Use and Preservationist Lands on Net Migration and Employment Growth

	Net Migration	Employment
Multiple-Use		
Direct	0.106**	0.010
	(2.62)	(0.08)
Indirect	0.002	0.097
	(0.07)	(1.48)
Total	0.128	0.127
	(2.86)**	(0.97)
Preservation		
Direct	0.071	-0.202
	(1.05)	(-0.96)
Indirect	-0.036	0.065
	(-0.86)	(1.04)
Total	0.042	-0.164
	(0.53)	(-0.72)

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

As I did earlier, I can compute the indirect and total effects of multiple-use and preservationist lands on net migration and employment growth (Table 8). None of the indirect effects of multiple-use lands are significantly different from zero; however, the total effect of multiple-use lands on net migration rates is significantly different from zero at the 5% level. The estimate indicates that an approximate 9% (absolute) increase in the county share of multiple-use lands increases (in absolute terms) net migration rates by 1%. The total effects of multiple-use lands are, thus, similar to the total effects for all conservation lands (Table 7). None of the effects of preservationist lands are significantly different from zero.

Effects of Increased Conservation Management On National Forest Lands (Model III)

The effects of increased conservation management on national forest lands is estimated on net migration and employment growth. As stated earlier, the equation system (3)-(4) is estimated with 3SLS, except that the total conservation land variable (TCO) is split into the percentage of total land in national forests (NF), state forests (SF) and preservationist lands (PR). In addition, a variable is introduced to proxy for the change in management on national forest lands (NFT). This model will be referred to as Model III. The regression results are very similar to those for the original models, so I focus only on the estimates of the coefficients on NF, SF, PR and NFT.

Between 1990 and 1997, changing national forest timber sales had no impact on either net migration or employment growth rates (Table 9). In the net migration equation, the coefficient on the state forest variable (SF) is positive and significantly different from zero at the 5% level. SF is negative, but not significantly different from zero in the employment growth equation. The coefficient on the preservationist (PR) and national forest (NF) variables are also positive, but not significantly different from zero in either the net migration or the employment growth equations.

As done previously, I calculate the reduced form effects of all the conservation variables (NF, SF, PR, NFT) on net migration and employment (table 10). The coefficients on the national forest and state forest variables are both positive and significantly different from zero at the 5% level in the migration equation, indicating a positive amenity effect of both national and state forests on households. The national forest variable is also positive and significantly different from zero in the employment equation, although the significance level is 10% rather than 5%.

Table 9 - Estimation Results for Net Migration and Employment Growth Rate Equations with Change in National Forest Timber Sales

	Migration		Employment	
	Coefficient	*t-stat*	*Coefficient*	*t-stat*
Intercept	-0.316	-2.24	0.386	0.95
Net Migration (NM)			0.799*	1.47
Employment Change (CE)	0.166**	1.99		
Pop Dens / Sq. Mi. (PDL)	0.001***	2.76		
Emp Dens / Sq. Mi. (EDL)			-0.002	-1.27
National Forest (% of county) (NF)	0.084	1.56	0.173	1.07
State Forest (% of county) (SF)	0.136**	2.55	-0.131	-0.75
Preservation (% of county) (PR)	0.100	1.42	-0.322	-1.50
Change in Nat Forest Timber (NFT)	-0.045	-0.38	0.329	0.85
% of People who own Home (PH)	0.006***	4.23		
Interstate Hwy Mile / Sq. Mi. (IH)	0.056	0.22	-0.158	-0.19
Median Family Income (I)	-0.000004	-1.56		
% of People Grad from High Sch. (SC)			-0.002	-0.47
Unemployment Rate (UE)			0.002	0.29
% of Income from Dividends (PD)			0.233	0.51
% of Emp. In Forest Products (PF)			-0.334**	-2.37
Gov Expend / Taxes (TR)	-0.019***	-2.74	-0.014	-0.71
Percent of Expend. On Education (PE)	-0.015	-0.19	0.281	1.38
Percent of Expend. On Police (PP)	-0.167	-1.15		
Percent of Expend. On Medical (PM)	0.177**	2.10		
Adjacent to Metropolitan County (UA)	-0.017	-1.50	0.036	1.05
City > 25k in County (CT)	0.026	1.10	-0.058	-0.80
Destination Ski Area (ES)			0.031	0.63
Maine	-0.030	-0.68	-0.241***	-2.70
New Hampshire	-0.004	-0.08	-0.275**	-2.39
Vermont	0.018	0.34	-0.330***	-3.35
New York	-0.014	-0.28	-0.239**	-2.31
Michigan	-0.054	-1.45	-0.204***	-2.72
Wisconsin	0.038	1.36	-0.174***	-2.94
Shoreline (SH)	0.014	1.10		
Adj R^2	0.485		0.327	
F Value	4.89		3.01	
Prob > F	0.0001		0.0003	
White	0.451		0.451	

Note: Since I anticipate positive coefficients on the endogenous variables (NM and CE), confidence intervals for these coefficients are based on a one-tailed test; all others are based on a two-tailed test.
* Significant at the 10% level
** Significant at the 5% level
*** Significant the 1% level

Perhaps most striking is the insignificance of the national forest timber sales variable in both the migration and employment equations. This finding indicates that declining timber harvests on national forest lands has no effect on county-level employment or migration growth rates. The coefficient of preservationist lands is again insignificant in both equations.

It is possible that the effect I find for the various measures of conservation land on county employment growth may be a statistical artifact of including the measure of significance of the forest products industry (FP) in the model. It is possible that the conservation land measures are indirectly affecting county employment growth rates through their effect on FP. To test for such an effect, I re-estimated each of the three models excluding FP. The results for each parameter estimate related to conservation land measures are not impacted in either their magnitude or their statistical significance.

I also re-estimated Model III adding an interaction effect for timber sales and FP (i.e., FP*NFT). If the impact of timber sales (the “natural experiment”) on county job growth rates is operating through FP, then the coefficient on the interaction term should be negative and significantly different from zero. The estimated coefficient is –2.14 with a standard error of 2.95, implying insignificance at the 5% level. None of the other coefficients in the model are affected either in magnitude or in statistical significance. I conclude that the negative employment effect of the FP variable is related to some factor other than inter-county variation in timber sales or conservation lands that lowered job growth rates during the 1990 to 1997 time period in the forest products industry. An example would be the substitution of capital for labor.

Table 10- Effects of National Forest, State Forest, Preservationist lands and National Forest Timber Sales on Migration and Employment

	Migration	Employment		Migration	Employment
National Forest			State Forests		
Direct	0.084	0.173	Direct	0.136**	-0.131
	(1.56)	(1.07)		(2.55)	(-0.75)
Indirect	0.029	0.067	Indirect	-0.022	0.109
	(0.94)	(1.08)		(-0.71)	(1.29)
Total	0.130**	0.277*	Total	0.132**	-0.026
	(2.58)	(1.73)		(2.38)	(-0.15)
Preservation			NF Timber		
Direct	0.100	-0.322	Direct	-0.045	0.329
	(1.42)	(-1.50)		(-0.38)	(0.85)
Indirect	0.079	-0.054	Indirect	-0.036	0.055
	(1.04)	(-1.44)		(-0.37)	(0.79)
Total	0.053	-0.280	Total	0.011	0.338
	(0.68)	(-1.22)		(0.09)	(0.82)

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

DISCUSSION

The growth rate model measures how public lands affected county net migration and employment growth between 1990 and 1997. The interpretation of the results depends on the timing of the adoption of conservation practices on these lands. In the case of lands that were managed for conservation uses long before 1990 (chiefly, lands defined above as preservationist), the model does not capture employment and population changes associated with the adoption of conservation management. For instance, the results would not capture the decline in employment depicted in Figure 2 since the adjustment to the adoption of conservation practices was complete before 1990. On the other hand, it is possible that the *stock* of conservation land deters or promotes future changes in population and employment. For instance, people increasingly have the option of telecommuting and may be more attracted to counties with conservation lands. My model would capture such an effect of conservation lands on migration rates.

Interpretation of the results is different for lands on which conservation practices were adopted around 1990 (chiefly, lands managed as national forests). In this case, my model measures the effects of *changes* in management practices on population and employment over the period 1990 to 1997. In terms of Figure 2, I would be able to capture at least some of the drop in employment associated with the establishment of conservation lands. To be precise, I've included a variable to proxy for the change in national forest conservation management into both the net migration and employment growth equations. This variable allows me to precisely measure the establishment of new conservation lands by using a proxy of changing national forest conservation management. In addition, my model would capture effects from the stock of national forest land as mentioned earlier. From a policy perspective, the important distinction between the two sets of results is that the latter provides insights into how population and employment would be affected by the establishment of new conservation lands, whereas the former does not.

I first evaluate the effects of all public conservation lands (preservationist and multiple-use lands combined). Conservation land is found to have a positive effect on net migration rates in the Northern Forest region between 1990 and 1997. The total effect indicates that, in absolute terms, counties with a 1% greater share of conservation land had 0.09% higher net migration rates, all else equal. To put these results in perspective, consider Hancock and Piscataquis counties in Maine, where Acadia National Park and

Baxter State Park, respectively, are found. Between 1990 and 1997, the net migration to Hancock and Piscataquis counties was approximately 2,600 and –200 people, respectively. My results indicate that had there been 10,000 fewer acres of conservation land in Hancock County, the net gain in population would have been lower by 41 persons. In this case, Piscataquis County would have lost an additional 6 persons. The total effect of conservation land is largely due to the direct effect on net migration. People may view conservation land as an amenity, and this has a positive effect on their decision to migrate to, or remain in, a county.

I find that the total effect of public conservation land on employment growth is positive, but not significantly different from zero. The indirect effect of conservation land on employment growth is positive and significantly different from zero, indicating that these lands increase employment by increasing net migration. The direct effect on employment growth is negative, but not significantly different from zero, and when the direct and indirect effects are combined, the resulting total effect is not significantly different from zero. In other words, over the period 1990 to 1997, I found no systematic differences in the employment growth rates of counties in the Northern Forest region attributable to conservation lands. One explanation is that conservation lands simply had no effect on employment growth. Another possibility is that they had counterveiling effects (e.g., a decline in employment in the wood products sector and an increase in the tourism sector) that, on net, were zero.

Examination of the separate effects of multiple-use and preservationist lands allows me to sort out the effects of different management programs on public conservation lands. I find that preservationist lands have no significant effects on either net migration or employment growth rates. This result is consistent with my expectation that adjustments to the adoption of conservation management on preservationist lands were completed before 1990. As discussed earlier, the last major tract of preservationist land to be added in the region was Voyageurs National Park, established in 1975. My results also indicate no effects from the stock of preservationist land over the 1990 to 1997 period. In particular, I did not find evidence of greater migration to counties with more preservationist lands. One explanation is that population shifts occurred prior to 1990. Another possibility is that preservationist lands appeal more to vacationers seeking multiple-day wilderness experiences than to potential migrants. For instance, this is likely the case with the Boundary Waters Wilderness Area in Minnesota and Baxter State Park in Maine.

Multiple-use lands are found to have a positive effect on net migration rates and no significant effect on employment growth. The finding of a positive effect on migration suggests that multiple-use lands provide amenity values to potential migrants. In contrast to many preservationist lands, national and state forests have better vehicular access and offer a greater range of day-use activities. This is a possible explanation for why I find a positive effect of multiple-use lands on migration and no significant effect of preservationist lands. Another explanation is that net migration may reflect a response to the recent conservation management changes on some of these lands, particularly national forest lands.

In the third model, the results are clarified as I examine the effects of increasing national forest conservation management as well as the differential effects of the stock of national and state forest lands in a county. National and state forests are managed for multiple uses, including timber harvesting. The distinction between the two is the policy change on national forests in the early 1990s that decreased timber sales and increased the amount of conservation management on national forests. Both national and state forests were found to have positive effects on net migration rates, reinforcing the notion that both national and state forests provide amenities to potential migrants. However, national forests were found to have a positive effect on employment growth rates whereas the effect of state forests was not found to be significantly different from zero. The total effect indicates that, in absolute terms, counties with a 1% greater share of conservation land had 0.27% higher job growth rates, all else equal. To put these results in perspective, consider Grafton county in New Hampshire, where just under 1/3 of the land base is owned by the White Mountain National Forest. Between 1990 and 1997, the net increase in employment to Grafton county was 8,119 jobs. My results indicate that had there been 10,000 fewer acres of conservation land in Grafton County, the net gain in employment would have been lower by 87 jobs. However, the positive effect of national forest land on jobs is only significant at the 10% level, so the effect on jobs should be considered with lower confidence.

Examination of the effects of increased conservation management on national forest lands is examined by including a variable that measures the change in timber sales on these lands (NFT). Since the decline in timber sales on national forest lands is due to a national policy (see chapter two) and not simply to market fluctuations, this decline is assumed to proxy for increasing the amount of conservation land in a county. This allows me to measure the effects of *designating new* conservation land rather than the effects of the *presence* of conservation lands.

Econometric results indicate that increased conservation management on national forest lands has had no statistically significant effect on either migration or employment growth rates. These findings are consistent with studies for other regions. Burton and Berck (1996) apply Granger causality tests to forest sector data for Oregon and find no causal relationship between national forest harvests and forestry employment. Further, Burton (1997) finds that in Oregon neither national forest harvests nor sales explain employment transitions between the forestry sector and other sectors. In a study of western Montana, Daniels et al. (1991) found that national forest harvests do little to stabilize employment. My findings yield insights into the impact that setting aside land for conservation may have on a county's migration and employment growth. In the case of the northern forest region, there is no evidence supported by this study that the designation of new conservation lands will have either a positive or negative effect on county-level migration and employment growth.

The finding that changing conservation management on national forest lands had no significant effect on employment growth is striking in light of the large decline in timber sales occurring in the early 1990s. As suggested above, it is possible that declines in wood products employment are offset by employment gains in other sectors, such as tourism. It is also important to recognize that wood products firms are ultimately concerned about prices for timber, and not about flows of timber in physical terms. While the two are obviously connected, there are many factors that mitigate the effect on price of a decline in timber harvests, including increased supplies from other regions and substitution of other inputs for timber. Whatever the explanation, I find no evidence that the adoption of conservation management on national forests had negative effects on employment in the Northern Forest region.

CONCLUSIONS

As the public's demand for non-commodity benefits of forests increases, so too will efforts to put more land in the Northern Forest region into publicly owned conservation uses. The debate over increasing the area of conservation land in the region often centers on the economic effects that conservation lands will have on rural counties. Property-rights advocates and forest industry representatives often claim there will be negative impacts on local economies, while environmental groups sometimes argue that the effects will be positive. In either case, objective evidence is rarely offered. In this study, I analyze available data to identify the effects that conservation lands had on net migration and employment growth in the region over the period 1990 to 1997.

My central finding is that public conservation lands have had little effect on recent growth of local economies in the region. Migration rates are systematically higher in counties with more conservation lands, but the effects are relatively small. Nevertheless, it appears that conservation lands offer amenity values attractive to potential migrants. In particular, my results indicate that migrants are more drawn to multiple-use lands such as national and state forests than to preservationist lands such as national parks and wilderness areas. Preservationist lands are found to have no effect on employment growth, most likely because conservation practices were adopted on these lands long before 1990. Decreased timber sales on national forest lands were also found to have no direct or indirect effect on employment, which is a significant finding given that timber sales declined by 41% in the New England forests and 22% in the Great

Lakes forests. This provides some evidence that the diversion of timberlands for conservation uses does not impact total employment in a county.

The decision to increase the amount of publicly owned conservation land in the Northern Forest region depends on the net benefits this provides to society as a whole as well as the distribution of benefits and costs among members of society. For instance, the ecological value of conservation lands would be a key input to the policy process, as would the value of increased recreational opportunities. In addition, an important consideration is the way in which conservation lands might transform the character of rural communities. The results of this study, however, suggest that economic development should not be the primary factor driving the decision process. I find no evidence that conservation lands have negatively impacted employment growth during the 1990s, despite the fact that national forest timber harvests declined considerably at the start of the decade. By the same token, I find little evidence that conservation lands should be viewed as a tool for promoting job growth in rural communities.

BIBLIOGRAPHY

Alverson, W., W. Kuhlmann and D. Walker. 1994. *Wild Forests: Conservation Biology and Public Policy,* Island Press, Washington, DC.

Bailey, T. and A. Gattrell. 1995. *Interactive Spatial Data Analysis.* Addison Wesley Longman Limited, Essex, England.

Barlowe, R. 1983. "Changing Land Use and Policies: The Lake States," in *The Great Lakes Forest: An Environmental and Social History,* Susan L. Flader (ed.), University of Minnesota Press, Minneapolis, MN.

Beeson, P. 1991. "Amenities and Regional Differences in Returns to Worker Characteristics," *Journal of Urban Economics* 30: 224-241.

Burton, D.M. 1997. "An Astructural Analysis of National Forest Policy and Employment," *American Journal of Agricultural Economics* 79: 964-974.

Burton, D.M. and P. Berck. 1996. "Statistical Causation and National Forest Policy in Oregon," *Forest Science* 42: 86-92.

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

Clark, D. and W. Hunter. 1992. "The Impact of Economic Opportunity, Amenities and Fiscal Factors on Age-Specific Migration Rates," *Journal of Regional Science* 32: 349-365.

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

Cubbage, F., J. O'Laughlin, and C. Bullock. 1993. *Forest Resource Policy,* John Wiley & Sons, Inc., New York, NY.

Daniels, S.E., W.F. Hyde, and D.N. Wear. 1991. "Distributive Effects of Forest Service Attempts to Maintain Community Stability," *Forest Science* 37: 245-260.

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

Evans, A. 1990. "The Assumption of Equilibrium and Disequilibrium in the Analysis of Migration and Interregional Differences: A Review of Some Recent Research," *Journal of Regional Science* 30: 515-531.

Gardocki, B. and J. Baj. 1985. “Methodology for Estimating Non-Disclosure in County Business Patterns,” Center for Governmental Studies, Northern Illinois University, De Kalb, IL.

Graves, P., and P. Mueser. 1993. "The Role of Equilibrium and Disequilibrium in Modeling Regional Growth and Decline: A Critical Reassessment," *Journal of Regional Science* 33: 69-84.

Greene, W. 1993. *Econometric Analysis.* Prentice-Hall, Englewood Cliffs, NJ.

Greenwood, M. and G. Hunt. 1984. “Migration and Interregional Employment Redistribution in the United States,” *American Economic Review* 74: 957-969.

Greenwood, M., G. Hunt, and J. McDowell. 1986. "Migration and Employment Change: Empirical Evidence on the Spatial and Temporal Dimensions of the Linkage," *Journal of Regional Science* 26: 223-234.

Griffiths, W., R. Hill, and G. Judge. 1993. *Learning and Practicing Econometrics*, John Wiley & Sons, Inc., New York, NY.

Hunt. G. 1993. “Equilibrium and Disequilibrium in Migration Modeling,” *Journal of Regional Science* 27: 341-349.

Irland, L. 1999. *The Northeast’s Changing Forest,* Harvard University Press, Cambridge, MA.

Knapp, T. and P. Graves. 1989. “On the Role of Amenities in Models of Migration and Regional Development,” *Journal of Regional Science* 29: 71-87.

Krutilla, J. 1967. "Conservation Reconsidered," *American Economic Review* 57: 778-786.

McGranahan, D. 1999. “Natural Amenities Drive Rural Population Change,” *Economic Research Service Report*, USDA No. 781.

Mueser P., and P. Graves. 1995. “Examining the Role of Economic Opportunity and Amenities in Explaining Population Redistribution,” *Journal of Urban Economics* 37: 176-200.

Perloff, H. and L. Wingo. 1964. “Natural Resource Endowment and Regional Economic Growth.” In *Regional Development and Planning: A Reader*. John Friedman & William Alonso (eds.), M.I.T. Press, Cambridge, MA.

Power, T. 1996. *Lost Landscapes and Failed Economies: The Search for a Value of Place,* Island Press, Washington, DC.

Roback, J. 1982. “Wages, Rents, and the Quality of Life,” *Journal of Political Economy* 90: 1257-1278.

Rudzitis, G. and H. Johansen. 1991. “How Important is Wilderness? Results from a United States Survey,” *Environmental Management* 15: 227-233.

Schneider, P. 1997. *The Adirondacks: A History of America’s First Wilderness*, Henry Holt & Co., New York, NY.

Shands, W. and R. Healy. 1977. *The Lands Nobody Wanted: Policy for National Forests in the Eastern United States.* The Conservation Foundation, Washington, DC.

Treyz, G., D. Rickman, G. Hunt, and M.Greenwood. 1993. “The Dynamics of U.S. Internal Migration,” *The Review of Economics and Statistics* 75: 209-214.

White, H. 1980. "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity," *Econometrica* 48: 817-828.

APPENDIX A. HAUSMAN SPECIFICATION TESTS

I use the Hausman test to test for the endogeneity of regressors (see Griffiths et al. 1993). Endogenous variables are contemporaneously correlated with the error term and the Hausman test involves comparing least squares estimates to instrumental variables estimates. The null hypothesis is that the estimates are the same, indicating a lack of correlation. In my case, the instrumental variables is the set of all remaining exogenous variables. The Hausman test statistic has an asymptotic chi-square distribution and all of the values in Table A1 below are less than the corresponding critical value at the 5% confidence level.

Table A1 – Hausman Specification Tests

	Net Migration	Employment
Conservation Land (% of county) ('90)	1.22	3.99
Interstate Hwy Mile / Sq. Mi. ('99)	0.11	1.23
Gov Expend / Taxes ('92)	0.22	3.98
Percent of Expend. on Education ('92)	2.4	3.2
Percent of Expend. on Police ('92)	1.09	
Percent of Expend. on Medical ('92)	2.27	
Change in Nat Forest Timber	0.067	0.197

APPENDIX B. INDIRECT AND TOTAL EFFECTS OF CONSERVATION LAND

The direct and indirect effects of conservation land on net migration are given, respectively, by,

$$\frac{\partial NM}{\partial TCO} = \hat{\alpha}_{TCO} \tag{A1}$$

$$\frac{\partial NM}{\partial TCO} = \frac{\partial NM}{\partial CE}\frac{\partial CE}{\partial TCO} = \hat{\alpha}_1\hat{\beta}_{TCO} \tag{A2}$$

where α_{TCO} and β_{TCO} are the parameter on TCO in (3) and (4), respectively, α_1 is the parameter on CE in (3), and hats indicate parameter estimates. The total (reduced-form) effect of conservation land on net migration is found by substituting the right-hand side of (4) into (3), collecting terms, and solving for,

$$\frac{dNM}{dTCO} = \frac{\hat{\alpha}_1\hat{\beta}_{TCO} + \hat{\alpha}_{TCO}}{1-\hat{\alpha}_1\hat{\beta}_1} \tag{A3}$$

where β_1 is the parameter on NM in (4). The effects of conservation land on employment growth are given by analogous expressions.

The indirect and total effects are functions of more than one estimated parameter and I compute standard errors for these functions using the delta method. In general, if A is a vector of estimated parameters and F(A) is a function of those parameters, then an estimate of the variance of F(A) is

$$\sigma_s^2 = [F_1(A),F_2(A),......,F_n(A)]'V(A)[F_1(A), F_2(A),.........,F_n(A)] \tag{A4}$$

where F_i is the derivative of F(A) with respect to the ith parameter and V(A) is the estimated covariance matrix for A.

APPENDIX C. SPATIAL ANALYSIS OF RESIDUALS

Given the inherent nature of cross-sectional data, I test for spatial autocorrelation of the residuals. A potential source of spatial autocorrelation is cross-county effects of conservation lands on employment and net migration growth, since I model only within-county effects of conservation lands. I first examine choropleth maps of the residuals for visual indications of spatial clustering for model I (Total Conservation Land), model II (Multiple-Use and Preservationist Lands) and model III (National Forest, State Forest, Preservationist Lands and National Forest Timber Harvests). Maps are found in figures C1 through C6.

Model I

Figure C1 – Model I Residuals (Net Migration Equation)

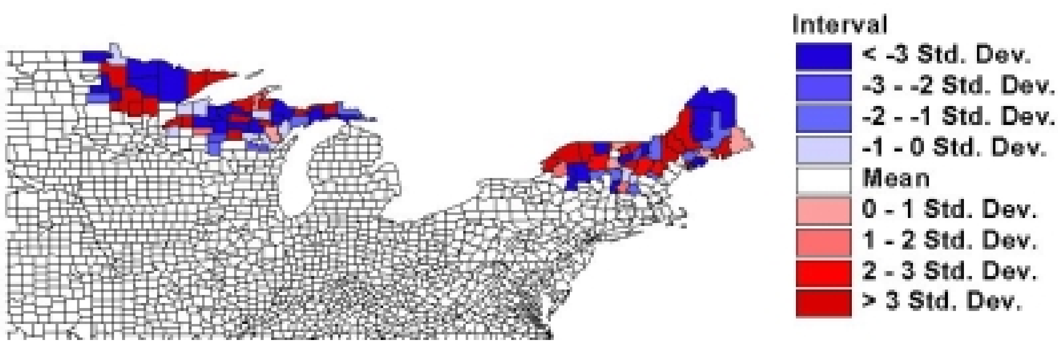
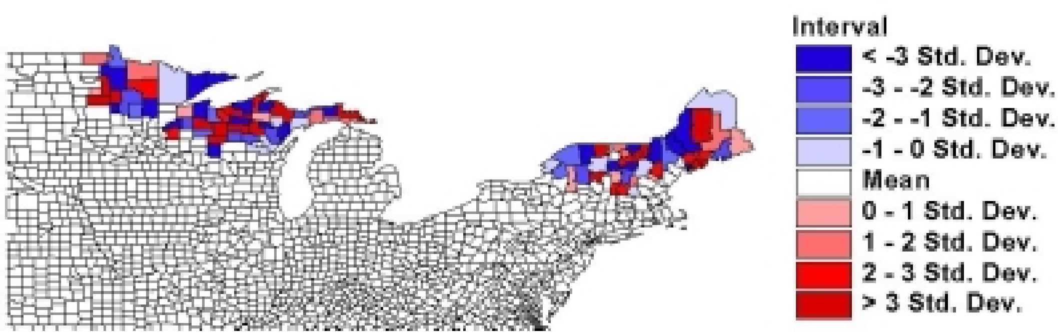


Figure C2 – Model I Residuals (Employment Growth Equation)



Visual inspection of the choropleth maps in figures C1 and C2 give little indication of spatial clustering of the residuals for either equation in Model I.

Model II

Figure C3 – Model II Residuals (Net Migration Equation)

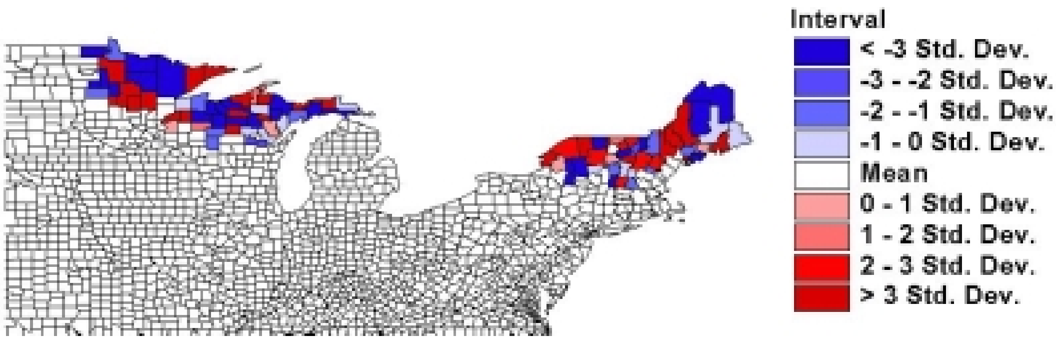
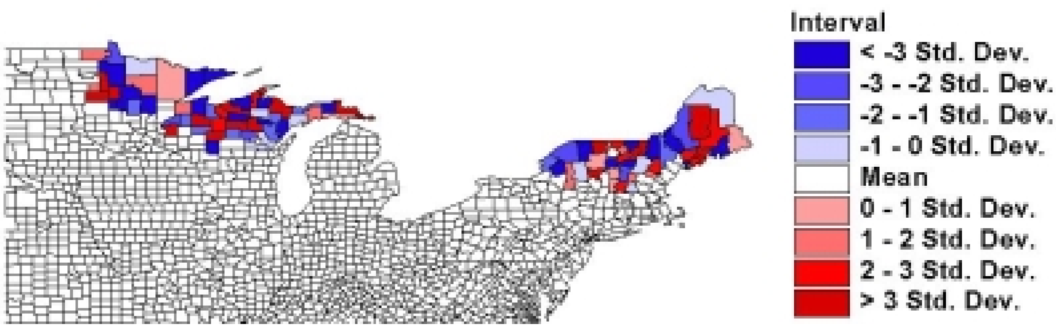


Figure C4 – Model II Residuals (Employment Growth Equation)



Visual inspection of the choropleth maps in figures C3 and C4 give little indication of spatial clustering of the residuals for either equation in Model II

Model III

Figure C5 – Model III Residuals (Net Migration Equation)

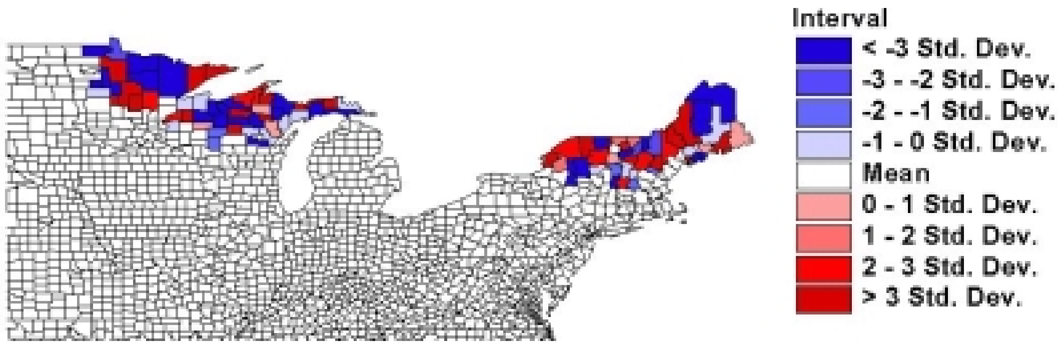
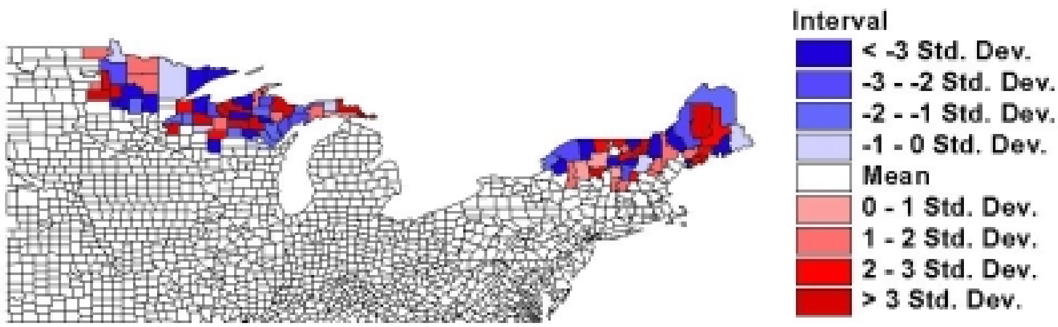


Figure C6 – Model III Residuals (Employment Growth Equation)



Visual inspection of the choropleth maps in figures C5 and C6 again give little indication of spatial clustering of the residuals for either equation in Model III

Next, I test for spatial variation in the mean of the estimated error terms (1st order effects) using a spatial averaging variable,

$$\mu_i = \frac{\sum_j w_{ij}\hat{e}_i}{\sum_j w_{ij}}$$

where w_{ij} takes the value 1 if the *i*th observational unit borders the *j*th unit and is 0 otherwise, and $\hat{e}_i$ is the estimated residual for the *i*th unit. Results are again plotted in choropleth maps found in figures C7 through C12. Spatial averages typically yield a smoother picture of spatial variation than a map of raw data and serve to highlight broad regional trends (Bailey and Gattrell 1995).

Model I

Figure C7 – Spatial Averaging of Residuals for Model I (Net Migration Equation)

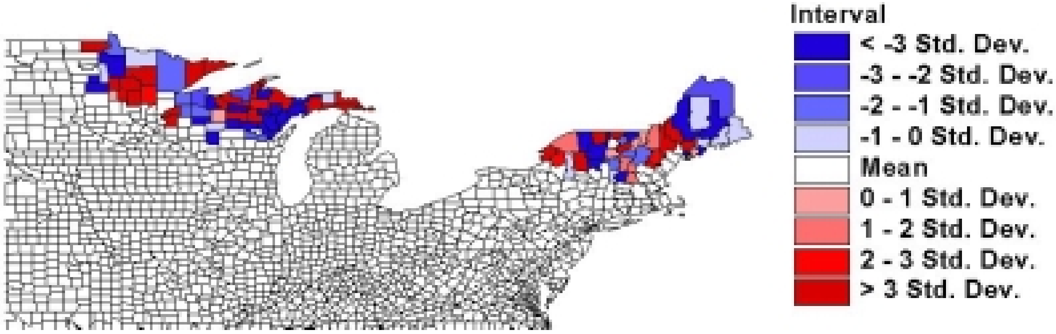
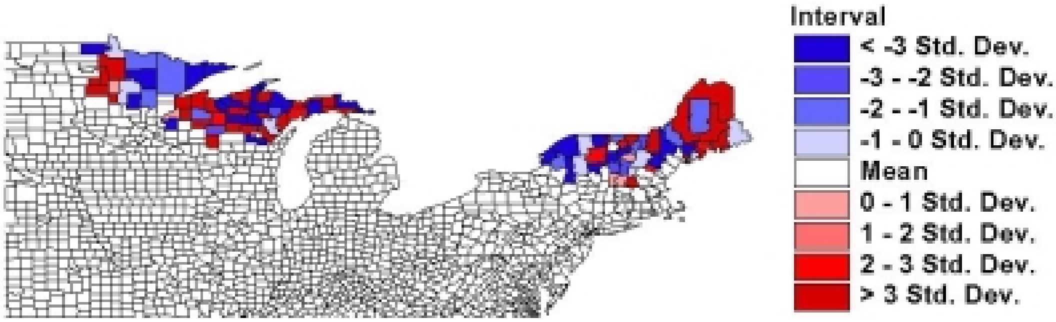


Figure C8 – Spatial Averaging of Residuals for Model I (Employment Growth Equation)



Visual examination of figures C7 and C8 yield no conclusive regional spatial trend in the residual terms. Therefore, I find no evidence of first order spatial effects that are not already accounted for in Model I.

Model II

Figure C9 - Spatial Averaging of Residuals for Model II (Net Migration Equation)

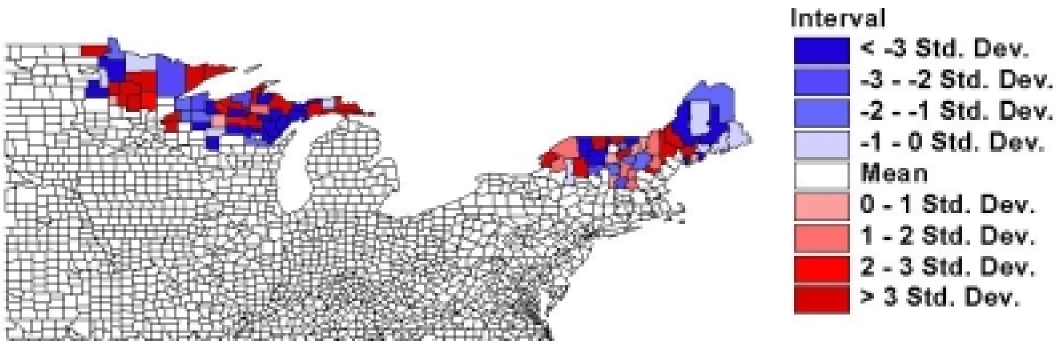
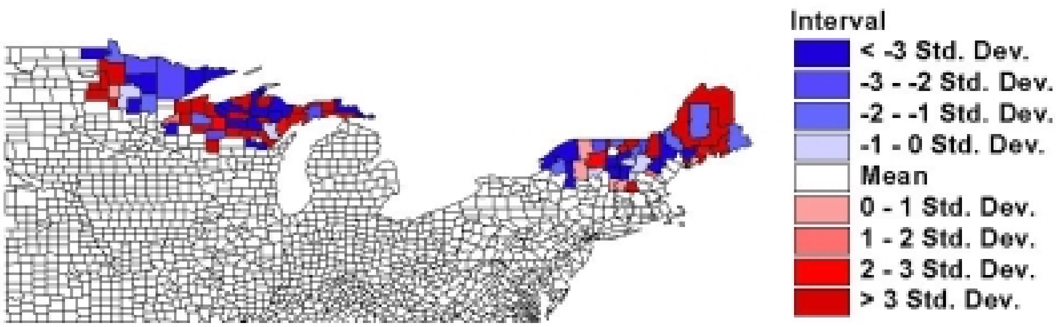


Figure C10-Spatial Averaging of Residuals for Model II (Employment Growth Equation)



Visual examination of figures C9 and C10 yield no conclusive regional spatial trend in the residual terms. Therefore, I find no evidence of first order spatial effects that are not already accounted for in Model II.

Model III

Figure C11 - Spatial Averaging of Residuals for Model III (Net Migration Equation)

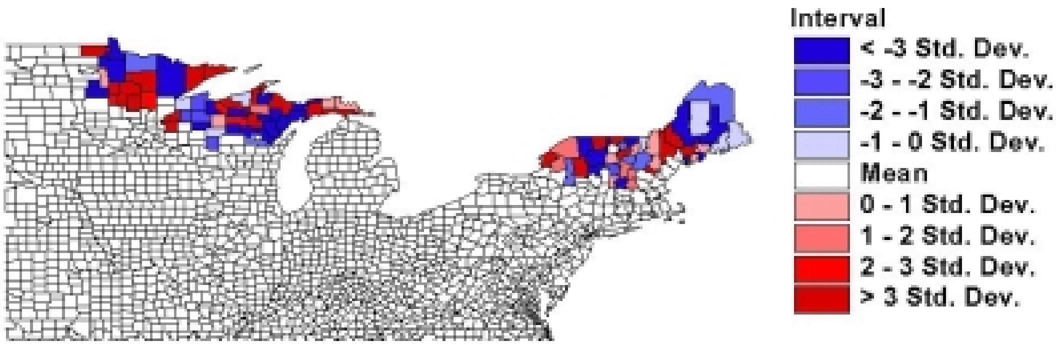
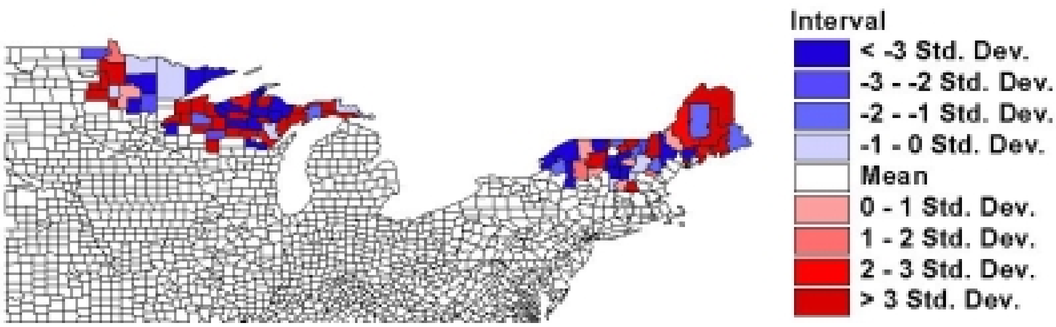


Figure C12-Spatial Averaging of Residuals for Model III(Employment Growth Equation)



Visual examination of figures C11 and C12 yield no conclusive regional spatial trend in the residual terms. Therefore, I find no evidence of first order spatial effects that are not already accounted for in Model III.

To explore spatial autocorrelation amongst the residuals (2nd order effects), I compute Moran's *I* statistic,

$$I^{(k)} = \frac{n \sum_{i=1}^{n} \sum_{j=1}^{n} e_i e_j w_{ij}^{(k)}}{\sum_{i=1}^{n} e_i^2 \sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}^{(k)}}$$

where *n* is the number of observations, $w_{ij}^{(k)}$ takes the value 1 if the *i*th observational unit borders the *j*th unit at the *k*th spatial lag and is 0 otherwise, and e_i is the estimated residual for the *i*th unit. Moran's *I* ranges in value from +1, (strong positive autocorrelation) to –1 (strong negative autocorrelation), and a 0 value indicates no spatial autocorrelation.

The statistical significance of Moran's I can be assessed through either normal approximation or randomization experiments. Given that the residuals ε_{1it} and ε_{2it} are assumed to have a normal distribution, it can be assumed that if the residuals are spatially independent, I has a sampling distribution which is approximately normal (Bailey and Gattrell 1995). The mean and variance of I are as follows:

$$E(I) = \frac{-1}{(n-1)}$$

$$Var(I) = \frac{n^2(n-1)S_1 - n(n-1)S_2 - 2S_0^2}{(n+1)(n-1)S_0^2}$$

where:

$$S_0 = \sum_{i \neq j} w_{ij}$$

$$S_1 = \frac{1}{2}\sum_{i \neq j} (w_{ij} + w_{ji})^2$$

$$S_2 = \sum_k \left(\sum_j w_{kj} + \sum_i w_{ik}\right)^2$$

Estimates of Moran's I along with corresponding test results are presented below for each model.

Model I

Figure C13 – Moran's I for 5 spatial lags for Model I (Net Migration Equation)

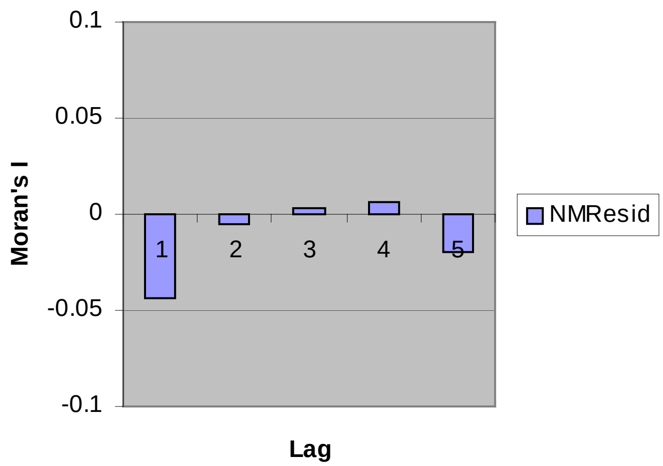
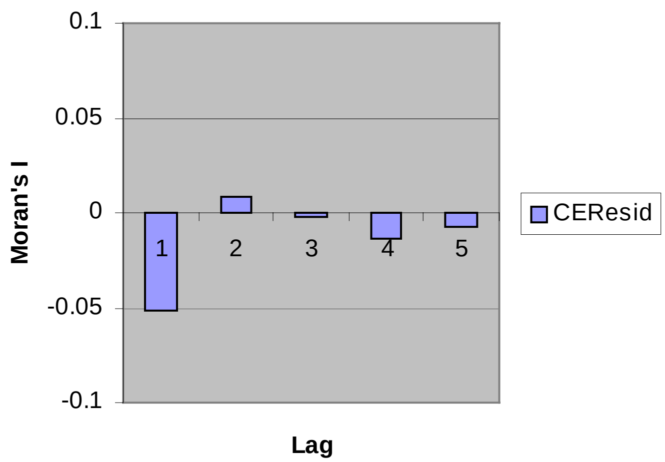


Figure C14 - Moran's I for 5 spatial lags for Model I (Employment Growth Equation)



The computed values are small (less than 0.05 in absolute value) for each equation and one through five spatial lags.

Table C1 – Test Statistics for Moran's I (Model I)

Lag	NM Equation	CE Equation
1	-0.443	-0.547
2	0.080	0.271
3	0.190	0.119
4	0.231	-0.033
5	-0.124	0.049

The test statistics have a z distribution and I fail to reject the null hypothesis of no spatial autocorrelation amongst the residuals for both equations and at all five spatial lags for model one.

Model II

Figure C15 - Moran's I for 5 spatial lags for Model II (Net Migration Equation)

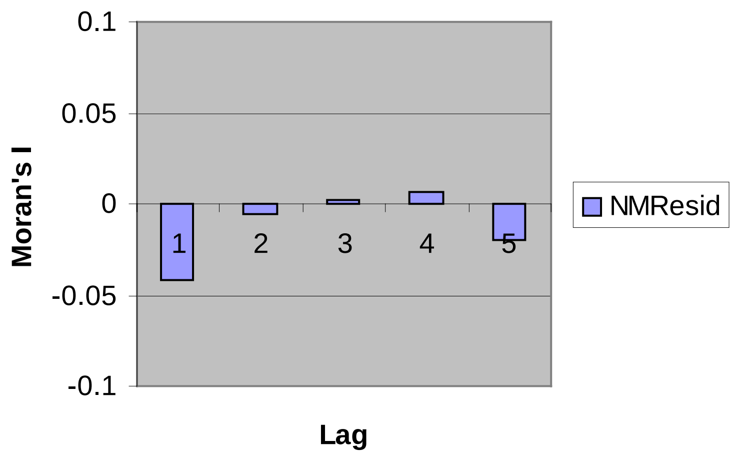
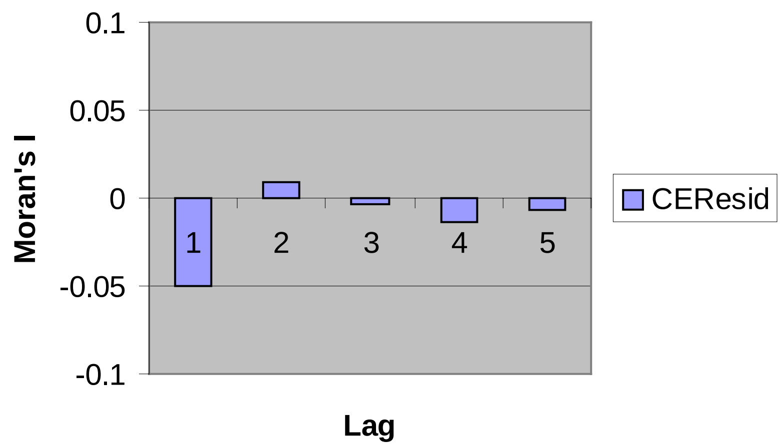


Figure C16 – Moran's I for 5 spatial lags for Model III (Employment Growth Equation)



The computed values are small (less than 0.05 in absolute value) for each equation and one through five spatial lags.

Table C2 – Test Statistics for Moran's I (Model II)

Lag	NM Equation	CE Equation
1	-0.425	-0.529
2	0.082	0.270
3	0.183	0.106
4	0.234	-0.030
5	-0.121	0.064

The test statistics have a z distribution and I fail to reject the null hypothesis of no spatial autocorrelation amongst the residuals for both equations and at all five spatial lags for model two.

Model III

Figure C17 – Moran’s I for 5 spatial lags for Model III (Net Migration Equation)

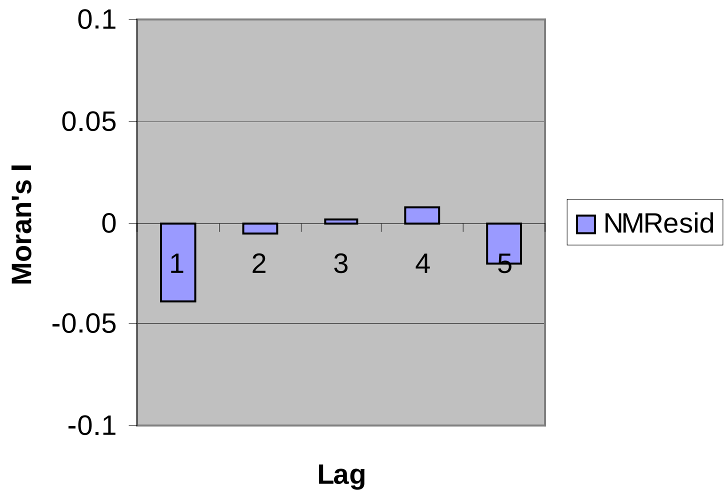
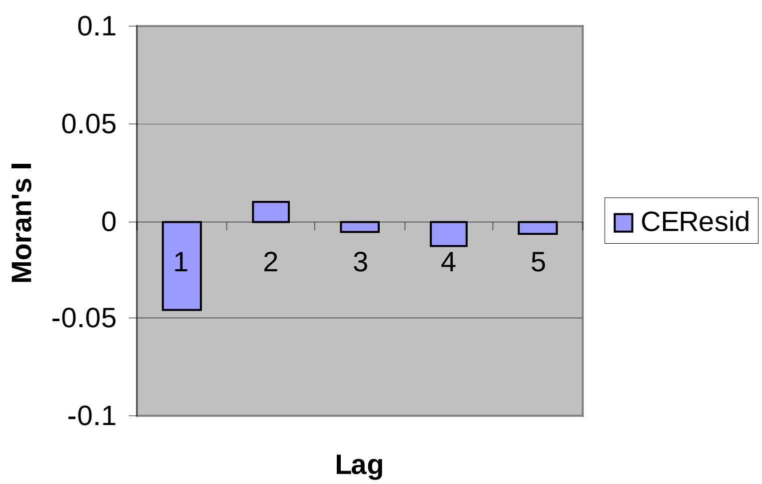


Figure C18 – Moran’s I for 5 spatial lags for Model III (Employment Growth Equation)



I fail to reject the null at the 5% level for each equation and spatial lag.

Table C3 - Test Statistics for Moran's I (Model III)

Lag	NM Equation	CE Equation
1	-0.387	-0.475
2	0.080	0.282
3	0.165	0.071
4	0.244	-0.024
5	-0.121	0.054

The test statistics have a z distribution and I fail to reject the null hypothesis of no spatial autocorrelation amongst the residuals for both equations and at all five spatial lags for model three.

BIOGRAPHY OF THE AUTHOR

David James Lewis was born in Portland, Maine on May 24, 1974. He was raised in Yarmouth, Maine and graduated from Yarmouth High School in 1992. He attended the University of Colorado-Boulder and graduated from the College of Engineering and Applied Science with a B.S. in Applied Mathematics in 1997. He was a software engineer for Roadmap Technologies in Stoneham, Massachusetts from September 1997 to March 1999. After a thru-hike of the Appalachian Trail, he entered the graduate program in Resource Economics and Policy at the University of Maine in September 1999, choosing to concentrate in Environmental and Natural Resource Economics. After receiving his degree, David will be enrolling in a PhD program in Agricultural & Resource Economics at Oregon State University in September 2001. David is a candidate for the Master of Science degree in Resource Economics and Policy from The University of Maine in August, 2001.