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Impacts of national forests in the West on county population and employment

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Impacts of national forests in the West on county population and employment

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ABSTRACT

This study seeks to understand the manner and extent to which western national forests influence an area's overall population and employment growth by evaluating changes in management emphasis from single to multiple uses. The Carlino and Mills model was used to examine county level data from 12 western states over the period 1977–2010. Changes in timber sales and the amount of land owned by the Forest Service were not found to be significantly related to employment growth.

1. Introduction

The National Forest System of the U.S. Forest Service has been called "an experiment in land management," but it is also an experiment in resource, environmental, and regional economics (Steen, 1991). Over the past 100 years the U.S. Forest Service has grown to encompass 193 million acres of land. This land has been divided into 155 national forests and 20 national grasslands distributed across 41 states with the majority located in the West. According to the Government Accountability Office, in 2009 the U.S. Forest Service employed approximately 30,000 people. In that same year, the U.S. Forest Service had an annual budget of $5.5 billion (U.S. Forest Service, 2010). Throughout its history, the U.S. Forest Service has worked with local communities, enterprises, and non-governmental organizations to promote both economic and environmental prosperity. Promoting economic interests was relatively simple when resource extractive uses, e.g. timber and mineral harvesting, were the primary activity; however, over the past several decades, non-extractive uses, e.g. tourism and wildlife protection, have come to parallel extractive uses (MacCleery, 2008).

Currently, there are active debates over how management of the National Forest System impacts nearby communities and their economies (Chen and Weber, 2011; Eichman et al., 2010; Moseley and Reyes, 2008; and Rasker et al., 2013). As indicated by Force et al. (1993) in their long-term case study of a timber-dependent community in north Idaho, factors that affect timber production affect employment in such communities. The objective of this research is contribute to that debate by examining what effect changes in management of national lands managed by the U.S. Forest Service have had on a broader scale, i.e. county-level population and employment. More specifically, have the decreases in timber sales experienced in national forests caused a change in employment?

2. Background

Society values national forests in many ways. The discipline of economics identifies four types of values; direct use, indirect use, option to use and nonuse (Pearce, 2001). Direct use refers to both consumptive and non-consumptive uses of forest resources that directly enter production or utility functions of agents. Two examples of direct use are timber extraction and tourism, both of which are understood to create local employment opportunities. Indirect use value arises from forest services that are an input into production of goods or services that we value, e.g. watershed protection provides cleaner water thus reducing treatment costs for drinking water, and may have impacts on fisheries (Pearce, 2001). Option to use values are potential future uses of forest products or services, e.g. a timber harvest in 15 years or a

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camping trip next spring. Nonuse or existence values are not related to current or planned consumptive or non-consumptive uses of the resource. People may value knowing that habitat for a species such as the spotted owl is protected, even though they do not plan to visit those forests (Pearce, 2001). Nonuse values of a forest are not known to create many employment opportunities.

Initially, the U.S. Forest Service played a custodial role on its land. As is depicted in Fig. 1, after World War II, the U.S. Forest Service shifted to active management; dramatically increasing harvest from less than 2 billion board feet in 1940 to more than 10 billion board feet in 1963 (Burnett and Davis, 2002). This change was applauded by many. Regional economies benefit both from increased employment opportunities and from revenue-sharing policies, which redirect 25% of all revenue from timber sales to local governments (Burnett and Davis, 2002). Concurrent with this period of flux, was an increase in tourism and environmentalism. In 1946, recreational use of national forest equaled 18 million visitor-days; in 1999 recreational use surpassed 1 billion visitor-days (Williams, 2007).

Eventually, conflict among those who were interested in timber production, recreational use, and environmental stewardship would lead to new legislation and government policy including, but not limited to, the Multiple-Use Sustained Yield (MUSY) Act, the Wilderness Act of 1964, the National Environmental Policy Act (NEPA), the Endangered Species Act, the National Forest Management Act, the Roadless Area Conservation Rule, and the Healthy Forest Restoration Act. The goal of these policies was to transition the U.S. Forest Service from a volume timber producer to an agency that manages for indirect, option, and nonuse values. One result of this transition was the dramatic reduction in timber sold from the National Forest System, starting in the 1990s. Another outcome is that the National Forest System now includes 36 million acres of lands designated as wilderness, a designation that prohibits resource extraction (Wilderness Act, 1964). The decrease in timber coming from National Forest System lands reduced the supply to timber mills, prompting many to close, thus reducing employment opportunities. Chen and Weber (2011) report that "two-thirds (282) of the 405 Oregon lumber mills operating in 1980 closed during the following three decades." Further, the decrease in national forest timber sales reduced federal revenue sharing with local governments. To stabilize these revenues, the Secure Rural Schools and Community Self-Determination Act (Public Law 106–393, 2000) was passed in 2000. Subsequently, since 2001, counties and schools in 42 states have received payments through this Act (Governor's Task Force, 2009). Federal conservation-based development programs were also created (Moseley and Reyes, 2008). In addition, there was federal funding for rural development (Chen and Weber, 2011).

Managing forests for all four forms of forest values has spurred much debate over the trade-offs between conservation and extractive uses (Duffy-Deno, 1998; Lewis et al., 2002). In practice, the U.S. Forest Service found itself in the middle of disputes between demands for ecosystem services and commercial logging activity. The U.S. Forest Service frequently lost credibility as it attempted to satisfy conflicting demands set forth by the timber industry, environmental groups, the tourism industry, and local and national politicians. Numerous studies questioned if and how the enforcement of national legislation impacted population, employment, and economic growth in areas around national forests (Chen and Weber, 2011; Duffy-Deno, 1998; Eichman et al., 2010; and Rasker et al., 2013), with differing results. A study by Eichman et al. (2010), which looked at the 73 counties affected by the Northwest Forest Plan, found that between 1994 and 2003, the presence of reserved land slowed employment growth by 0.23%. However, Rasker et al. (2013) found positive relationships between protected public lands, and three measures of economic growth between 1990 and 2010, after controlling for a variety of factors. Chen and Weber (2011) found that results varied by decade. In the 1990's, in Oregon, proximity to reserved land increased population, while mill closures during this period had no effect on population but did reduce industrial property values. In addition to changes in timber production, community employment can also be affected by issues such as technological change in the forestry industry and labor disputes (Force et al., 1993).

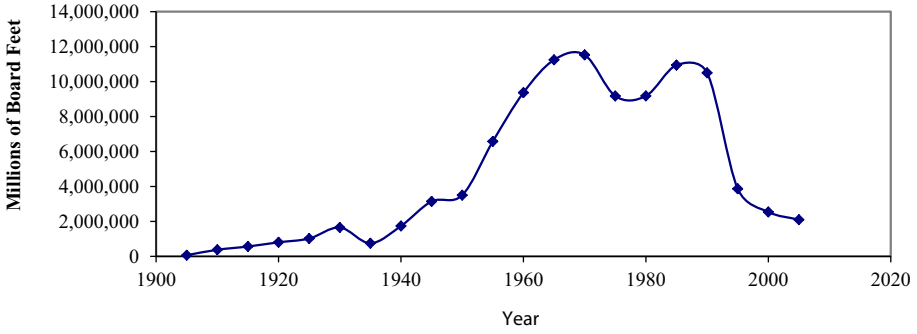
The objective of the current study is to determine if and how national forests impact county-level population and employment growth. Ideally, the results of this research will inform policy makers on the relationship between public forestland policy and growth and prosperity in the surrounding areas. Specifically this research addresses whether changes in the amount of timber sold impacted aggregate county employment.

This question is aimed at evaluating the impact of changes in the extractive use of national forests on employment growth. While we recognize changes in policy of this nature will likely have differential impacts by sector (such as those found by Nielsen-Pincus et al. (2014) after wildfires), we are primarily interested in this paper on the overall impact of these policy changes. We would expect that reduced sales would negatively impact employment in the local forestry sector; however, it is not obvious how total employment at the county level will be affected. If job losses in the forestry sector are offset by job growth in other sectors, for example, recreational or tourism related industries, the overall impact could be neutral, or perhaps even positive.

The next section will provide a literature review of the previous studies, models, and variables that are pertinent to this study. The subsequent sections explain the conceptual model used for analyzing population and employment growth, and detail the data and methods used in this study. The final two sections present and discuss the results of the regression model and summarize the major findings and ideas for future research.

3. Previous studies of economic impacts of land use policy

Land use is of special interest to regional economics. Decisions related to the direct use of forest resources can be easily directed by the price



Source: U.S. Forest Service. 2011. Cut and Sold Reports.

Fig. 1. Historical volume of timber harvested from the National Forest System.

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 have profound impacts on regional economies (Pearce, 2001). As such, this implies a role for public policy involvement in forest management, including "direct controls upon land use" (Hoover, 1971).

To what extent does land use policy detract from or contribute to a region's economy? A now common approach to answering this question is the application of the Carlino and Mills' model, which simultaneously models an interregional area's population and employment densities (Carlino and Mills, 1987). In addition, the Carlino and Mills' model incorporates economic, demographic, and climatic variables. This model has a spatial framework to the extent that the selected exogenous variables capture the peculiarities of space (Boarnet et al., 2001). In accordance with Boarnet et al.'s (2001) findings, this study uses lagged exogenous variables to capture their impacts and influence on present endogenous variables.

Duffy-Deno (1998), Lewis et al. (2002) and Deller and Lledo (2007) demonstrate how regional economists have attempted to capture the impact national forests exert on regional development. While each article reviewed different study areas and included varying exogenous factors, all three used a version of the Carlino and Mills model and guided the development of our study.

Duffy-Deno's (1998) paper attempted to investigate the common concern that wilderness designation will negatively impact rural county economies. Many have speculated that wilderness designation of federal lands can lead to a decrease in local employment opportunities in extractive resource industries (Duffy-Deno, 1998). This interaction between wilderness and employment assumes that extracting resources from wilderness lands was economically viable. This may not be the case. An alternative idea was that wilderness as an amenity would attract firms and thus increase employment. Focusing on the intermountain west because of the high percentage of land owned by the federal government, Duffy-Deno found no discernible relationship between federal wilderness and population density or total employment density. However, Duffy-Deno did not explicitly account for the dramatic changes in timber sales on national forests that occurred during his study period, 1980–1990.

Lewis et al. (2002) studied counties with a large percentage share of publicly owned land in the northern forest region, defined by the authors as an area ranging from northern Minnesota to Maine, and distinguished between strictly preservation lands and multiple-use lands. In that study, preservation 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 from national forests. Neither the amount of public land nor changes in timber sales had a significant effect on regional employment growth (Lewis et al., 2002). However, net migration was slightly higher in counties with more conservation lands. 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. This could have potentially misrepresented the impacts reductions in timber sales from publicly owned lands have on neighboring economies. Also, much of the controversy regarding management changes relates to the Northwest Forest Plan, which, as Eichman et al. (2010) point out, affected an area where timber acreage and production were greater.

Deller et al. (2001) contend that the rudimentary amenity values used by Duffy-Deno and others fail to measure the vital role amenities have on regional development. Kwang-Koo et al. (2005) clarify the perceived roles amenities have in regional development. First, a region's tourism industry may be latently dependent on a combination of regional amenities. Second, it is this combination of amenities that influences human migration and firm location decisions through increasing regional quality-of-life attributes (Kwang-Koo et al., 2005). The new people and firms attracted by high amenities can potentially be drivers of economic growth, as demonstrated by Rasker et al. (2013), who examined the effect of protected federal lands in the West. In Oregon, Chen and Weber (2011) found that proximity to protected lands increased population in the 1990's.

Deller and Lledo (2007) use a principal component method to assess the influence of combined amenity values in rural Appalachia, an area which is both historically dependent on extractive industries and well-endowed with natural amenities. Their results show that depending on location, land characteristics are significant in explaining income growth. Furthermore, climate, recreational infrastructure, and water amenities are statistically significant in explaining changes in employment. While other studies found evidence that amenity values explained net migration, Deller and Lledo found no significant relationship between amenity values and population growth in rural Appalachia.

This study will draw on the approaches used by three previous studies either in its conceptual framework, data, or methods. More specifically, this paper expands upon Duffy-Deno's (1998) study area and period. This study includes nearly three-quarters of all National Forest System lands and covers 12 states: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington and Wyoming. Of the 477 counties located in the study area, the U.S. Forest Service owns an average of 17% of each county; in 30% of the counties studied, it owns more than 25% of the land and in several counties it owns more than 80% of the land. The large percentage of National Forest System lands as well as the variation in percentage of the land owned provides an appropriate context to examine the significance of the U.S. Forest Service on regional economies.

In an attempt to better capture the impact changes in management policy have had on regional growth, this study will include a variable that accounts for the changes in national forests' timber sales, similar to Lewis et al. (2002). This variable is more specific than examining county-level performance before and after a policy change, as was done by Eichman et al. (2010). Timber sales are of interest because they generate opportunities for employment and added income from exported goods. As such, it is hypothesized that any management policy that leads to the reduction in timber sales will reduce the opportunities for employment generated from a national forest. To more fully capture how changes in timber sales affect county-level economies, the study period starts in 1977 and extends to 2007. Overall, timber sales were radically reduced during this period; however, the period also captures two peak-to-nadir cycles (Fig. 1). This combination of study area, period and variables should provide a more general understanding of how national forests impact county population and employment growth through timber sales.

4. Model

Following the trend established by Duffy-Deno (1998), Lewis et al. (2002) and Deller and Lledo (2007), this study will use the Carlino and Mills model to test our hypothesis that decreases in timber sales from national forests have a statistically significant and negative influence on county-level employment growth.

The Carlino and Mills (1987) model assumes that firms and households are geographically mobile. Households seek to maximize utility, which in indirect form, is a function of wages, rents and other location specific characteristics including nonmarket amenities. Firms maximize profits in competitive markets, where profits depend on wages, rents and other location specific attributes. In particular, firm productivity varies over locations due to differences in regional comparative advantages, including but not limited to, transportation costs and labor costs, amenities and land-use controls (Carlino and Mills, 1987). Firms and households migrate across regions until utility and profit levels are equalized across locations. Equilibrium levels of population (P^*) and employment (E^*) are determined simultaneously and are affected by a

Table 1
Population and employment growth variables.

Variable	T variable	S variable	Source
Log of lagged initial population	X		E
Log of lagged initial employment		X	D
Population growth		X	E
Employment growth	X		D
Log lagged median household income (1990 dollars)	X		E
Percent housing owner occupied	X		E
Percent of earnings from service sector	X	X	D
Percent of earnings from retail sector	X	X	D
Percent of county dedicated to recreation	X		C
Average precipitation (CM)	X		C
Average temperature	X		C
Percent of county mountainous	X		C
Ski area (square miles)	X		C
Miles of river	X		C
Percentage of county under water	X		C
Unemployment (rate)		X	B
Average wage per job (1990 dollars)		X	D
Percentage of population with college education		X	B
Percentage of employment that is federal		X	D
Percentage of inc. from dividends, interest and rents		X	D
Percent change in timber volume sold		X	A
Percent of county owned by National Forest Service		X	A
Town or city population ≥ 25,000 (base: no)	X		E
Adjacent to a urban county (base: no)	X		F
State (base: South Dakota)	X	X	E

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

bank of other location specific exogenous factors, **T**, and **S**, respectively (Table 1). This leads to the simultaneous equations:

$$P^* = \alpha_0 E + \boldsymbol{\alpha}'\boldsymbol{T} \quad (1)$$

$$E^* = \beta_0 P + \boldsymbol{\beta}'\boldsymbol{S}. \quad (2)$$

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

$$P_t = P_{t-1} + \lambda_P(P^* - P_{t-1}) \quad (3)$$

$$E_t = E_{t-1} + \lambda_E(E^* - E_{t-1}). \quad (4)$$

The *t* subscript references time periods and the range for the speed-of-adjustment coefficients λ_P and λ_E falls between zero and one. Bringing the lagged values of P and E to the left hand side of the equation and substituting for their equilibrium values, the theoretical model takes on the form of:

$$\Delta P = P_t - P_{t-1} = -\lambda_P P_{t-1} + \lambda_P \alpha_0 E + \lambda_P \boldsymbol{\alpha}'\boldsymbol{T} \quad (5)$$

$$\Delta E = E_t - E_{t-1} = -\lambda_E E_{t-1} + \lambda_E \beta_0 P + \lambda_E \boldsymbol{\beta}'\boldsymbol{S}. \quad (6)$$

Note that the model results in population and employment growth being contingent on their lagged values, the other endogenous variable, and a vector of exogenous variables. We estimate the model using three-stage least squares estimation to account for the simultaneity of the dependent variables and to allow for cross-equation correlation of the error terms.

5. Data and Methods

Similar to other studies of this nature, the data used to estimate Eqs. (5) and (6) are county-level data. The county is an appropriate level to examine broader employment effects since labor market areas, as defined by the Bureau of Labor Statistics (2014), often coincide with counties in the West and since 73% of people work in their county of residence (Pisarski, 2006).

Population growth, an endogenous variable in this study, was calculated using county populations from the 1977, 1987, 1997 and 2007 bi-annual economic censuses. It is hypothesized that population growth depends on present employment growth 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; Lewis et al., 2002). The first exogenous variable is lagged population. Because we have written the equations in terms of growth rates, the coefficient on lagged population allows us to examine convergence in the data. Given the negative sign in front of the coefficient in Eq. (3), if the coefficient on lagged population is positive, it implies that on average, counties with higher past values of population grew more slowly. This is consistent with convergence (Barro and Sala-i-Martin, 1992). In contrast, if this coefficient is negative, it suggests that counties with higher past values of population grow more quickly, which is consistent with divergence.

This study uses lagged median household income provided by the Census Bureau 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. There is an expected positive relationship between median household income and population growth (Carlino and Mills, 1987). Additionally, persons are expected to be drawn to areas that offer a strong sense of community and a variety of services (Carlino and Mills, 1987). These characteristics are

captured by including the percent owner occupied homes, the percent earnings generated by the service and retail sectors, and the percent of county area dedicated to recreation. The earnings generated by the service and retail sectors and area dedicated to recreation capture the significance of non-extractive resource use in the county and are included to control for sectoral diversity in the local economy.

It is important to control for the role natural amenities exert on population growth. As such, this study included a bank of natural amenity characteristics from the National Outdoor Recreation Supply Information System (NORSIS) data set that encompasses county-level data from the entire U.S. and catalogs 3,116 observations and 492 variables (Betz, 1997). The data set inventoried individual county characteristics gathered between 1987 and 1997, making it impossible to measure change over time. As such, it is implicitly assumed that the amount of natural amenities present at the county level including: percent recreational area, average precipitation, average temperature, and the presence of mountains, skiing area, rivers and open inland water, are constant.

Employment growth is the second endogenous variable in this model. Today's employment growth is explained by today's population growth as well as several other exogenous variables. The first variable is lagged employment. Again, exogenous variables are lagged to account for simultaneity and direction of causation (Carlino and Mills, 1987; Duffy-Deno, 1998; Lewis et al., 2002). Based on these previous studies this is expected to have a positive relationship with today's employment growth. Interestingly, past unemployment rates too, are expected to be positively related to today's employment. This may potentially be because firms are attracted to regions with high unemployment (Carlino and Mills, 1987). The second variable is average wage per job. It is expected that firms are attracted to counties with low average wages (Duffy-Deno, 1998). The third variable is the percentage of the population that has a college degree. Firms are expected to be attracted to areas with higher education rates (Carlino and Mills, 1987). 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, as well as income from dividends, interest and rents, are included in this model to account for this potential employment generation.

In light of the substantial amount of land the U.S. Forest Service holds in this area, it is important to understand the effect, if any, that a national forest has on employment. Table 1 lists the three variables that are used to assess the effect a national forest has on county employment. They are the percentage of employment that is federal employment, the percent change in timber sales, and the percentage of the county owned by the national forests.

The effect federal expenditures have on present employment growth is captured through the variable percent employment that is federal. Serving as a source of imported money, federal employment is expected to have a positive relationship with employment growth. 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 is a source of imported money and thus increases employment (Hoover, 1971). Conversely, a decrease in timber sales would decrease the amount of money imported into a community and in turn decrease employment. Percentage changes in timber sales were calculated as the base year timber sales (e.g. 1977) subtracted from the sales ten years later (e.g. 1987), divided by the base year sales, using data from the annual cut and sold reports provided by the U.S. Forest Service. Alternative measures of timber sales were used to verify the robustness of the findings, as discussed at the end of the results section.[1] The restriction federal land ownership exerts on land-based commercial enterprise is accounted for by the variable percent land owned by the U.S. Forest Service. The percent of land owned by the U.S. Forest Service is expected to have an inverse relationship with employment growth when controlling for natural amenities.

Four structural variables were included in the population and employment equations. 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 in the population equation (U.S. Census Bureau, 2012). County population may also be influenced by the presence of a large town or city in nearby counties. In 2003, 30% of the counties under review were adjacent to an urban county. A binary variable that captures the presence of an adjacent urban county is therefore included. 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. South Dakota serves as the base. Dummy variables for decade are also included as a control variable with the 1987–1997 period serving as the base. Table 2 provides the range, means and standard deviations for the variables used in the final model.

6. Results and discussion

We estimate the model using three-stage least squares (3SLS) estimation to account for the simultaneity of the dependent variables and to allow for cross-equation correlation of the error terms. The results can be found in Table 3. Given the large number of independent variables, multicollinearity may be a concern. Diagnostic tests found no evidence that mulitcollinearity was an issue in our model, so we retained the full set of regressors.[2] The coefficients provide the marginal effects of changes in the independent variables on population and employment growth, all else equal. For example, if the percent of earnings from the services sector were to increase by 0.1 from the mean of 0.25 to 0.35, the model implies that population growth over a ten year period would be slower by less than 1% (0.007), holding all other factors unchanged.

The population growth equation explains 71% of the variance in population growth between 1977 and 2007. Using Fields' decomposition (Fields, 2003) we find that 47% of the variation in population growth is explained by employment growth, followed by lagged population (11%). Within the population growth equation seven variables and nine state dummies are significant at the 10% level or better. The time period dummy variables are also significant and negative, indicating that population growth decreased over the course of the study period, all else equal. Present employment growth is significant at the 1% level and has a positive influence on present population growth, in line with previous studies. The overall magnitude of the influence on population growth is relatively large. The log of lagged population is also significant at the 1% level, although the coefficient is fairly small.

The literature indicates that amenities are often significantly related to population and employment. 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 was found to be significantly and positively related to population growth at the 5% level. However, with a coefficient of 0.072, the magnitude of influence homeownership has on present population growth is not strong. Population growth was negatively affected by the percent of earnings in both the service and retail sectors. We had hypothesized that these amenities might attract people to the area. On the other hand, these sectors may not provide high enough wages to attract

[1] To check the robustness of results, data for alternative measures of timber sales were collected. These include 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.

[2] To examine multicollinearity, we used the _rmcoll command in Stata to detect multicollinearity problems. The results do not flag any of the variables to drop because of collinearity. As an alternative check, we ran the equations separately using OLS and computed the variance inflation factor for each. The mean VIF for the population growth equation is 2.05 and 2.02 for the employment growth equation. These values are well below the rule of thumb that a VIF > 10 indicates collinearity problems (Kennedy, 2003, pg. 213).

Table 2
Select variable means and standard deviations.

Variable	Variable name	Range	Mean	St. dev.
Ln (lagged initial population)	*Ln lag P*	6.14–16.04	9.81	1.66
Ln (lagged initial employment)	*Ln lag E*	5.21–15.44	9.09	1.67
Population growth	*Popgr*	−0.49–1.02	0.10	0.18
Employment growth	*Empgr*	−0.86–2.06	0.18	0.21
Ln (lagged median household income (1990 dollars))	*Ln lag Inc*	0.16–2.06	1.01	0.27
Percent housing owner occupied	*Pct_Own*	0.33–0. 89	0.70	0.08
Percent of earnings from service sector	*Pct_Earn_Ser*	0.01–0.96	0.25	0.11
Percent of earnings from retail sector	*Pct_Earn_Ret*	0.01–0.50	0.17	0.06
Percent of county dedicated to recreation	*Pct_Rec*	0–13	0.88	1.75
Average precipitation	*Av_Precip*	0–2.25	0.53	0.37
Average temperature	*Av_Temp*	37.2–71.3	48.25	6.13
Percent of county mountainous	*Pct_Mts*	0–1	0.38	0.38
Ski area (square miles)	*Ski Area*	0–1.69	0.03	0.15
Miles of river	*River Miles*	0–6.29	0.05	0.93
Percentage of county under water	*Pct_Water*	0–0.58	0.19	0.04
Unemployment (rate)	*UnE*	0.005–0.28	0.06	0.03
Average wage per job (1990 dollars)	*Av_Wage*	1.09–3.96	1.86	0.42
Percentage of population with college education	*Pct_Coll Ed*	0.04–0.60	0.17	0.08
Percentage of employment that is federal	*Pct_Fed_E*	0.002–0.40	0.03	0.04
Percentage of inc. from dividends, interest and rents	*Pct_Div_Inc*	0.04–0.50	0.21	0.06
Percent change in timber volume sold[a]	*Pct_Change_Timber*	−3.30–2.33	−0.24	0.83
Percent of county owned by national forest service[a]	*Pct_Land_NF*	0–0.93	0.17	0.22
Town or city population ≥ 25,000 (base: no)	*City*	0–1	0.24	0.43
Adjacent to a urban county (base: no)	*Adj. _UC*	0–1	0.22	0.42

[a] Statistics only include counties that have a National Forest present.

people who plan to live and work in the area. Of the variables relating to climate or natural amenities, only temperature was significant in predicting growth in population. As expected there was a positive effect of being adjacent to an urban county. All states except Montana and Wyoming had higher growth rates than South Dakota, which served as the base. The coefficient for Nevada was more than twice as high as any other state.

The employment growth model had an R^2 of 0.68. Within the employment growth model five explanatory variables were found to be significant at the 10% level or better (Table 3), in addition to eight of the state dummy variables and the time period variables. Using Fields' decomposition we find that 54% of the variation in employment growth is explained by population growth, followed by lagged employment (4%). Present population growth was found to have a positive influence on present employment growth. Percent earnings from both the services and retail sectors had a positive effect on employment growth. Employment growth was found to be positively influenced by an area's education level, similar to Duffy-Deno (1998), Deller and Lledo (2007) and Eichman et al. (2010). Higher average wages deter employment growth; the negative and significant coefficient is in line with the expectation that employers would seek out low wage areas. The estimated impacts of education levels and wage rates on regional employment are especially important because these are two common topics among policy makers. Employment growth rates were lower than South Dakota in all states and the difference was significant in eight of the eleven state dummies. As was the case for population growth, the largest difference was for Nevada. Employment grew faster relative to the 1980s.

Counties with higher proportions of earnings attributed to the services and retail sectors experienced slower population growth on average but relatively higher levels of employment growth. These findings concur with comparable investigations conducted by Duffy-Deno (1998) and Lewis et al. (2002). This strengthens the notion that while the service sector may generate employment opportunities, they are not attractive enough to entice people to move to an area.

Referring to the variables pertinent to our research question, neither the percent federal employment nor the percentage of the county owned by the U.S. Forest Service was significant. Percentage changes in the volume of timber sales did not significantly impact overall employment growth; while the coefficient for that variable has the expected positive sign in the employment growth equation, it is not statistically significant. Therefore the concern that decreasing timber sales decreases regional employment is not supported by the analysis.

It is possible that this variable will become significant when the payments from the Secure Rural School and Community Self-Determination program terminate (Governor's Task Force, 2009). Also, there may be individual counties or regional clusters that are impacted by fluxes in U.S. Forest Service timber sales. While alternative variables, such as a cumulative sum of timber sold, or timber cut rather than sold, would have followed the same downward trend, there remains the possibility that modeling timber production changes with these variables may reveal an impact on employment growth. However, an examination of Cut and Sold data (U.S. Forest Service, 2011) for the years just before and after our study years, and for timber sold versus harvested indicates that the years used in the study are representative and that changes in cut versus sold for these years have similar magnitudes.

To examine the possibility that the effects of the forestry variables impact employment growth differently across states, we created interaction terms between each state dummy and the two key forestry variables, the change in timber sales and land in the National Forest System, as well as dividend income and federal employment, and included these in the regression model. We computed a joint test of the null hypothesis that all coefficients were equal across all states. We cannot reject the null hypothesis at the 10% level for any of the variables.

To check the robustness of our key variables, we also ran models with employment density rather than growth as the dependent variable. We also replaced percentage change in timber sales in the regression model with various other measures of timber sales. None of the alternative metrics, which 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, resulted in significant coefficients in the employment function. While the correlation coefficient between percentage change in timber sold and percentage of the county owned by the U.S. Forest Service is only 0.41, the model was also run with only one of the two variables. Neither dropped variable resulted in the other becoming significant at the 10% 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 percentage

Table 3
Population and employment growth regression results.

	Population growth		Employment growth	
	Coefficient	t-statistic	Coefficient	t-statistic
Intercept	−0.193***	4.5	0.034	1.03
Ln lag P	0.009***	3.63		
Ln lag E			0.000	0.00
Popgr			1.10***	59.5
Empgr	0.778***	59.24		
Ln lag Inc	0.010	0.81		
Pct_Own	0.072**	2.27		
Pct_Earn_Serv	−0.070***	2.57	0.088***	2.75
Pct_Earn_Retail	−0.094**	2.08	0.113*	1.88
Pct_Rec	−0.002	1.49		
Av_Precip	−0.007	1.02		
Av_Temp	0.001**	1.96		
Pct_Mts	0.005	0.74		
Ski Area	0.008	0.61		
River Miles	−0.001	0.64		
Pct_Water	−0.025	0.47		
UnE			0.079	0.88
Av_Wage			−0.022**	2.12
Pct_Coll Ed			0.001***	3.11
Pct_Fed_E			−0.001	0.13
Pct_Div_Inc			0.031	0.58
Pct_Change_Timber			0.001	0.30
Pct_Land_NF			0.018	1.31
City	−0.003	0.53		
Adj_UC	0.011**	2.5		
AZ	0.055***	2.75	−0.063***	3.13
CA	0.053***	3.69	−0.075***	5.25
CO	0.041***	3.79	−0.037***	2.92
ID	0.042***	3.81	−0.041***	3.06
MT	0.011	1.05	−0.013	1.05
NV	0.142***	8.12	−0.130***	5.93
NM	0.022*	1.68	−0.033**	2.30
OR	0.044***	3.44	−0.053***	3.57
UT	0.026*	1.92	−0.017	1.09
WA	0.067***	5.44	−0.074***	5.08
WY	0.017	1.24	−0.006	0.36
1990–2000 vs 1980s	−0.047***	7.42	0.059***	6.86
2000–2010 vs 1980s	−0.050***	7.4	0.039***	4.50
N	1337		1337	
R^2	0.7143		0.6782	

* Significant at the 10% level.
** Significant at 5%.
*** Significant at 1%.

change in timber sold 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, indicating the robustness of our finding that timber sales have little effect on employment at the county level.

7. Conclusions

This study captured a period in which forest policy shifted from a timber-centric analysis to broad consideration of ecosystem services (Wang, 2013). Today, the U.S. Forest Service must meet the challenge of managing for both extractive and non-extractive use in parallel. This turn of events adds complexity to the U.S. Forest Service's mission to both care for the land and serve people, and creates the potential for conflict. Frequent and intense confrontation 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. Specifically, reductions in timber sales are often perceived to negatively impact regional employment. The research presented here informs this conflict by investigating the effect of changes in timber sales on employment at the county level in 12 Western states.

In general, the presence of national forests and the natural amenities they provide were not found to be significant in this study, although temperature and the percent of owner-occupied homes were positive and significant. This is in contrast to Chen and Weber's (2011) as well as Rasker et al.'s (2013) community-level findings that towns close to preserved land experience higher growth in population. The hypothesis that decreased timber sales from national forests have a statistically significant and negative influence on employment growth at the county level was rejected. This is in line with the results from Lewis et al.'s (2002) study of the northern forests. Additionally, the hypothesis that the percent of land encompassed by a national forest has a statistically significant and negative influence on employment was rejected. Related to these findings are the Duffy-Deno (1997, 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. The combined conclusions of Duffy-Deno and the results of this study undermine the credibility of the claim that environmental regulations and their impacts on extractive resource uses negatively affect employment.

Given the contentious nature of the research question, our results need to be viewed in context. Some positive impacts from the changes in management are widespread, even national in scale. Job losses occur in communities. We note that the broader, county-level analysis may mask more localized impacts at the community level, such as those documented by Force et al. (1993).[3] In addition, jobs in logging and at sawmills typically pay higher than average salaries, i.e. they are high paying, if dangerous, jobs. Our data only examines employment.

One reason for the lack of a significant effect may be the small percentage of employment that forestry represents (see Artz et al. (2007) for an examination of the meatpacking industry). Using 2013 Bureau of Labor Statistics data for two industry categories, Forestry and Logging (113) and Sawmills (321113) we find that the percentage of the labor market represented is less than 1% for all states. The highest value was for Oregon, at 0.77%. Reports that examine a broader definition of the wood products industry, including the pulp and paper industry, wood furniture, etc. find a higher percentage of the workforce employed. For example, in 2009, the percentage of the workforce of Oregon (the state with the largest number of people employed in forestry and the highest percentage of the labor force) employed in the wood products industry was 3% (Oregon Department of Forestry, 2009). In Idaho, employment in the industry is 10,510 workers (Morgan et al., 2014) so the comparable figure is 1.7%. From 1987 to 1996, a period of sharply reduced timber harvest, the percentage of the Oregon labor force in the overall wood products industry declined from 7.5% to 4.4% (Oregon Department of Forestry, 2000). Another reason for the lack of a significant effect could be labor-saving technical change in forestry (Stier and Bengston, 1992).

While conclusions from the empirical analysis expanded our understanding of how national forests impact regional economies, questions for future research remain. We acknowledge that our measures of the impact of changing extraction policies do not address the full range of possible impacts to the local economy. In addition to differential impacts across sectors, future research might examine how forest policy changes affect wages, income distribution and inequality, capital investment and other measures. Recent research by Nielsen-Pincus et al. (2014) has shown that exogenous events, such as wildfires, in national forests have measurable, albeit small, differential impacts on individual sectors. Therefore, including variables that capture employment specifically in the forestry sector might show that there have been impacts on that sector even if county employment more generally was not significantly affected by changes in timber sales. In addition a study could

[3] It is possible that change in timber sales is significantly related to employment growth in individual towns, either positively or negatively. Some towns in the county may experience employment losses as a result of declining timber sales, while other towns with more recreational and tourism related businesses could see employment increases. However, since labor markets, particularly in rural areas, span one or more counties we would expect employment effects to extend beyond town boundaries. For example, Chen and Weber (2011) examine community level data in Oregon and find amenity effects are more localized than mill closure effects.

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, interest in this factor will increase and should be explicitly examined. Including whether or not a community has a gateway into the forest may prove to be a useful variable to capture amenity values. This study could also be expanded in future work to examine the effects of the sale of minerals and natural gas from federally owned lands.

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