A STUDY OF THE IMPACT NATIONAL FORESTS

HAVE ON COUNTY POPULATION AND EMPLOYMENT DENSITIES

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By

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The undersigned, appointed by the dean of the Graduate School, have examined the thesis entitled

A STUDY OF THE IMPACT NATIONAL FORESTS

HAVE ON COUNTY POPULATION AND EMPLOYMENT

Presented by Andrew Pugliese,

a candidate for the degree of master of Agricultural and Applied Economics ,

and hereby certify that, in their opinion, it is worthy of acceptance.

Professor Laura McCann

Professor Thomas G. Johnson

Professor Francisco Xo. Aguilar

Thanks Mom and Dad.

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A STUDY OF THE IMPACT NATIONAL FORESTS HAVE ON COUNTY POPULATION AND EMPLOYMENT

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ABSTRACT

The U.S. National Forest Service owns and manages close to 200 million acres of land and has an annual budget in excess of $5.5 billion. This study seeks to understand the manner and extent to which national forests influence an area's population and employment densities. This study specifically evaluates changes in national forest timber sales, recreation and natural amenity values. Nearly 75 percent of the Forest Service lands are located in 11 western states. Thus, this study will focus on all 477 counties in those states. National Forest timber harvest reports are available starting in 1977 so the study period starts then and continues through 2007. This study thus captures the period when extractive uses, e.g. timber harvesting decreased and non-extractive uses, e.g. tourism, increased, to become more equal. The Carlino and Mills model was used to track changes in population and employment densities. Several metrics for natural and recreational amenities such as precipitation and skiing facilities were found to be significantly related to population densities. However, changes in timber sales and the amount of land owned by the Forest Service were not found to be significantly related to employment densities.

CHAPTER 1: INTRODUCTION

The United States Federal government has a long history of protecting the environment and natural resources. Several federal agencies which work to ensure environmental and resource protection date back to before World War II including the Department of Interior, Department of Agriculture, the National Forest Service and National Park Service. Founded in the 1940s, were the Bureau of Land Management and the Fish and Wildlife Service. Finally, the Environmental Protection Agency was founded in 1970. To varying degrees, each of these agencies works with businesses and communities to promote both economic and environmental prosperity. Promoting economic interests was relatively simple when resource extractive, e.g. timber and mineral harvesting, uses were the primary activity. Over the past several decades however, non-extractive uses, e.g. tourism and wildlife protection, have come to parallel extractive uses. This change was prompted by new environmental legislation. Examples of such legislation include the Wildness Act of 1964 and the Endangered Species Act of 1973. Currently, there is an active debate over the economic impacts of such legislation.

This thesis informs this debate by examining the National Forest System of the U.S. Department of Agriculture's Forest Service, (FS). This agency was chosen because its multiple use approach to land management causes ambiguity in deciding between extractive and non-extractive uses (Clawson 1974). Also, the Forest Service has a

national scope with locations in 41 states. Lastly, much of the environmental legislation under discussion applies to Forest Service holdings.

Research Objectives

The objective of this research is to determine what, if any, effect does national forests lands, and changes in their management, have on regional population and employment. By determining if and how national forests impact local population and employment densities, policy makers can better understand how past, existing and future policies influence regional growth and prosperity. Ideally, the results of this thesis will increase knowledge and lead to more effective public forestland policy.

Research Questions

Specifically this research addresses the following research questions.

- To what extent do natural amenity values influence a county's population density?
- To what extent does the presence of a national forest influence an adjacent county's employment density?
- Do changes in amount of timber sold impact county employment?
- Does the percentage of the county managed by the National Forests Service impact county employment?

Organization of the Thesis

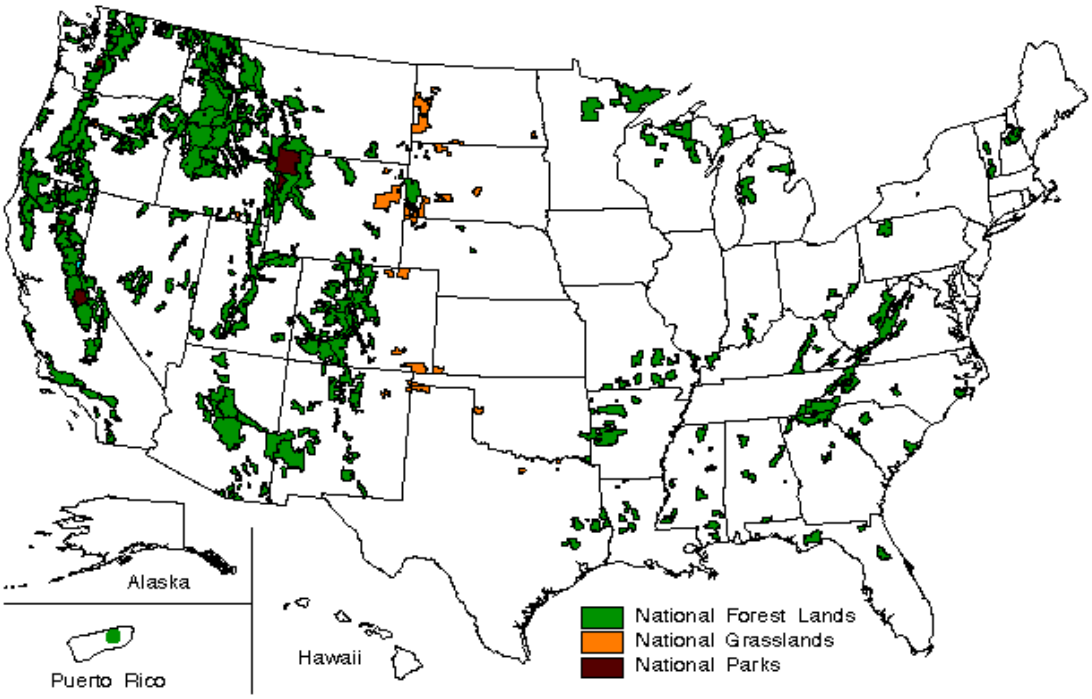
The remainder of this chapter will provide a brief history of the FS. Chapter 2 provides a review of regional economics and studies that have reviewed national forests, wilderness, and other amenities. This review provides insight into the pertinent

models and variables used in this study. Chapter 3 explains the conceptual model used for analyzing population and employment density. Chapter 4 details the data and methods used in this study. Chapter 5 presents and discusses the results of the regression model. Chapter 6 concludes the study by summarizing the major findings and discussing future research opportunities.

A Brief History of the USDA Forest Service

Established in 1897, the National Forest Service is a multi-faceted institution that spans the United States both spatially and temporally. After more than 100 years of history, the FS has grown to encompass 193 million acres of land. There are 155 national forests and 20 national grass lands distributed across 41 states and the Common Wealth of Puerto Rico (Figure 1). In 2009 the FS directly employed 34,250 people and had an annual budget of $5.5 billion (US Forest Service a 2009). It has been estimated that 60 million Americans draw their drinking water from national forests and grasslands (Williams 2007). The FS works to improve watersheds, while allowing for resource extraction and recreational use. The National Forest System has been called "an experiment in land management," but it is also an experiment in resource, institutional, environmental, and regional economics (Steen 1991). To further evaluate the FS of today, one should understand its history.

Figure 1: Map of US National Forests System



US Forest Service b 2009

Pre- 1945

Harold Steen's 1991 historical report states that between 1871 and 1897, Congress debated approximately 200 bills relating to forest on western lands. This historical fact is testimony to the complexity surrounding how to best protect a nation's forests. Debaters had seen the devastation brought by deforestation in Europe, Asia, and Africa and fretted over how the U.S. could avoid such a fate. Scientists had documented, but not yet fully understood the connection between healthy forest and favorable water supplies (Steen 1991). Developers recognized the importance of navigable rivers, and reliable supplies of water for irrigation, but feared that restricted

access to timber, minerals, grazing lands, and other resources would stifle growth. These initial debates lead to the development of several federal land management agencies. Table 1 compares the three current federal agencies and the largest private land conservation program.

Table 1: Comparison of Land Conservation Agencies

Agency	Amount of Land (Millions of Acres)	Budget (2009 Billion)	Mission (taken from agencies websites)
US National Forest Service, FS (US Department of Agriculture)	193 In 41 States	$5.92	The USDA FS sustains the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations.
US National Park Service, NPS (Department of Interior)	84.4 In 49 States	$2.92	The NPS preserves, unimpaired, the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations.
Bureau of Land Management, BLM (Department of Interior)	253 In 11 States	$0.96	BLM sustains the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations

The Timber Culture Act of 1873 was Congress's initial attempt to protect the Nation's timber supply. This act allowed homesteaders to claim an additional 160 acres of land if they planted trees on 40 acres of that land. This approach was projected to increase the number of trees on the Great Plains, where there was a perceived dearth in timber, thus improving the environment and fulfilling homesteaders' timber needs. In practice, the act fostered land fraud (Steen 1991). In 1891, President Benjamin Harrison signed the Forest Reserve Act, which repealed the Timber Culture Act and temporarily

granted the President the ability to set aside forest reserves in the public domain. The Forest Reserve Act laid the foundation for the Forest Service, placing it originally in the General Land Office. From this foundation, the Forest Management Act of 1897 created the National Forest Service and guided it for more than 70 years. The Act provides that a national forest can only be created in order to protect the forest, secure favorable conditions of water flows, and to furnish a continuous supply of timber (US Forest Service 3/2011). These provisions are the roots of today's Forest Service mission, which is to "sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations" (US Forest Service 2008).

With legislation in place, the Forest Service quickly grew, first in the west and later in the east; Figure 1 shows the current location of all national forests. In 1898 William Kreutzer became the first forest ranger with the General Land Organization (Williams 2007). At this time, a rangers' task was primarily to find and put out forest fires and document the damage done to timber. Later that year, Gifford Pinchot became the Chief of the Division of Forestry. Pinchot greatly expanded not only the roles and responsibilities of rangers, but the National Forest system as a whole. Pinchot moved the Forest Service from the GLO to the Department of Agriculture. This move was made to get away from corruption and develop closer ties to the silviculture expertise found within the Department of Agriculture (Williams 2007). Pinchot also worked closely with President Theodore Roosevelt to expand the area under protection.

From 1900 to 1920 much of the newly formed Forest Service directed its energies at simply surveying, mapping, and building the necessary infrastructure on the newly created national forests. In addition to receipts from timber sales, the Forest Service worked with lawmakers to develop a fee system for sheep and cattle grazing. This lead to a 1906 law that directed a proportion of forest receipts back to the states in which the forest resided to help support roads and schools (Williams 2007). It was during this period that district offices were created, the Division of State and Private Forestry was established, and a system of forest products labs and experimental forests started. These efforts were made to better implement basic and applied timber management, recreational planning, and highway construction (Williams 2007). The Roaring Twenties saw a dramatic increase in both the demand for timber resources and recreational opportunities in National Forests. On the periphery of these events were Arthur H. Carhart and Aldo Leopold, two pioneers developing the future of the conservation movement (Williams 2007). As will be made clear shortly, the themes which characterize the first 20 years of the Forest Service have continued to play out during the following 90 years.

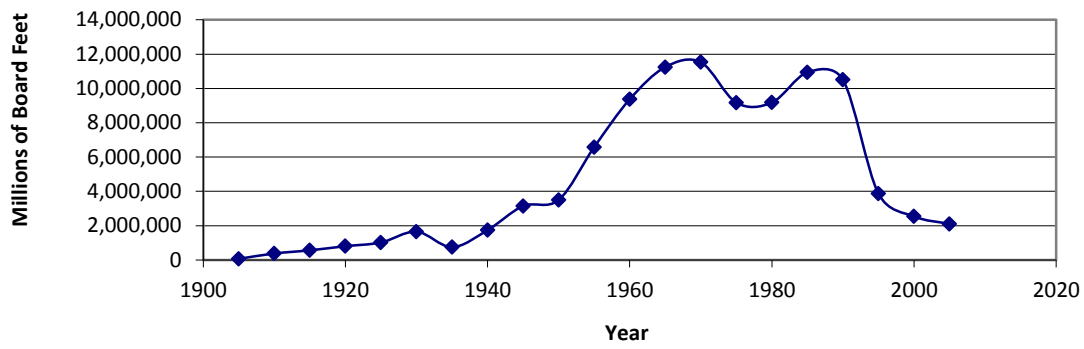
Through the Civilian Conservation Corps, more than 3 million men found employment in national forests during the Great Depression (Otis *et al* 1986). This was an integral part of President Roosevelt's New Deal. By employing out of work men, the project had immediate social benefits. Further, the improvements made to recreational facilities, roads, and firefighting capabilities would provide benefits for decades to come. The CCC was disbanded in 1942, but would be used as a model for future employment

programs. During World War II, national forests supplied the war effort with much needed timber for docks, planes, barracks, bridges, and other uses (Williams 2007).

1945 - 1990

Much of the nation's private timber supplies were depleted by the end of WWII. As a result, the nation turned to its national forests to supply a housing boom with timber. The purpose of the Multiple-Use Sustained Yield (MUSY) Act of 1960 was to reinforce the 1897 Forest Management Act (US Forest Service 2008). While many, including then Chief Ed Cliff, claimed that MUSY had not catalyzed any significant change in forest land management, there was a noticeable increase in the amount of timber harvested Figure 2. At this time, forest managers increased the use of commodity-oriented timber harvesting. To support this accelerated state 9,000 men were employed in 100 different national forests (Williams 2007). As is depicted in Figure 2, the amount of timber harvested from national forests increased from less than 2 billion board feet in 1940, to more than 10 billion board feet harvested in 1963 (US Forest Service 4/2011). This exhaustive rate of harvesting reached its peak in 1976, when 13 billion board feet were harvested in a single year (Williams 2007).

Figure 2: Historical Volume of Timber Harvested from the National Forest System



Concurrent to this period of increased resource extraction were growing concerns over environmental issues. A growing group of people became aware of the perils arising from rapid growth and a disregard for the environment. Aldo Leopold's A Sand County Almanac and later Rachel Carson's Silent Spring humanized and explained scientifically documented environmental degradation. From this increase in knowledge, the nation began to prioritize the protection of its environment. One of the first steps was the passing of the Wilderness Act of 1964. The Act protected designated federal holdings which;

> In contrast with those areas where man and his own works dominate the landscape, (are) hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain (Wilderness Act of 1964).

This Act immediately placed approximately 9 million acres of land under wilderness protection. Today, there are close to 110 million acres of protected wilderness, with the FS managing 36 million of them (University of Montana 2010). In addition, the Wild and

Scenic Rivers Act (WSR) was passed in 1968. This Act provided another mechanism for the Forest Service to fulfill its role of protecting the nation's natural resources.

Congress and President Nixon took the next big step in promoting environmentalism by enacting the National Environmental Policy Act (NEPA) in December, 1969. Often called the "Magna Carta" of environmental law, NEPA is the foundation for the U.S.'s environmental policies (Council on Environmental Quality 2007). Under NEPA, the Forest Service has to assess and take into consideration the environmental effects of proposed actions (Williams 2007). NEPA was intended to promote more informed decisions and increased citizen involvement (Citizens Guide). The Endangered Species Act of 1973 was passed with the intent of protecting endangered species until their populations were restored to self-sustaining levels. Protecting individual species was accomplished by protecting entire ecosystems (Brown and Shogren 1998). In practice, the Act dragged the Forest Service into the middle of disputes between the timber industry and environmental groups. The National Forest Management Act was passed in 1976. The principal objectives of the Act is to get forest managers to take a multi-stakeholder approach to the planning process, mandate long term sustainability and increase coherent public involvement (Nie 2004). In practice, public controversy erupted over environmental regulation and the management of national forests. During this time, the amount of timber harvested from national forests decreased dramatically (Figure 2). The FS frequently lost credibility as it attempted to satisfy the conflicting demands set forth by the timber industry and environmental

groups. Further, many began to question if the enforcement of national legislation was resulting in the loss of jobs in areas around national forests (Duffy-Deno 1998).

1990 - 2007

It is reported that Aldo Leopold once said "instead of learning more and more about less and less, we must learn more and more about the whole biotic landscape" (Williams 2007). During the 1990's and 2000's, the FS began to put into practice Leopold's words. The Forest Service was revolutionizing its management practices, seeking sustainable resource management through ecosystem management (Collins 2005). This approach followed watersheds across municipal and private boundaries. This new paradigm for management has led to coalitions with the Bureau of Land Management, the Fish and Wildlife Service, the National Park Service, as well as other federal, state and county agencies. These scientifically based and legally defensible collaborations were designed to maintain and restore a region's culture, economy, and environmental quality of life (Williams 2007). This approach has led to 12 watershed restoration projects with footprints on 23 states. The Forest Service has invested $24 million into these projects. Additional program funding from federal, state, tribal, and private partners amounted to $22 million. These resources have gone to a range of programs including the creation of a 3-million-acre demonstration area, 70 miles of riparian forest, and pioneering of new technologies (Williams 2007).

While the Forest Service has always incorporated recreational use into mission and goals, it has rarely ever made management decisions based on recreational use. In 1946, recreational use of national forest equaled 18 million visitor-days; in 1999

recreational use surpassed 1 billion visitor-days (Williams 2007). This visitation volume made recreation the number one use of national forests and grasslands. The Forest Service took actions both within the forest and in surrounding communities to meet visitor expectations and ensure environmental sustainability. One action was to start collecting recreational user fees which would be retained and used to maintain trails, improve campsites, and expand hours. In 1999, the Forest Service collected $26.5 million in recreational fees (Williams 2007).

In 2001, the U.S. Department of Agriculture instituted the Roadless Area Conservation Rule, which prevented construction, reconstruction, and timber harvesting in inventoried roadless areas on National Forest System lands (Nie 2004). The intention of this rule was to safe-guard the remaining 58.5 million acres of pristine national forest, which existed in 39 states, from industry (Nie 2004). While developing this rule, the FS held 187 public meetings, drawing 160,000 audience members. In addition, the Forest Service established a website soliciting public commentary which received 11 million hits in 6 months. "In all, the FS notice of intent elicited more than 517,000 responses, an unprecedented number for any federal rule making" (Williams 2007). The Roadless Rule has been embraced for its promise to protect wildlife, habitat, drinking water, and recreational areas. Concurrently, dismay over the rule has arisen from fear of decreases in regional employment and federal encroachment on state rights. A proposed amended rule was presented on July 16, 2004 and received 1.8 million comments in 122 days. The debate over this contentious rule is on-going.

This brief historical recounting captures the scope of the Forest Service. Presidents have turned to national forest to aid in job creation and economic relief. Industrialists have used the resources found on NF lands to grow businesses. Scientists have used national forest as laboratories. The public at large have used national forest and grasslands as their backyards. While much attention has been given to the forest and the trees, this study will now focus on the communities around the forests.

CHAPTER 2: LITERATURE REVIEW

Introduction

Thousands of counties in the U.S. are impacted by how the National Forest Service manages the 190 million acres of land under its discretion. Communities value the goods and services provided by a forest in four ways: direct use, indirect use, option, and nonuse (Pearce 2001). While the FS has always been cognizant of each of these, it has historically placed a special emphasis on direct use values. Historical direct use of national forests includes timber harvesting, minerals extraction and grazing. These direct uses quickly privatize goods and services and it is easy to measure costs and benefits. Since the 1970's though, there has been a shift in emphasis toward the public goods captured in indirect use, option and nonuse values. The nation at large opted to turn portions of national forest into sanctuaries for endangered species. Communities benefited indirectly by an increase in watershed protection. Further, there was an increase in the demand for forest to be set aside for scenic beauty and tourism. This rebalancing of management has spurred much debate over the trade-offs between increased conservation and open access (Duffy-Deno 1998 and Lewis *et al.* 2002).

Many have questioned how this balancing, or multiple use management, has impacted regional economies. This chapter will review the theoretical, methodological and substantive findings from the literature which focus on the role national forests have on regional economies. Pertinent to this review is an explanation of regional economics, economic base theory and the role space, place and amenities play in

regional economics. Additionally, this section will elaborate on the various ways simultaneous equations for employment, residency, population, and income have been applied in regional economics.

Regional Economics

Regional economists have attempted to estimate the impacts of federal lands on regions. Edgar Hoover (1971) provides a thorough description of regional economics in his textbook. He wrote "the most important purpose of the whole economic system is to provide a livelihood for people" (Hoover 1971). Under this light, regional economics emphasizes measuring differences in population, employment, income and opportunities for communities and individuals (Hoover 1971). Regional economics' most fundamental questions focus on understanding the type of economic activity taking place in a particular location (Hoover 1971). According to Hoover (1972) two central questions in regional economics are: 1) where do individuals, firms and other organizations choose to reside and 2) what influences their decision making process? Common approaches to analysis include the examination of transport costs, location patterns, economic structure, policies and spatial structures.

Land use is of special interest to regional economics. Decisions related to the direct use of a forest resource are easily directed by the price mechanism and markets. However, the decisions required when managing for indirect values, option values and nonuse values are poorly represented by the price mechanism and markets but, may have profound impacts on regional economies (Pearce 2001). As such, Hoover writes "direct controls upon land use are vital elements of rational public policy" in part to

insure those goods and services not represented by the price mechanism are still protected and properly provided (1971).

Regional economists frequently use economic base theory to study regional changes in employment, population, incomes and other indicators of regional vitality (Malizia and Feser 1999). As described by Hoover (1971) and Malizia and Feser (1999), economic base theory asserts that a region's prosperity hinges on external demand for a region's goods and services. Economic base theory starts by dividing an area's activities into two categories. First are "basic" activities, which are those that attract outside money. The second group of activities is labeled "non-basic." While growth is driven by basic activities, both basic and non-basic participants support and rely on each other for inputs and income. Additionally, benefits from non-basic activities are a result of the outside revenue attracted by basic activities (Hoover 1971, Malizia and Feser 1999). According to Hoover, economic base theory explains regional growth by

1- explaining the location of basic activities
2- tracing the processes by which basic activities in any region give rise to an accompanying development of non-basic activities.

Economic base theory tracks changes in output, income and/or employment in response to external changes in demand (Malizia and Feser 1999). While economic base theory is often used for impact analysis, special attention to changes in local export sectors and economic structure over long periods of time is required (Malizia and Feser 1999).

Economic base theory provides a suitable conceptual approach to understanding how shifting national forests management from extractive resource use to non-extractive resource use impacts regional economies. Under this approach two essential questions arise. The first is to what extent does protectionist management detract from a region's historical basic activities? Second, does protectionist management create new basic activities? Employment in extractive industries, a historical basic activity and source of high paying employment in rural regions, has been perceived to decrease under protectionist management (Kwang-Koo *et al.* 2005 and Duffy-Deno 1998). Parallel to this perceived decrease are projected increases in employment related to natural amenity -based tourism and employment in non-resource based firms that are drawn to natural amenities (Kwang-Koo *et al.* 2005).

Numerous regional economists have incorporated amenity values into regional development models. Kwang-Koo *et al.* provides a useful summary of this field in their 2005 paper. Originally, amenity values were relatively crude measures of climate, crime rates, or congestion. These early attempts found significant relationships between climate and population migration, housing prices and wages (Kwang-Koo *et al.* 2005). More recent studies of human migration and firm location have used the existence of specific natural amenities as proxies for quality-of-life factors. Duffy-Deno and Lewis *et al.* examined how the presence of various types of wilderness, an amenity assumed to proxy for quality-of-life measurements, impacted county growth and found no significant relationships (Duffy-Deno 1998 and Lewis *et al.* 2003).

Studies that use principal components analysis are at the forefront of amenities and regional economics. Principal component analysis "condenses a set of related amenity attributes into a smaller set of amenity scores" (Kwang-Koo *et al.* 2005). For example, average temperature, rainfall, and snow-fall can be condensed into one climate principal component. The Kwang-Koo *et al.* (2005) paper provides an example of how more than 40 location-specific amenities can be condensed into five amenity values. Employing such a technique allows for dozens of variables to be consolidated into four or five principal components that are then used in a regression analysis. By including more variables in the analysis, the principal component method is less subjective than the single index approach, but the results are more difficult to interpret (Kwang-Koo *et al.* 2005).

During the 1970s two sub-disciplines within regional economics emerged, spatial econometrics and Steinnes and Fisher's simultaneous model of regional development. The term 'spatial econometrics' was coined by Jean Paelinck in the 1970s and is used to describe a field of study that is concerned with how the flow, patterns and structure of economic activity impact economic results (Anselin 1988). Spatial econometrics has grown in importance as regional scientists learn more about the extent of spatial autocorrelation and the effect it and heterogeneity have on regional economic models which use cross-sectional and time series data (Anselin 1988). The problems caused by spatial autocorrelation and heterogeneity can arise in both the study area and the selected observations. The arbitrary delineation of spatial boundaries may lead to autocorrelation between study areas (Boarnet *et al.* 2001). Further, spatial

autocorrelation may arise when observations in cross-sectional data lack spatial independence (Anselin 1988). For example, spatial autocorrelation exists when observed population change in county X depends on observed employment opportunities within county X as well as observed employment opportunities in nearby counties (Boarnet *et al.* 2001). Understanding the influence of spatial heterogeneity is best done through example. If the study area is at the state level, heterogeneity amongst states arises from differences in state size, population density, and natural environments, just to list a few examples.

Interestingly, Boarnet *et al.* (2001) found that while recent regional development models that used cross-sectional and time serious data, but neglected to use a spatial model to study regional development approaches, were valid. Boarnet *et al.* (2001) specifically looked at the Carlino and Mills simultaneous equation model that tracked changes in population and employment. The difference between successful and unsuccessful approaches came down to the type of question asked and the data used to generate an answer (Boarnet *et al.* 2001). For lagged adjustment questions, data ought to be from the start of the study period. For example, Lewis *et al.* used land conservation values from 1990 and government expenditures from 1992 to predict changes in employment and net migration in 1997 (2002). While exploring the role location-specific amenities have on regional development, Boarnet *et al.* found that a plethora of explanatory variables is required. A spatial model is required when the Carlino and Mills model is utilized to explicitly study the interactions between

employment and population changes (Boarnet *et al.* 2001). The question 'do jobs follow people or people follow jobs?' is the classic example of such a study.

Steinnes and Fisher (1974) were the first to study regional economics by simultaneously modeling regional employment and residency. The premise of the Steinnes and Fisher model is that decisions are motivated by economic and non-economics exogenous factors. While the two pioneering authors applied their model to metropolitan areas, later economists adapted the Steinnes and Fisher base model to a wide-variety of issues. Carlino and Mills' adaptation of Steinnes and Fisher's model allowed for interregional areas to be studied making it of particular interest to this review (Carlino and Mills 1987). In addition, the Carlino and Mills' (1987) model considered economic, demographic, and climatic variables. Both models have a spatial framework to the extent that the selected exogenous variables capture the peculiarities of space (Boarnet *et al.* 2001). However, as is described above, studies that examine lagged impacts and the influence of amenities can be properly modeled.

Three Pertinent Articles Explained

Duffy-Deno (1998), Lewis *et al.* (2002) and Deller and Lledo (2007) have been selected for more detailed reviews because together, they demonstrate how regional economists have attempted to capture the impact national forests exert on regional development. Table 2 provides a condensed summary of each. While each article reviewed different study areas and included varying exogenous factors, all three used a version of the Carlino and Mills model. Following Table 2**,** this review will proceed

chronologically. Such an approach depicts the progress of the debate between conservation and open access policies.

Table 2. Previous Studies

Study	**Duffy-Deno, K. 1998. The Effect of Federal Wilderness on County Growth in the Intermountain Western United States**	**David Lewis *et al.* 2002. Public Conservation Land and Employment Growth in the Northern Forest Region**	**Deller, S. C and V. Lledo 2007. Amenities and Rural Appalachia Economic Growth**
Key Research Question	What effect does wilderness have on population and employment growth?	What effect does the amount of public conservation lands and declines in timber sales from public lands have on employment and net migration?	Is regional growth conditional upon amenity factors?
Model	System of simultaneous equations (Carlino and Mills)	System of simultaneous equations (Augmented Calino and Mills)	System of simultaneous equations (Expanded Carlino and Mills)
Principle Exogenous Variables	Percentage of federal lands which is protected wilderness	Share of land base in public conservation uses and changes in public timber harvests	Principle components for climate, land, water, winter recreation, and developed recreational infrastructure
Study Area	280 nonurban counties in the intermountain west	Northern Forests of the U.S.	290 rural counties in Appalachia
Results	No evidence that the existence of federal wilderness is directly or indirectly associated with either population-density or total-employment-density growth 1980-1990.	Net migration rates were higher in counties with more conservation lands and no significant effect on employment growth.	Amenity values had no statistically significant impact on population. Land characteristics influenced employment and income growth. Employment was also significantly influenced by climate measures.

Duffy-Deno's 1998 and Lewis *et al.* 2002 papers attempt to investigate the common concern that wilderness designation will negatively impact rural county economies. Many speculated that wilderness designation of federal lands, a designation that restricts access to resources on that land, can lead to a decrease in local employment opportunities in extractive resource industries (Duffy-Deno 1998). Focusing on the intermountain west because of the high percentage of land owned by the federal government Duffy-Deno found no discernable relationship between federal wilderness and population density or total employment density growth. Lewis *et al.* (2002) studied counties with a large percentage share of publicly owned land in the northern forest region and distinguished between preservationist lands and multiple-use lands. For the Lewis *et al.* 2002 study, preservationist lands are publicly owned and restrict access to extractable resources, whereas multiple use lands allow for resource extraction. An additional exogenous variable included by Lewis *et al.* (2002) was the percent change in timber sales on national forests. Neither changes in public timber harvest nor the amount of public land had a significant effect on regional employment growth (Lewis *et al.* 2002). However, net migration was slightly higher in counties with more conservation lands (Lewis *et al.* 2002). Recognizing the importance amenities can have on regional development studies, both Duffy-Deno and Lewis *et al.* incorporate amenity values into their studies. However, they were relatively crude measurements. For example, Duffy-Deno accounted for heating and cooling days, rain fall and the presence of a ski resort, airport and near-by city and found no significant relationship (1998). Lewis *et al*. included local government expenditures and dummy variables for

ski resorts and proximity to an urban area (2002). Lewis *et al.* found amenity values, specifically conservation lands, had a significant statistical relationship with net migration (2002).

Table 3. Public Land Ownership by State

		State	Total Area of State[1]	Total Area Owned by Federal Gov'ts[1]	% of State's Total Area	State Rank[1]	Area owned by USFS[2]	% of State Held by the USFS
Study Area		California	99,822.70	40,044.78	40.12	7	20,697.51	20.73
		Oregon	61,441.90	16,407.70	26.70	12	15,657.82	25.48
		South Dakota	48,574.70	3,569.88	7.35	19	2,012.43	4.14
		Washington	42,612.50	11,648.40	27.34	11	9,214.45	21.62
	States in Duffy-Deno 1998 Study	Arizona	72,730.90	29,894.99	41.10	6	11,254.99	15.47
		Colorado	66,387.20	23,541.19	35.46	8	14,509.18	21.86
		Idaho	52,960.60	32,496.40	61.36	4	20,458.28	38.63
		Montana	93,155.80	27,276.82	29.28	10	16,893.50	18.13
		Nevada	70,275.80	56,846.08	80.89	1	5,832.77	8.30
		New Mexico	77,673.60	22,854.72	29.42	9	9,326.79	12.01
		Utah	52,587.50	33,194.97	63.12	3	8,178.60	15.55
		Wyoming	62,147.20	30,099.43	48.43	5	9,237.62	14.86
	States In Lewis *et al.* 2002 Study[3]	Maine	19,753.60	170.26	0.86	45	53.04	0.27
		Minnesota	50,954.90	3,572.92	7.01	20	2,837.65	5.57
		New Hampshire	5,740.20	744.21	12.96	13	728.15	12.69
		New York	30,223.40	79.55	0.26	48	16.18	0.05
		Vermont	5,919.40	390.97	6.60	22	376.25	6.36
		Wisconsin	34,761.00	1,987.71	5.72	24	1,522.52	4.38
		Total Study Area	820,124.00	328,045.62			143,326.98	
		National Total	2,263,221.90	588,134.76			192,239.12	
		Study Area as a Percent of the U.S Total	36.24	55.78			74.56	

1. NRC Main 2011

2. Forest Service 4/2011

3. Lewis *et al.* 2002 studied selected counties in the listed states.

All values relating to area are in thousands (000's) of acres.

Deller and Lledo contend that the rudimentary amenity values used by Duffy-Deno, Lewis *et al.* and others fail to measure the vital role amenities have on regional

development (Deller and Lledo 2001). Kwang-Koo *et al.* describes two roles amenities have in regional development. The first is that they act as "substantive, but latent primary factor input(s) into tourism industry output" (Kwang-Koo *et al.* 2005). It should be noted that tourism can be classified as a basic activity for a region, as it brings in out-side money. Second, amenities influence human migration and firm location decisions through increasing regional quality-of-life attributes (Kwang-Koo *et al.* 2005). The new firms recruited by high amenities can potentially be basic activities.

Deller and Lledo (2007) applied a principal component method to assess the influence amenities have on rural Appalachia. The authors chose this area because it is both historically dependent on extractive industries and well-endowed with natural amenities (Deller and Lledo 2007). Such a location has the potential to reveal how non-consumptive use of natural resources can act as an engine of economic growth (Deller and Lledo 2007). As was described before, the principal component method compresses "a set of related variables into a single scalar measure" (Deller and Lledo 2007). Deller and Lledo capture fifty-four amenity values in five indices in their 2007 study. For example, the climate index includes values for temperature, precipitation, January temperature, January sunny days, July temperature, and July humidity (Deller and Lledo 2007). The four additional indices are developed recreational infrastructure, land attributes, water attractions, and winter recreation opportunities (Deller and Lledo 2007). The results of Deller and Lledo's 2007 study that are pertinent show that land characteristics are significant in explaining income and employment growth and that climate is also significant in the explanation of employment growth (Deller and Lledo

2007). While other studies found evidence that amenity values explained net migration, Deller and Lledo found no significant relationship between amenity values and population growth (Deller and Lledo 2007).

Duffy-Deno (1998) explored the impacts wilderness lands had on population and employment. As such, he focused on the amount of land designated as wilderness in the intermountain west and collected panel data at the county level from 1980-1990. Participants in the debate around how federal lands should be managed claimed that wilderness designation would decrease employment by decreasing access to resources. This interaction between wilderness and employment assumes that extracting the resources on wilderness lands was economically viable. This simply may not be the case. Parallel to this perception was the idea that wilderness as an amenity would attract firms and thus increase employment. This interaction between wilderness and firms' location decisions may not exist (Duffy-Deno 1998). Later, Lewis *et al.* augmented the Carlino and Mill's model to track changes in employment and net migration induced by reductions in public land timber sales (2002). While the Lewis' *et al.* study was conducted in counties with a high concentration of publicly owned land, the northern forest region as a whole is an area where only a small fraction of the timber is publicly owned (Table 3). This could have potentially misrepresented the impacts reductions in timber sales on publicly owned lands have on regional economies elsewhere.

Interestingly, the national base model developed and used by Deller and Lledo (2007) found that climate, water resources, winter amenities and urban development have a significant influence on population growth (Deller and Lledo. 2007). Further,

climate, recreational infrastructure, and water amenities are statistically significant in explaining changes in employment (Deller and Lledo 2007). No amenity value had a statistical influence on income at the national level (Deller and Lledo 2007). The discrepancy between the national base model and Appalachia model suggest that amenities matter depending on location.

This study will draw on the approaches used by each of these economists either in its conceptual framework, data, or methods. More specifically, this thesis expands upon Duffy-Deno's (1998) study area and period. This thesis also incorporates the percent change in timber values in its model. This variable was used by Lewis *et al.* (2002). This combination of study area, period and variables should provide a more complete understanding of how national forests impact county population and employment densities.

CHAPTER 3: CONCEPTUAL MODEL

Introduction

When considered in parallel, the existence of a positive relationship between amenities and economic performance as was found by Deller and Lledo (2007) and the lack of a significant impact on employment caused by varying forest management regimes as was found by Duffy-Deno (1998) and Lewis *et al.* (2002) is peculiar and warrants further investigation. This study will test two hypotheses. The first is that amenities have a statistically significant and positive influence on population density. The second is that timber sales from national forests have a statistically significant positive influence on employment density. Answering such questions should reduce the uncertainty around the economic impact of federally owned lands on regional population and employment.

This is a positive economic study; as such the study will test to see if there is either a positive or negative impact of the introduced exogenous variables rather than determining an optimal management regime. Following the trend established by Duffy-Deno, Lewis *et al.* and Deller and Lledo, this study will manipulate the Carlino and Mills model under the economic base theory framework. The Carlino and Mills model has been frequently used to examine regional growth, effect of public land management, and the significance of amenity values. The study area (Table 3) encompasses and expands on the region Duffy-Deno (1998) studied. This area covers 11 states and

includes nearly three-quarters of all USFS lands, representing more than half of the land owned and managed by the federal government. However, in an attempt to better capture the impact changes in management policy have had on regional growth, this study will replace Duffy-Deno's federal wilderness acres with Lewis *et al.'s* changes in timber sales. Timber is the primary extracted resource provided by national forests. It is hypothesized that as timber sales increase, a region's economy will improve and vice-versa. This study will test that hypothesis.

In addition, this study will assess the significance of amenity values in explaining regional population and employment growth. This will be accomplished by incorporating amenities' characteristics into the model. Deller and Lledo (2007) and Kwang-Koo *et al.* (2005) utilize data from the National Outdoor Recreation Supply Information System (NORSIS) data bank. The FS developed NORSIS from 1987 – 1997. The data set encompasses county-level data for the entire United States and catalogs 3,116 observations and 492 variables (Betz 1997). Deller and Lledo (2007) and Kwang-Koo *et al.* (2005) use the NORSIS principal component values for climate, developed recreational infrastructure, land attributes, water attributes, and winter characteristics. Many of the values used to generate the NORSIS principal components are too recent to permit their use in this study. As such, this study will use data provided by NORSIS that represent the amount of natural amenities present at the county level and include: recreational facilities, average temperature, average precipitation, average snow fall, and the presence of mountains, skiing facilities, rivers and open in-land water. It is the

contention of this study that regional population and employment are significantly and positively impacted by such amenities.

Theoretical Model

The Carlino and Mills (1987) model assumes firms and households are geographically mobile and seek to maximize utility and profits in competitive markets in part by migrating to areas with lower costs. Regional comparative advantages, including but not limited to transportation costs and differences in labor costs exist, causing different production functions across regions (Carlino and Mills 1987). Amenities and land-use controls may impact the labor supply (Carlino and Mills 1987). Duffy-Deno (1998) describes how present equilibrium population density (P*) and employment density (E*)

> are assumed to be determined simultaneously and depend on a variety of other factors **T, S,** respectively, that affect production costs and utility levels across regions.

A full list of **T** and **S** variables can be found in Table 4 located in Chapter 4. This leads to the simultaneous equations

$$P^* = \alpha_0 E + \alpha_1 \mathbf{T} \quad (1)$$

$$E^* = \beta_0 P + \beta_1 \mathbf{S} \quad (2)$$

Following Carlino and Mills (1987) and Duffy-Deno (1998) this model applies an adjustment lag for both population and employment densities:

$$P = P_{-1} + \lambda_p(P^* - P_{-1})$$

$$E = E_{-1} + \lambda_E(E^* - E_{-1})$$

The -1 subscript equates to a one-period lagged variable and the range for the speed-of-adjustment coefficients λ_p and λ_E falls between zero and one. Through substitution the theoretical model takes on the form of:

$$P = \lambda_p \alpha_0 E + \lambda_p \alpha_{1\text{-}13}\mathbf{T} + (1 - \lambda_p) P_{-1} \quad (3)$$

$$E = \lambda_E \beta_0 P + \beta_{1\text{-}11}\mathbf{S} + (1 - \lambda_E) E_{-1} \quad (4)$$

Note that the model results in current population and employment levels being contingent on their lagged values, the other endogenous variable, and a vector of exogenous variables.

As described before, the change in timber sales and natural amenities will be included in the exogenous variables for both the population and employment equations (Table 4, Chapter 4). Additionally, values for home ownership, income, and the presence of a city either within or adjacent to the county of interest will be incorporated into the population equation. The employment equation will include values for: education levels, unemployment rates, average wage, levels of federal employment, amount of income derived from investment and savings and the presence of a city either within, or adjacent to, the county of interest. Each of these variables will be measured at the county level. The next chapter provides more detail on the variables used, data sources and methods of analysis.

CHAPTER 4: DATA AND METHODS

Introduction

In this chapter, the variables, data sources and methods of analysis used in this research project will be explained. First, will be an explanation of specifically what the independent and dependent variables are, where they come from and how they will be applied (Table 4). Second, will be specification and justification of the quantitative estimation techniques used. Finally, there will be an explanation of how results will be interpreted.

Variables

All of the data used in this study is freely and readily available on the internet either through the U.S. Bureau of Economic Analysis (BEA), U.S. Census Bureau or the USDA Forest Service web sites. The majority of both rural and urban counties in Arizona, California, Colorado, Idaho, Montana, New Mexico, Oregon, South Dakota, Washington and Wyoming have been included in this study. This encompasses portions of the Forest Service's regions one and two and all of regions three, four, five and six. The study area includes every county in the study area, totaling 477 counties. In an attempt to capture as much information as possible the study period starts in 1977 and extends until 2007. Timber harvest reports are not available prior to 1977.

Table 4. Population and Employment Density Variables

Equation		Variable	Definition	Source
Population Density		*Ppr*	Present Population Density	E
		Epr	Present Employment Density	D
	T Variables	*Ppa*	Lagged Population Density	E
		Inpa	Median Household Income (1990 Dollars)	E
		PCT_Own	Percent Housing Owner Occupied	E
		PCT_Earn_Ser	Percent of Earning from Service Sector	D
		PCT_Rec	Percent of County Dedicated to Recreation	C
		AV_Temp	Average Temperature (Celsius)	C
		AV_Percip	Average Precipitation (CM)	C
		AV_Snow	Average Snowfall (CM)	C
		PCT_Mts	Percent of County Mountainous	C
		Ski	Ski Area (Square Miles)	C
		River	Miles of River	C
		PCT_Water	Percentage of County Under Water	C
		City	Town or City Population >= 25,000 (Base: No)	E
		ADJ_UC	Adjacent to a Urban County (Base: No)	F
		State Dummy	State (Base: South Dakota)	E
Employment Density		*Epr*	Present Employment Density	D
		Ppr	Present Population Density	E
	S Variables	*Epa*	Lagged Employment Density	D
		UnE	Unemployment (rate)	B
		AV_Wage	Average Wage per Job (1990 Dollars)	D
		PCT_Ed	Percentage of Population with High School Education	B
		PCT_Fed_E	Percentage of Employment that is Federal Employment	D
		PCT_Div_Incom	Percentage of Income from Dividends, Interest and Rents	D
		PCT_Change_ Timber	Percent Change in Timber Volume Sold	A
		PCT_Land_NF	Percent of County Owned by National Forest Service	A
		City	Town or City Population >= 25,000 (Base: No)	E
		ADJ_UC	Adjacent to a Urban County (Base: No)	F
		State Dummy	State (Base: South Dakota)	E

Source Code	Source
A	USDA Forest Service, *Cut and Sold Reports*
B	U.S. Bureau of Census, *County and City Data Book*
C	USDA Forest Service, Southern Research Station *NORSIS* Data
D	U.S. Bureau of Economic Analysis, *Local Area Personal Income and Employment*
E	U.S. Bureau of Census, *Census of Population*
F	USDA, *Rural Urban Continuum Codes*

Population Equation

Today's population density, an endogenous variable in this study, was calculated using county size from the 2000 census and county populations from the 1977, 1987, 1997 and 2007 bi-annual economic censuses. It is hypothesized that population density, i.e, population per square mile, depends on present employment density and several lagged exogenous variables. This study uses a ten year lag to help avoid simultaneity and explain the direction of causation (Carlino and Mills 1987, Duffy-Deno 1998 and Lewis *et al*. 2002). The first exogenous variable is lagged population density. Areas with high populations in the past are expected to have high population density today (Carlino and Mills 1987 and Duffy-Deno 1998). This study uses lagged median household income as an exogenous variable, just as Duffy-Deno (1998) used median household income and Lewis *et al.* (2002) used median family income to partially explain population density. These values can be found through the Census Bureau. There is an expected positive relationship between median household income and population density. Additionally, persons are expected to be drawn to areas that offer a strong sense of community and a variety of services. These characteristics are captured by including the percentage of owner occupied homes, the percent of earnings generated by the service sector and the percent of county area dedicated to recreation. The Census Bureau and BEA provide home tenure and earnings data. The earnings generated by the service sector and area dedicated to recreation capture the significance of non-extractive resource use in county. Values for the percent of land dedicated to recreation were found in the Forest Service's NORSIS data set.

Of particular interest to this study is the role natural amenities exert on population density. As such, this study will included a bank of natural amenity characteristics including: average temperatures, average snowfall, average precipitation, amount of river miles, percentage of county underwater, skiable area and the percentage of land that is mountainous. This information was provided by the Forest Service. While the data was gathered between 1987 and 1997, it is assumed that these climatic and topographic characteristics are constant enough to be applied to the start of the study period. Further, National Forests provide and protect amenities including recreational opportunities, open space and scenic beauty at a grand scale. In some counties, the National Forest Service owns in excess of 80 percent of the area and on average the National Forest Service owns 17 percent of the study area. This study predicts a positive relationship between the percentage of land owned by the National Forest Service and population density.

Employment Equation

Employment density, employment per square mile, is the second endogenous variable in this model. Values for employment density were taken from the BEA. Today's employment density is explained by today's population density as well as several other exogenous variables. Again, each exogenous variable is lagged to account for simultaneity and direction of causation (Carlino and Mills 1987, Duffy-Deno 1998 and Lewis *et al*. 2002). The first is lagged employment density value. Based on previous studies this is expected to have a positive relationship with today's employment density (Carlino and Mills 1987, Duffy-Deno 1998 and Lewis *et al*. 2002). Interestingly, past

unemployment rates too, are expected to be positively related to today's employment density. This may potentially be because firms are attracted to regions with high unemployment. Unemployment rates were found in the centennial censuses. The second variable is average wage per job. These values are found through the BEA. It is expected that firms are attracted to counties with low average wages (Duffy-Deno 1998). Third is the percentage of the population that has completed high school. Firms are expected to be attracted to areas with higher education rates. High school graduation rates are included in the centennial censuses. Through reinvestment in local enterprises and increases in demand for local goods, external sources of money can generate local employment opportunities (Lewis *et al.* 2002). The federal share of total employment and income from dividends, interest and rents, are included in this model to account for this potential employment generation. These values are obtained through the BEA.

Within the study area the Forest Service owns an average of 17 percent of each county. In 30 percent of the counties studied, the Forest Service owns more than 25 percent of the land. In light of the substantial holdings it is important to understand the effect, if any, that a national forest has on employment. A common argument is that the Forest Service and the legislation that it operates under decrease employment opportunities by restricting access to the resources (Duffy-Deno 1997). To capture this effect, this study will incorporate the percent change in volume of timber sold in each county. Timber sales are the main revenue generating extractive resource use activity associated with national forests. It is assumed that the majority of the timber sold is not

consumed in the county. If this assumption is met, the revenue from timber sales represents imported dollars and is thus a "basic" activity. Changes in timber sales were quantified by comparing the annual cut and sold reports provided by the National Forest Service. This study predicts a positive relationship between changes in timber sales and employment density.

Structural Variables

Three structural variables were included in both the population and employment equations. A state dummy variable is included in each equation to account for differences, such as state taxes and regulations, that may exist between states but not between counties. Roughly a quarter of the counties have a town or city with a population greater than 25,000. A binary variable capturing the presence of a large town or city is included. This information was found through the Census Bureau. County population and employment opportunities may also be influenced by the presence of a large town or city in nearby counties. In 2003, 30 percent of the counties under review were adjacent to an urban county. A binary variable that captures the presence of an adjacent urban county is included in both equations.

Model Selection

Put simplistically, this study mimics Duffy-Deno's 1998 study of the effects of Federal Wilderness on county growth in the West, but includes the percent change in timber sales, a variable used by Lewis *et al.* (2002). Both Duffy-Deno (1998) and Lewis *et al.* (2002) use a variation of the Carlino and Mills model; as such it makes sense that this study will use the same general model.

This study's empirical model is

$$P = \lambda_1 E + \beta_{2-13} \mathbf{T}_{-1} + \varepsilon_1 \quad (5)$$

$$E = \lambda_2 P + \alpha_{2-11} \mathbf{S}_{-1} + \varepsilon_2 \quad (6)$$

Where (P) represents population density, (E) represents employment density, (-1) is a one period lag, **T** and **S** are listed in Table 4, and (Ɛ) is a random error term.

The variables P and E are simultaneously determined. Simultaneity causes covariance between the independent variables through their respected error terms, prohibiting the use of an ordinary least squares approach (Keshk 2003). To overcome the problem presented by covariance, this study used a two-stage least squares approach (2SLS). Studenmund (2002) concisely describes 2SLS as

> "a method of systematically creating instrumental variables to replace the endogenous variables where they appear as explanatory variables in simultaneous equations systems."

Such an approach eliminates the problem of covariance by creating a variable that is both correlated with the endogenous variable and uncorrelated with the disturbance term (Keshk 2003). The created variable acts as a proxy for the original endogenous variable.

A key requirement of 2SLS is that both P and E be fully observed, i.e. that the actual values, P_1 and E_1, are equal to the observed values, P^*_1 and E^*_1 respectively:

$$P_1 = P^*_1$$
$$E_1 = E^*_1$$

With this criteria met, the first stage of 2SLS is to regress the endogenous variables on all exogenous variables, via OLS

$$P^* = \alpha_{2\text{-}11}\,\mathbf{S}_{-1} + \beta_{2\text{–}13}\,\mathbf{T}_{-1} + v_1 \quad (3)$$

$$= \pi_1 X + v_1$$

$$E^* = \beta_{2\text{–}13}\,\mathbf{T}_{-1} + \alpha_{2\text{-}11}\,\mathbf{S}_{-1} + v_2 \quad (4)$$

$$= \pi_2 X + v_2$$

From above, (π) is the matrix of all coefficients, (X) represents all exogenous variables, and (v) represents errors. As a result, the endogenous variables are now fully expressed by exogenous variables and their errors. Under the assumption that the summation of errors is equal to zero we arrive at estimations for P^* and E^*

$$\dot{P}^* = \pi_1 X \quad (5)$$

$$\dot{E}^* = \pi_2 X \quad (6)$$

The second stage of 2SLS calls for substituting $\dot{P}^*$ and $\dot{E}^*$ into equations (1) and (2) for P and E, respectively. This results in the equations:

$$P = \gamma_1\,\dot{E}^* + \beta_{2\text{–}13}\,\mathbf{T}_{-1} + \varepsilon_1 \quad (7)$$

$$E = \gamma_2\,\dot{P}^* + \alpha_{2\text{-}11}\,\mathbf{S}_{-1} + \varepsilon_2 \quad (8)$$

There are several common issues associated with 2SLS. As is noted by both Keshk (2003) and Studenmund (2001) both equations must be identified for accurate results. Simply put, each equation must have at least one significant exogenous variable that the other does not. Each model has at least seven variables not common to both the population and employment models. Another concern with 2SLS models is that small samples will generate biased estimates. With close to 500 counties in this study, there should be no cause for concern. A final concern revolves around the reduced-

form equation. If the reduced form equation fits poorly, then the correlation between the instrumental variables and the original endogenous variables will decrease, causing 2SLS to generate unreliable results (Studenmund 2001).

Interpreting the Results

With the goal of understanding the impact a national forest has on nearby counties, we must first consider how well the model represents those counties. The total sum of squares explained by the regression (R^2) expresses how well the estimated model fits the observations (Dougherty 2007). The maximum value for the R^2 is 1, indicating a perfect fit. Carlino and Mills' (1987) model had R^2 values of 0.99 for both population and employment. Duffy-Deno's (1998) adaptation of Carlino and Mill's model resulted in adjusted R^2 values of .98 for both population and employment. This study will look to R^2, adjusted R^2 and F-test values to interpret how well the model fits. To gain a deeper understanding of how a national forest may impact a local community, this study will examine the coefficients for those exogenous variables that are related to national forests and natural amenities. The direction, magnitude and significance of each of these variables are of interest. A t-test was used to assess the significance of each variable in the model.

CHAPTER 5: RESULTS AND DISCUSSION

Introduction

Figures 3, 4, 5 and 6 provide useful depictions of how population density and employment density have changed over time and within the study area at the state level. These figures show that overall population and employment densities increased from 1977-2000. California and Washington are clear outliers with regards to both population and employment densities. By excluding California and Washington from Figures 4 and 6 the rest of the states' population and employment densities are shown at a finer resolution than in Figures 3 and 5.

The rest of this chapter will discuss how population density and employment density have changed over time and within the study area at the county level. Included is a discussion of more than 36 variables and their influence on population and employment densities. Variable summary statistics and noteworthy correlations are presented in Tables 5 and 6 respectively. Model results are presented in Table 7.

Figure 3: Population Density

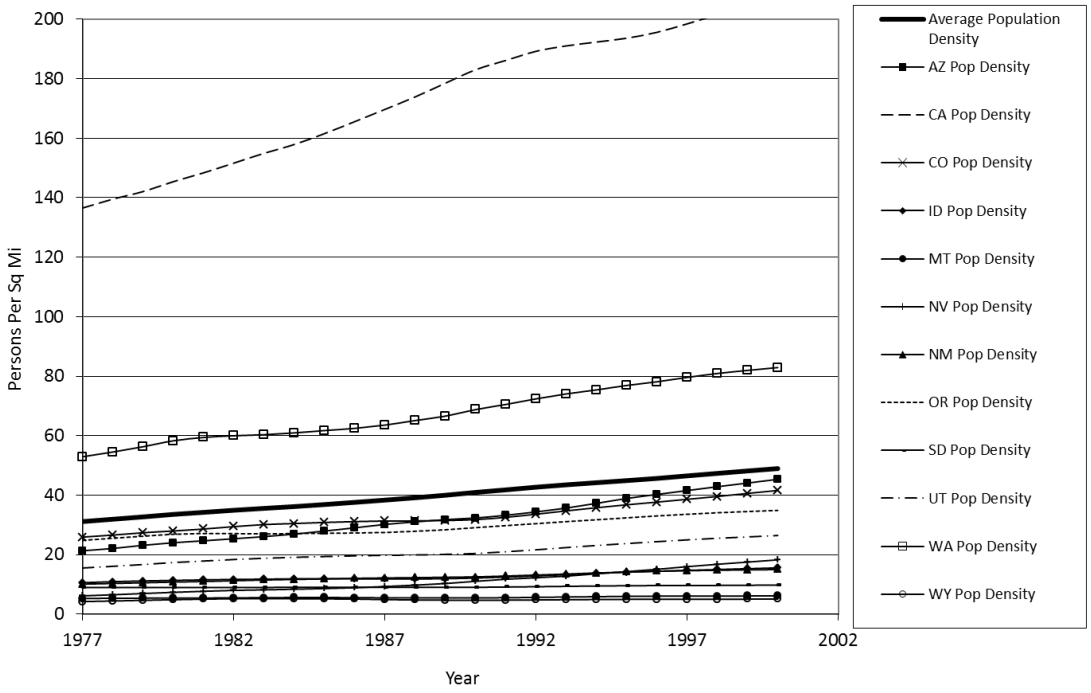


Figure 4: Population Density Excluding California and Washington

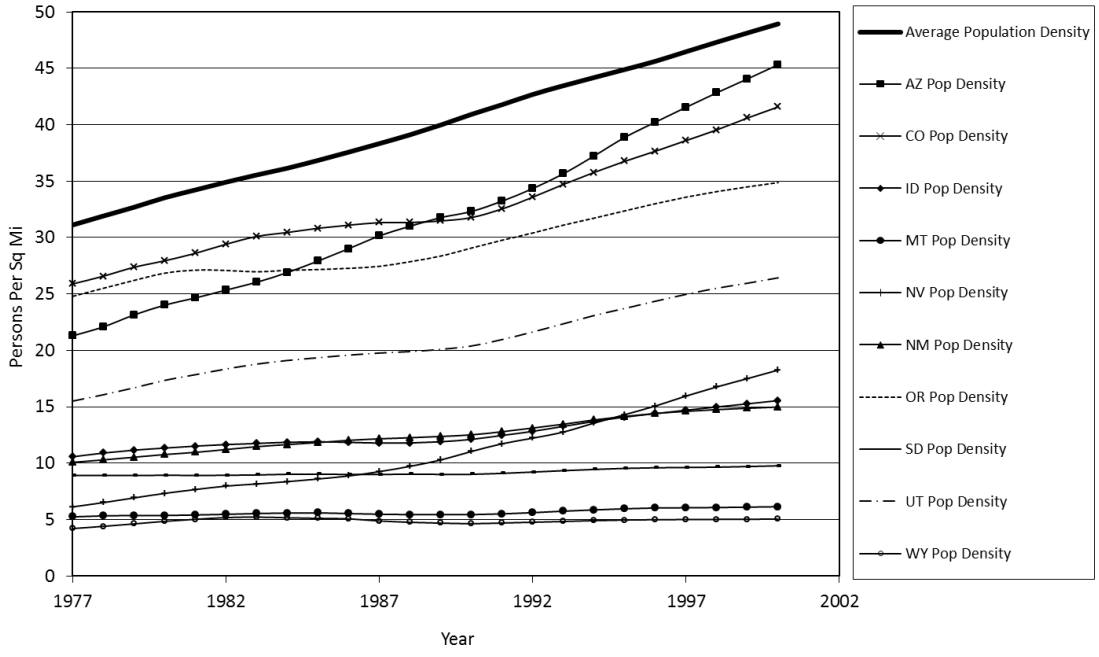


Figure 5: Employment Density

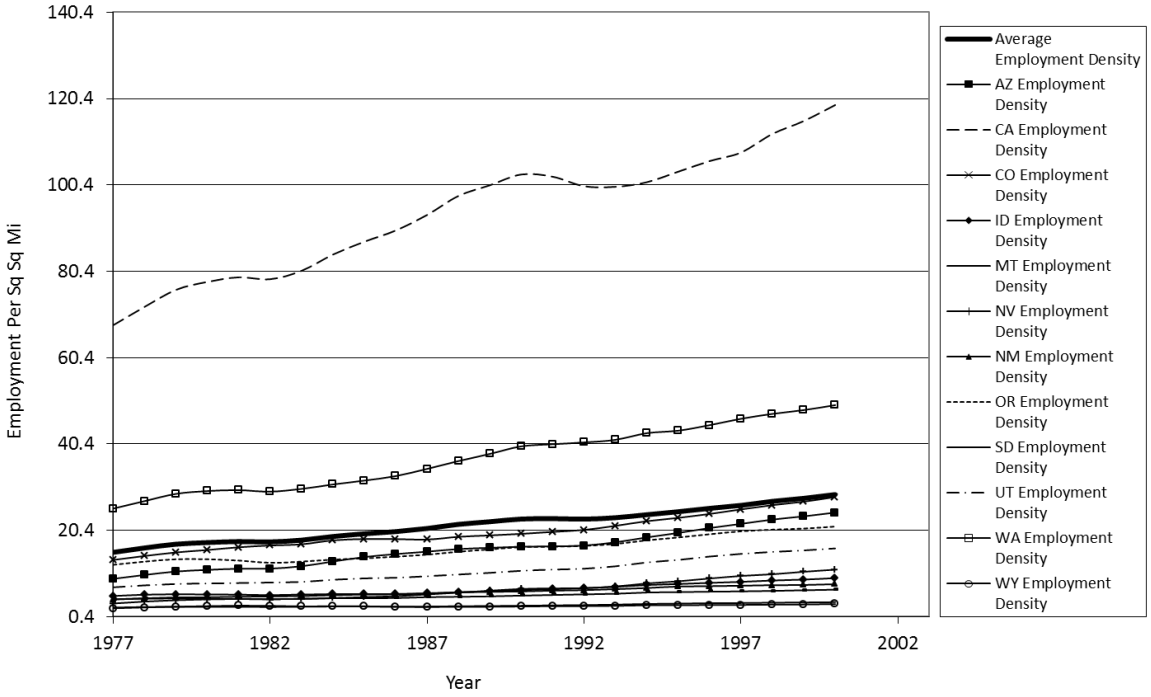
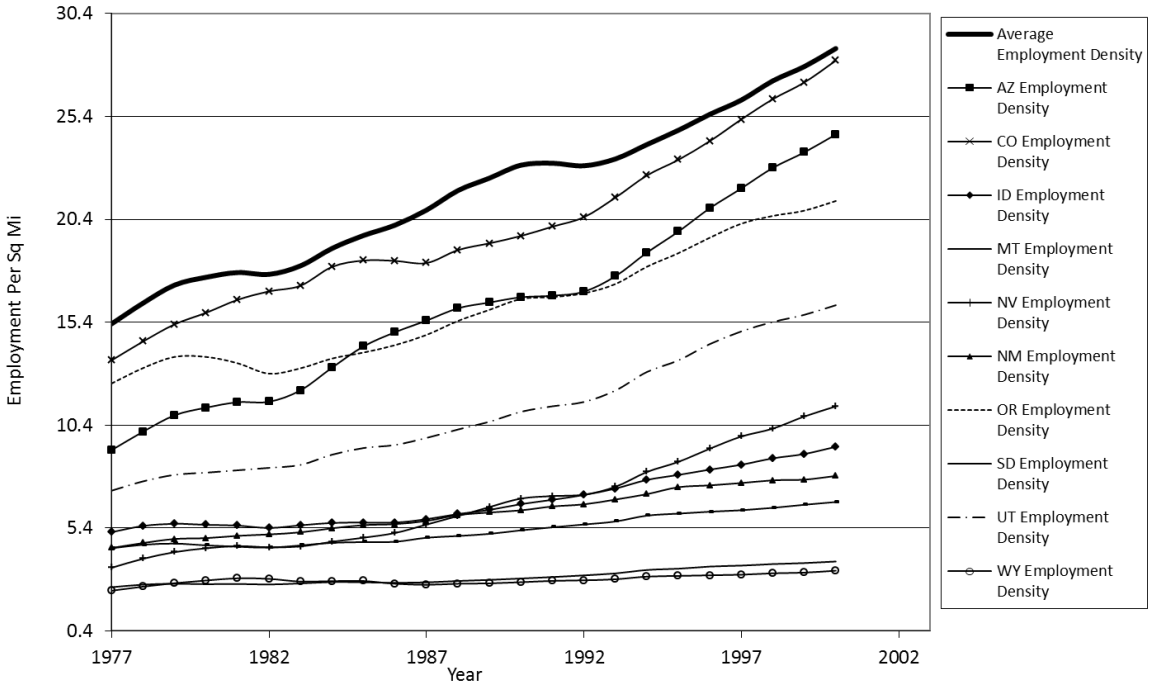


Figure 6: Employment Density Excluding California and Washington



Mean and Standard Deviation

Table 5 provides the mean and standard deviation values for the variables used in the final model, group 'A'. The variables in group 'B' on Table 5 were not used in the model, because their combined values create Ppr, Ppa, Epr, Epa and PCT_Change_Timber, respectively. However, the variables in group 'B' on Table 5 provided useful information. The means for Ppr, Ppa, Epr and Epa all fall within the means for the individual census years P77, P87, P97, P07, E77, E87, E97 and E07 respectively. The differences in direction and magnitude between PCT_Change_Timber 77-87, PCT_Change_Timber 87-97 and PCT_Change_Timber 97-07 are a cause for careful consideration. This issue is addressed and discussed later in the additional models section of this chapter.

Table 5: Select Variable Mean and Standard Deviation

Group	Variable	Mean	Standard Deviation		Variable	Mean	Standard Deviation
A	Ppr	0.13	0.49		PCT_Div_Incom	21.14	6.25
	Epr	0.08	0.39		PCT_Change_Timber*	18.20	235.65
	Ppa	0.11	0.45		PCT_Land_NF*	-0.31	7.11
	Epa	0.07	0.35		City	0.22	-
	Inpa	28518.96	8201.87		ADJ_UC	0.22	-
	PCT_Own	69.91	7.62		AZ	0.03	-
	PCT_Earn_Ser	25.10	11.14		CA	0.12	-
	PCT_Rec	0.88	1.75		CO	0.13	-
	Av_Percip	48.25	6.13		ID	0.09	-
	Av_Snow	28.95	15.75		MT	0.12	-
	PCT_Mts	38.03	38.18		NV	0.03	-
	Ski	275.46	955.78		MN	0.07	-
	River	49.31	92.71		OR	0.08	-
	PCT_Water	1.85	3.65		SD	0.14	-
	UnE	6.00	3.30		UT	0.06	-
	AV_Wage	18564.98	4153.63		WA	0.08	-
	PCT_Ed	69.88	10.00		WY	0.05	-
	PCT_Fed_E	3.02	3.67				
B	P77	0.09	0.40		PCT_Change_Timber 77-87*	128.17	179.00
	P87	0.11	0.44				
	P97	0.13	0.49		PCT_Change_Timber 87-97*	-55.62	54.02
	P07	0.15	0.53				
	E77	0.05	0.30		PCT_Change_Timber 97-07*	12.91	96.29
	E87	0.07	0.35				
	E97	0.08	0.39				
	E07	0.15	0.43				

* Summary statistics only included counties that have a National Forest present.

Correlation Coefficients

Results were generated through the use of SAS software. Pearson correlation coefficients were generated using the 'Proc_Corr' statement. This test measures the degree of association between each pair of dependent and independent variables, assigning values from -1 to 1. Of the 36 variables, eight combinations have a value greater than 0.5. Table 6 lists these eight.

Table 6: Selected Correlation Coefficients

Variables	Correlation Coefficient
Epr - Ppr	0.97
Ppa - Ppr	0.99
Epa - Epr	0.95
Ppa - Epr	0.99
Epa - Ppa	0.98
Inpa-AV_Wage	0.53
CA - AV_Percip	0.54
Av_Percip - Av_Temp	0.97

A high correlation coefficient may indicate multicollinearity between explanatory variables, making it hard to distinguish between "the separate effects of the multicollinear variables" (Studenmund 2001). A high incidence of multicollinearity can cause an increase in variances and standard errors causing estimated coefficients to be false representations of true coefficients (Dougherty 2002). Additionally, t-scores will be lowered and changes in specification may cause dramatic changes in estimates (Dougherty 2002). As such, adjusting a model to correct for multicollinearity is only required when its effects significantly suppress t-scores and create unreliable estimated coefficients (Studenmund 2001). There are a few techniques for dealing with multicollinearity.

By creating and using instrumental variables (IV) for both present population, Ppr and employment, Epr, the issues associated with their high degrees of correlation are circumvented. The variables Ppa and Epa interact only through the IV; Epa is part of the IV for Epr in the population equation and Ppa is part of the IV for Ppr in the

employment equation. This effectively means Epa and Ppa never directly interact in either model. Additionally, the correlation between Ppa - Ppr, Epa - Epr and Ppa - Epr, are uni-directional, past to present, also decreasing the cause for concern (Duffy-Deno 1998). Again, Inpa – Av_Wage are in two separate equations and only interact through the IV. This justifies a lack of concern over their moderate correlation coefficient. Still, a variable that was the combination of Inpa and Av_Wage was created and tested. This resulted in lower t-scores and p values. Since the combined Inpa and AV_Wage variable performed worse than the separated variables, multicollinearity does not appear to be a problem. California has a moderate correlation coefficient with Av_Precip and has numerous correlation coefficients with other variables in the 0.30 – 0.40 range. To make sure CA was not lowering other variable statistics, it was dropped and the model re-run. Dropping CA resulted in lower t-scores and p values for AV_Precip. Because CA and AV_Precip are significant variables and the removal of CA lowered other variables t-scores it was kept in the model, Table 7. Av_Temp is highly correlated with Av_Precip and has correlation coefficients with other variables in the 0.30 – 0.40 range. When AV_Temp was dropped from the model the only remarkable change to the model was that AV_Precip became a significant variable, Table 7. As a result, AV_Temp was dropped from the final model.

Model Results

A two-stage least square, (2SLS) method was carried out in SAS using the 'PROC SYSLIN' statement. The results can be found in Table 7. The model's performance is similar to the Duffy-Deno (1998) model. The population density equation explains 99

percent of the variance in population density between 1977 and 2007. Within the population density equation five variables are significant at the 5 percent level or better. Present employment density is significant at the one percent level and negatively influences present population density. This result is unexpected and contrary to previous studies (Carlino and Mills 1987 and Duffy-Deno 1998). One interpretation of this result is that rising employment rates increase employment competition and this creates a disincentive to migrate into an area. Simultaneously, the relationship between population density and employment density may be explained by increases in the retired population seeking amenities, not employment, or younger people leaving the area. Past population density is also significant at the one percent level. The large positive estimated coefficient for past population density, Ppa provides support to the idea that people are slow to migrate (Duffy-Deno 1998). Further, Ppa is the only variable with a coefficient greater than 1, making it the most significant exogenous variable.

The literature indicates that amenities are often significantly related to population and employment densities. Both Duffy-Deno (1998) and Lewis *et al* (2002) used percentage of homes that are owner occupied to partially account for the amenity that is a sense of community. This variable has consistently been found to be significantly and positively related to population metrics and in this study is significant at the five percent level. With temperature dropped, both average precipitation and skiing facilities were found to be positively related to population density. In addition, the amount of snow fall is significant at the 10 percent level, (p value of 0.09). The positive

relationship between precipitation and population densities may be a result of the relatively dry climate in the study area. Also, these findings suggest people are drawn to areas with abundant winter amenities. Interestingly, the t-value for snow decreased when the variable was run as a percentage of precipitation. It is worth noting that Colorado is significant at the 10 percent level, (p-value of 0.09). The amount of mountainous land might be significant if the study was expanded to include a large area that is without mountains. None of the remaining coefficients for amenity values or states were found to be significantly different from zero at the ten percent level.

The employment density model had an R^2 and adjusted R^2 value of 0.99. Within the employment density model five explanatory variables were found to be significant at the 5 percent level or better (Table 7). The positive coefficient and significance level for present population densities estimated in this model are remarkably similar to those found by Duffy-Deno 1998 and Carlino and Mills 1987. While this study only uses a simple linear equation, Duffy-Deno's 1998 study conducted both a linear and log-linear regressions. The positive coefficient for past employment levels, Epa, was expected. However, with a coefficient value less than 1, past employment does not appear to be a driver of growth. Employment density is found to be positively influenced by an area's education level. This finding highlights an inconsistency in the literature. Both Duffy-Deno (1998) and Deller and Lledo (2007) found education to be significant. However, Lewis *et al* (2002) reported education levels to be insignificant. Interestingly, the level of federal employment has a negative relationship with overall employment density as does being located in California. The variable AV_Wage was not found to be significant

at the 10 percent level. In line with this finding, Duffy-Deno (1998) concludes that production worker wage is not significantly related to employment density. The estimated impacts of education levels and wage rates on regional employment are especially important because these are two common topics amongst policy makers. The evidence presented here suggests that higher average wages have no impact on regional employment while higher levels of education lead to higher levels of employment.

Three variables PCT_Change_Timber, PCT_Land_NF and PCT_Earn_Ser were included to capture the influence a national forest has on regional population density and employment density. The variable, PCT_Change_Timber, quantifies changes in timber sales from one decade to the next. In this study, timber sales are assumed to be exports and under the economic base theory, a driver of growth (Hoover 1971). A national forest may also introduce new money into a system, and thus drive growth, through federal expenditures and tourism. Both PCT_Land_NF and PCT_Earn_Ser are used to capture these potential effects. It is worth pointing out that while neither variable is significant, the coefficient for PCT_Change_Timber is positive and the coefficient for PCT_Land_NF is negative in the employment density equation, which is in line with expectations. This lends support to two common concerns. First, decreasing timber sales decreases employment density. Second, the restriction associated with Forest Service land ownership adversely impact employment density. However, this study found these variables to be insignificant, revealing these two concerns to be not supported by the analysis. The PCT_Earn_Ser variable was incorporated into both

equations. Interestingly, PCT_Earn_Ser has a negative coefficient in the population density function and a positive coefficient in the employment density function. These findings are in concurrence with comparable investigations conducted by Duffy-Deno (1998) and Lewis *et al.* (2002). This strengthens the notion that while the service sector may generate lots of employment opportunities, they are not attractive enough to entice people to move. Neither a decrease in timber sales, brought about by environmental regulations, nor an increase in timber sales, has a significant impact on over all regional employment. Furthermore, tourism and federal aid associated with national forests do not appear to be drivers of growth. This finding should aid policy makers in their decision making.

Additional Models

In addition, the variable 'PCT_Change_Timber' was replaced with various other measures of timber sales. The variations included timber volume sold measured in millions of board feet, volume sold measured in 1990 dollars and percent change in volume sold measured in 1990 dollars. None of these alternative metrics for volume sold resulted in significant coefficients in the employment function. While the correlation coefficient between PCT_Change_Timber and PCT_Land_NF is only 0.41, the model was also run with only one of the two variables. Neither combination of dropped variables resulted in the other becoming significant at the 10 percent level. Additionally, the model was run with only the counties that have a national forest present and with a dummy variable for the presence of a national forest. Neither of these variations resulted in changes in the model's performance. Finally, the log and

square root of PCT_Change_Timber and volume sold were used as variables. None of these manipulations resulted in a significant relationship between timber sales on national forests and county employment.

Due to concern over the long time period this model spans, the data was subdivided into three groups: 1977-1987, 1987-1997 and 1997-2007. Each group was then run through the 2SLS method. This process neither resulted in higher R^2 values nor significantly changed the coefficients.

Table 7: Population and Employment Density Results

	Population Density, Present		Employment Density, Present	
	Coefficient	*t-statistic*	Coefficient	*t-statistic*
Intercept	-0.0690***	-3.02	-0.0151**	-1.98
Ppr			0.2024***	39.14
Epr	-0.2639***	-17.49		
Ppa	1.3165***	96.18		
Epa			0.8530***	124.7
Inpa	-8.86E-08	-0.01		
PCT_Own	0.0004**	2.3		
PCT_Earn_Service	-5.96E-7		0.0001	1.26
PCT_Rec	0.0003	0.45		
AV_Precip	0.0009**	2.22		
AV_Snow	0.0001*	1.7		
PCT_Mts	-0.00004	-1.21		
Ski	5.188E-6***	4.04		
River	-1.46E-6	-0.12		
PCT_Water	-0.0001	-0.37		
City	0.0176	6.27		
ADJ_UC	-0.0034	-1.4		
UnE			7.584E-6	0.03
AV_Wage			-3.8E-7	-1.6
PCT_Ed			0.0003***	4.31
PCT_Fed_E			-1.88E-6***	-6.52
PCT_Div_Incom			-0.00011	-0.81
PCT_Change_Timber			4.48E-6	0.59
PCT_Land_NF			-0.00045	-1.24
AZ	-0.00568	-0.65	0.0052	1.21
CA	-0.00618	-0.95	-0.0077**	-2.48
CO	0.0075*	1.69	0.0038	1.46
ID	0.0023	0.52	-0.00017	-0.06
MT	0.0021	0.5	-0.00024	-0.09
NV	0.0079	1.14	0.0030	0.62
NM	-0.0070	-1.26	0.0028	0.89
OR	-0.0010	-0.2	0.0007	0.23
UT	0.0071	1.32	0.0023	0.69
WA	0.0039	0.74	-0.00009	-0.03
WY	0.0023	0.41	0.0002	0.04
R^2	0.99		0.99	
Adjusted R^2	0.99		0.99	
F Value	11259	P <.0001	18884	Pr <.0001

** Significant at the 10% level: **Significant at the 5% level: *** significant at the 1% level*

CHAPTER 6: CONCLUSIONS

German (1999) succinctly wrote "social conflicts over the management of natural resources are increasing". In short, the importance of non-extractive resource uses has come to parallel the importance of extractive resource uses. This turn of events adds complexity to the Forest Service's mission to both care for the land and serve people. Additionally, the Forest Service's national scope provides ample opportunities for conflictive uses. Frequent and intense conflict will continue for as long as non-extractive and extractive resource uses and the economic benefits from both types of uses are perceived to be mutually exclusive. The thesis presented here informs this conflict by investigating the effect of timber sales and the presence of natural amenities on population and employment at the county level.

The hypothesis that amenities have a statistically significant and positive influence on population density was not rejected. While not every metric for amenity values was found to be significant, the following three were at the 5 percent Type – I error: owner-occupied, which served as a proxy for the sense of community, skiing amenities, and precipitation levels. This leads to the conclusion that national forests managers can best influence population by maintaining skiing facilities.

The hypothesis that decreased timber sales from national forests have a statistically significant and negative influence on employment density was rejected. Table 7 shows that this study found an insignificant relationship between changes in timber sales and employment density. This is in line with the results from Lewis *et al's.*

(2002) study of the northeastern forests. Related to these findings are the Duffy-Deno (1997 and 1998) studies on the economic effects of the Endangered Species Act and Wilderness Act; both sets of results failed to find significant relationships between the implementation of the Acts and regional economic performance. It is possible that change in timber sales is significantly related to employment density in individual towns, and that the county level was not the correct level of measurement. The combined conclusions of Duffy-Deno and the results of this thesis undermine the credibility behind the concept that environmental regulations and their impacts on extractive resource uses negatively affect local economies.

Limitations of the Research Methods

The approach used to examine the importance of amenities in this study is potentially hindered by variable selection bias (Deller 2001). For example, this study only included the amount of land owned by the Forest Service, measured as a percentage of individual counties. This study did not include land owned by the BLM, National Park Service, or other federal agencies. Nor did it factor in state land ownership, limiting how the results can be interpreted and compared to other studies. Selection bias can also be introduced through how variables are measured. The Carlino and Mills model used in this study found a significant relationship between the presence of skiing facilities and population while Duffy-Deno (1998) did not. However, these two studies use different variables, which make comparisons difficult. In this model, skiing is a continuous variable generated by the NORSIS data set. In Duffy-Deno (1998), skiing is a dummy variable, capturing the presence of a destination ski resort or lack thereof.

Principle component analysis presents a solution to this issue of ambiguous amenity variables. It does so by systematically incorporating many variables into a few principle components. For example, a principle component for land would combine all forms of land ownership, cover and terrain, into a single value. Deller *et al.* (2001), Kwang-Koo *et al.* (2005) have both developed and practiced this approach from the NORSIS data set, but found conflicting results. Deller *et al.* (2001) found that with regards to changes in population, employment and net income, principal component variables for climate, developed recreation facilities, land, water, and winter attributes were all significant in explaining at least one of the three dependent variables. Kwang-Koo *et al.* (2005) found no significant relationship between natural amenities and population growth, retail and service employment, income growth, or changes in the Gini index. The hypothesis of the thesis presented here could be further examined by using principle component values for natural amenities. The principal components method would both enhance the explanatory power of the model and allow for additional comparisons between studies. However to do this, the variables included in the NORSIS data set, would need to be gathered for earlier time periods since they currently only extend back to the 1990's.

Directions for Future Research

While conclusions from the empirical analysis expanded our understanding of how national forests impact local economies, questions do remain. In addition to not using the principal components analysis, this study did not take into consideration the amount of money visitors spend at national forests. This money is captured in the

earnings from the service sector. However, with forest visitation on the rise, the interest in this value will increase and should be explicitly examined. Other types of federally owned lands are included in this study only through the variable Per_Rec. Lands owned by the BLM, NPS, and states ought to be examined both individually and collectively. An individual approach would capture differences in management, perception and use. A collective approach that distinguished between different levels of government land ownership would provide insight into preferences for protected lands and open access. This study could also be expanded to include the sale of minerals and natural gas from federally owned lands. Additionally, including variables that capture employment specifically in the forestry sector might show that there have been impacts on that sector even if employment more generally was not significantly affected by changes in timber sales.

Another lens through which we can study the impact of the Forest Service National Forest System is through changes in the characteristics of places and interpersonal relationships (Johnson 2006). Consider that the standard deviation for the percent change in timber sales in general and specifically from 1997 – 2007 is quite large (Table 6), suggesting that there are outliers. One point to research further is whether these outliers can be explained through differences in place and interpersonal characteristics. A final item on the research agenda is to look at the Endangered Species Act, National Environmental Policy Act and Wilderness Act to determine if these policies changed the relationships between Forest Rangers and local business interests.

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