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Local Employment Growth, Migration, and Public Land Policy: Evidence from the Northwest Forest Plan

Henry Eichman, Gary L. Hunt, Joe Kerkvliet, and Andrew J. Plantinga

Debates over protecting public land reveal two views. Some argue protection reduces commodity production, reducing local employment and increasing out-migration. Others contend protection produces amenities that support job growth and attract migrants. We test these competing views for the Northwest Forest Plan (NWFP), which reallocated 11 million acres of federal land from timber production to protecting old-growth forest species. We find evidence that land protection directly reduced local employment growth and increased net migration. The total negative effect on employment was offset only slightly by positive migration-driven effects. Employment losses were concentrated in metropolitan counties, but percentage losses were higher in rural counties.

Key Words: amenities, employment growth, migration, Northwest Forest Plan, old-growth forests, public land management

Introduction

Major controversy has surrounded U.S. land conservation policies over the past three decades. In 1994, the U.S. Bureau of Land Management (BLM) and the U.S. Forest Service (USFS) complied with judicial directives by adopting the Northwest Forest Plan (NWFP). Adoption of the NWFP followed a tumultuous period during which numerous lawsuits were brought against the USFS and BLM (e.g., under the Endangered Species Act) and U.S. courts blocked timber harvests on USFS and BLM lands. This plan restricted commodity production on public lands in order to provide habitat for northern spotted owls and hundreds of other species associated with late-successional old-growth forests. The NWFP reallocated over 11 million acres—77% of USFS and BLM land in the northern spotted owl's range—from commodity production to ecosystem management. The USFS and BLM adopted the NWFP to comply with national environmental laws, but the policy affected public lands solely within the Pacific Northwest region. This created a "natural experiment" with which to measure the NWFP's impact on county employment growth and net migration rates.

Many observers assume that conservation entails a tradeoff between environmental quality and measures of economic success such as jobs (Marcot and Thomas, 1997; Goodstein, 1999).

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In the NWFP case, ex ante input-output analyses projected job losses ranging from 13,000 (Anderson and Olsen, 1991) to 147,000 (Beuter, 1990). An ex post analysis reported 45,000 lost jobs with 30,000 of those occurring in the timber industry (Phillips, 2006).

Others argue that public land conservation may improve local economies by increasing natural amenities and attracting migrants (Power, 1996, 2006; Niemi, Whitelaw, and Johnson, 1999; Power and Barrett, 2001; Charnley, 2006). Such positive effects must be large enough to offset negative employment effects of reduced commodity-based land uses. The role of amenities in influencing regional economies is well established (e.g., Roback, 1982; Carlino and Mills, 1987; Mueser and Graves, 1995), but earlier public land preservation studies have failed to find significant impacts on local economies. Duffy-Deno (1998) examined federal wilderness areas and found no effect on employment or population densities in 250 western rural counties. In an earlier study Duffy-Deno (1997) concluded that state parks have a small positive effect. Lewis, Hunt, and Plantinga (2002, 2003) found conservation lands to have a small positive effect on migration in the Northern Forest region but no effect on employment and wage growth. Daniels, Hyde, and Wear (1991), Burton and Berck (1996), and Burton (1997) reported no evidence linking federal timber harvests with local economic indicators. Finally, Lorah and Southwick (2003) observed positive correlations between conserved public land and county employment, income, and population growth.

There are three potential reasons why many previous studies have failed to find substantive local economic impacts. First, examined lands may be relatively unproductive of extractive resources, such that conserving these lands has little effect on local commodity production or supply of amenities. Second, lands may have been designated so long ago that all economic adjustments have occurred (Lewis, Hunt, and Plantinga, 2002, 2003). Hunt (2006) showed employment and population growth adjustments to regional shocks are completed in 15–20 years, indicating that observations post-dating conservation policies by several decades are unlikely to reveal effects. Duffy-Deno's (1998) study of wilderness areas evaluated employment and population changes from 1980 to 1990, but designation of these lands occurred largely in 1964. Third, conserved land acreage may be too small to produce measurable effects.

A study of the NWFP will not encounter these potential problems. Much of the reclassified land is among the most productive timberland on the planet. Conserved acreage is almost equivalent to the combined areas of New Hampshire and Vermont. Among the affected counties, an average of 12% of total county land is reserved from timber cutting; over 20% of total county land is reserved in 11 counties. Finally, we use data closely connected to political, scientific, and economic events surrounding the development and implementation of the NWFP. Observations are pooled for the decades before and after the NWFP's implementation, increasing our ability to detect measurable effects.

We follow a modeling tradition in the regional economics and migration literature and analyze the simultaneous relationship between county-level employment and net migration (e.g., Greenwood and Hunt, 1984; Greenwood, Hunt, and McDowell, 1986). Our data cover 73 counties containing lands reclassified under the NWFP or adjacent to such counties.

Empirical Modeling Approach

The Employment-Migration Model

We consider the NWFP's effect on county employment growth rates and net migration rates in the Pacific Northwest region. A closely related approach models employment and population change (e.g., Carlino and Mills, 1987; Duffy-Deno, 1998; Deller et al., 2001). Because we are interested in potential migration offsets to employment effects, a net migration measure is used that excludes population changes due to natural causes. Employment growth and net migration are modeled using a simultaneous equations framework:

$$(1) \qquad EGR_{j,t,t+n} = f(NMR_{j,t,t+n}, \mathbf{x}_{j,t}; \boldsymbol{\alpha}),$$

$$(2) \qquad NMR_{j,t,t+n} = g(EGR_{j,t,t+n}, \mathbf{y}_{j,t}; \boldsymbol{\beta}),$$

where $EGR_{j,t,t+n}$ (employment growth rate) is average annual percentage change in total jobs in county j from year t to $t + n$, $NMR_{j,t,t+n}$ (net migration rate) is average annual percentage change in population excluding changes due to births and deaths, $\mathbf{x}_{j,t}$ and $\mathbf{y}_{j,t}$ are explanatory variable vectors, and $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ are parameter vectors. In our application, we use a linear specification for f and g and include percentage of total county land area allocated to reserved and unreserved uses under the NWFP as explanatory variables.

Three reasons exist for choosing this modeling approach. First, county economies in the United States resemble small open economies embedded in free-market areas. This implies an elastic supply of mobile factors in response to spatial variations in firm profitability and household utility. The dependent variables reflect regional factor quantity adjustments induced as county economies adjust to evolving spatial general equilibrium. Second, inter-county profitability and utility variations depend on differences in county amenities, amounts of immobile factors, industry mix, forward and backward linkages, extant agglomeration, and policy. Much of the regional economics literature (e.g., Roback, 1982; Kim, 1998, 1999; Beeson, DeJong, and Troesken, 2001; Deller et al., 2001; Hanson, 2005; Rappaport, 2007) emphasizes the importance of such variables in regional economic growth and development. Below, we describe the explanatory variables chosen to reflect these profitability and utility factors and how they facilitate econometric identification and estimation. Third, the model in (1) and (2) allows the simultaneous modeling of employment growth and net migration rates. This can determine directly whether positive migration effects of the NWFP attenuate negative employment effects.

Econometric Considerations

We confront four key econometric issues in this study: stationarity and simultaneity of jointly dependent variables, potential endogeneity of the NWFP policy, robustness of results, and pooling of observations across periods.

- First, population-employment models estimated in level form or with a partial adjustment specification exhibit serious nonstationarity and lead to spurious results (Hunt, 2006). Computing the jointly dependent variables in growth rate form, as in (1) and (2), remedies this problem. In recognition of the simultaneity of employment growth and net migration rates, we treat these variables as endogenous and estimate the model with an instrumental variables technique.

- Second, we explore potential endogeneity in NWFP land allocations. For example, decision makers may have conserved smaller land areas in economically depressed counties (i.e., those with low employment growth). Our use of time-lagged NWFP variables to explain subsequent changes in employment growth and net migration rates may not solve the endogeneity problem if there is selection on time-invariant unobservables. Therefore, we develop instrumental variable estimates of NWFP variables and use these to compute a Hausman test for the policy's exogeneity.

- Third, because many variables potentially influence profitability and utility variation across counties and over time, we considered five alternative specifications for the employment growth and net migration equations. All the specifications contain the same variables for public lands and NWFP policy, but include different sets of additional exogenous variables. We present the results of only one specification, but the full set of results is available from the authors upon request. For our chosen specification, effects of the NWFP policy variables are robust to the inclusion of additional exogenous regressors.

- Fourth, we pool observations for the decades before and after the NWFP implementation to increase our ability to detect measurable effects. Data following the formal implemention of the NWFP in 1994 provide one information source for identifying and estimating these effects. In addition, because the NWFP differentially restricts USFS and BLM timber harvests across counties in the region, observations in this period provide cross-sectional contrasts in county employment growth and net migration potentially related to the NWFP policy. To further enhance the identification of the NWFP's effects, we add observations to our pooled sample from 1980–1990. The NWFP was not in effect during this decade, nor is it likely to have been anticipated. USFS and BLM timber harvests were high and relatively stable during the 1980s, and lawsuits related to the northern spotted owl were not filed until the end of the decade.

The years 1990–1994 were a transitional period with respect to the use of these lands. Initially, the northern spotted owl was listed under the Endangered Species Act and court injunctions blocked nearly all USFS and BLM timber sales. The USFS and BLM subsequently sought to develop management plans that would resolve the numerous lawsuits brought by environmental groups.[1] The courts ultimately accepted the NWFP as providing adequate protection for northern spotted owls and other species associated with Pacific Northwest old-growth ecosystems (Noon and McKelvey, 1996; Marcot and Thomas, 1997; Thomas et al., 2006). One modeling approach would be to treat 1990–1994 as a distinct period in the same way we handle the before and after periods (1980–1990 and 1994–2003). However, because regional economic upheaval, political controversy, judicial intervention, information gaps, and scientific uncertainty characterize the transition period, it is unlikely that firm profitability and household decisions were strongly operative. The early part of the transition period also coincided with a national recession. For these reasons, we exclude observations for the period 1990–1994 from our sample.[2]

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[1] For more details, see the May 1990 report of the Interagency Scientific Committee to Address the Conservation of the Northern Spotted Owl, and the October 1991 report of the Scientific Panel on Late-Successional Forest Ecosystems.

[2] Interested readers may consult a previous version of this paper (Hunt, Kerkvliet, and Plantinga, 2004) in which we attempt to model the 1990–1994 transition period explicitly.

In summary, we estimate the employment-migration model with a panel data set consisting of cross-sectional observations on Pacific Northwest counties during the decade preceding the spotted owl controversy (1980–1990) and the decade following its resolution with the adoption of the NWFP (1994–2003). We test for differences in effects of USFS and BLM management on county employment growth and net migration across these periods.

Variables and Measurement

Our data cover 73 counties in Oregon, Washington, and northern California. The NWFP allocated land to be reserved for conservation in 53 of these counties, varying from 0.006% to 37.5% of total county land, with an average of 12%. To increase the precision of our estimates, an additional 20 counties are included that do not contain any reserved land, but which are adjacent to counties that do. Marin, Napa, and Alameda counties are omitted because they are located in the San Francisco Bay Area and have economies that differ substantially from those in our sample. Four counties adjacent to the Bay Area counties (San Mateo, Santa Clara, Contra Costa, and Solano) are also omitted.

Dependent Variables

We measure the jointly dependent variables $EGR_{j,t,t+n}$ and $NMR_{j,t,t+n}$ as average annual growth rates over the 1980–1990 and 1994–2003 periods because these periods have different lengths. Definitions and data sources are presented in table 1 and summary statistics are reported in table 2.

Explanatory Variables

The time-lagged regressors in the employment growth and net migration equations—$\mathbf{x}_{j,t}$ and $\mathbf{y}_{j,t}$, the vectors of explanatory variables in equations (1) and (2)—are partitioned into two subsets, one measuring features of public lands and the NWFP policy, and the other county features influencing firm profitability and household utility.

Public Land and NWFP Policy Variables

Timber harvests on USFS, BLM, and state lands in the Pacific Northwest region fueled a substantive wood processing sector and associated industries following World War II. County-level timber volumes are not available, but we can capture the influence of public timber harvests over the 1980–1990 period with variables that measure the percentage of total county land devoted to public timber production: *USFS Percentage*, *BLM Percentage*, and *State Forest Percentage*. Remaining lands include federal land managed as national parks and wilderness, which we treat separately, and land in private and other public uses (e.g., airports, military installations). Specifying land management variables as shares of total county land can capture effects of both alternative management objectives and land diversion from private and other public uses.

The NWFP allocated BLM and USFS lands to one of five categories upon its adoption in 1994 (Espy and Babbitt, 1994). Brief descriptions and total acreage of these categories are presented in table 3. The policy applied only to lands managed by the USFS and BLM (not to state or private lands) and did not affect USFS and BLM lands already designated as wilderness

Table 1. Definitions of Variables and Their Data Sources

Variable	Definition	Source
Net Migration Rate	Average annual rate of net migration: 1980–1990, 1994–2003	U.S. Bureau of the Census, Population Estimates Archives (http://www.census.gov/popest/archives/)
Employment Growth Rate	Average annual rate of employment growth: 1980–1990, 1994–2003	U.S. Bureau of Economic Analysis, Regional Economic Accounts, Table CA04 (http://www.bea.gov/regional/reis/)
Unreserved NWFP Percentage	Proportion of county land classified as matrix or adaptive management under the Northwest Forest Plan	Northwest Forest Plan Regional Ecosystem Office and authors' calculations
Reserved NWFP Percentage	Proportion of county land classified as late successional reserves, managed late successional reserves, or riparian reserves under the Northwest Forest Plan	Northwest Forest Plan Regional Ecosystem Office and authors' calculations
BLM Percentage	Proportion of county land managed by U.S. Bureau of Land Management excluding wilderness areas and administratively withdrawn areas	U.S. Forest Service, Forest Inventory and Analysis Map Maker
USFS Percentage	Proportion of county land managed by U.S. Forest Service excluding wilderness areas and administratively withdrawn areas	U.S. Forest Service, Forest Inventory and Analysis Map Maker
State Forest Percentage	Proportion of county land managed by state forestry departments	U.S. Forest Service, Forest Inventory and Analysis Map Maker
Log Export Potential	Proportion of county land producing logs for export, divided by square of distance to nearest exporting port, and then multiplied by 10,000,000,000	U.S. Forest Service, Forest Inventory and Analysis Map Maker; Mapquest; Warren (1989)
National Park Percentage	Proportion of county land managed by National Park Service	U.S. Forest Service, Forest Inventory and Analysis Map Maker
January Rain	Average January rainfall in inches in largest city/town in county (1970–2000)	Western Regional Climate Center, Western U.S. Climate Historical Summaries
January Temperature	Average daily high temperature in January in degrees Fahrenheit (1970–2000) in the largest city/town in the county	McGranahan (1999)
Northern Spotted Owl Center	Number of land use tracts within a county with at least one northern spotted owl center where center is defined as one owl or one owl pair	Soules (2002) and Northwest Forest Planning Process
Marbled Murrelet Center	Number of land use tracts within a county with at least one marbled murrelet center where center is defined as one bird or one bird pair	Soules (2002) and Northwest Forest Planning Process
Key Watershed	Indicator variable equal to unity if the county contains a watershed providing habitat for potentially threatened fish species	Soules (2002) and Northwest Forest Planning Process
Home Ownership	Percentage of households in a county owning their homes	USA Counties
College Graduate Percentage	Percentage of persons 25 years of age and older who have graduated from college	USA Counties
Metro County	Indicator variable equal to unity if county is part of a metropolitan area and zero otherwise	U.S. Bureau of the Census
Adjacent Metro County	Indicator variable equal to unity if county is geographically adjacent to a county that is part of a metropolitan area and zero otherwise	Authors' calculations

Table 2. Summary Statistics: 1980–1990 and 1994–2003

	1980–1990			1994–2003		
Variable	Mean (Std. Dev.)	Minimum	Maximum	Mean (Std. Dev.)	Minimum	Maximum
Net Migration Rate	0.008 (0.012)	−0.016	0.041	0.006 (0.009)	−0.017	0.037
Employment Growth Rate	0.022 (0.019)	−0.036	0.064	0.018 (0.010)	−0.008	0.053
Unreserved NWFP Percentage	0.000 (0.000)	0.000	0.000	0.080 [a] (0.082 [a])	0.000 [a]	0.299 [a]
Reserved NWFP Percentage	0.000 (0.000)	0.000	0.000	0.118 [a] (0.092 [a])	0.0001 [a]	0.375 [a]
BLM Percentage	0.027 (0.056)	0.000	0.308	0.000 (0.000)	0.000	0.000
USFS Percentage	0.167 (0.184)	0.000	0.743	0.000 (0.000)	0.000	0.000
State Forest Percentage	0.057 (0.098)	0.000	0.577	0.057 (0.098)	0.000	0.577
Log Export Potential	4.91E-05 (0.0002)	0.000	0.001	0.000 (0.000)	0.000	0.000
National Park Percentage	0.002 (0.008)	0.000	0.057	0.002 (0.008)	0.000	0.057
January Rain	5.910 (4.112)	0.920	19.850	5.910 (4.112)	0.920	19.850
January Temperature	37.056 (6.519)	18.000	47.900	37.056 (6.519)	18.000	47.900
Northern Spotted Owl Center	0.000 (0.000)	0.000	0.000	3.932 (6.957)	0.000	37.000
Marbled Murrelet Center	0.000 (0.000)	0.000	0.000	1.822 (4.730)	0.000	25.000
Key Watershed	0.000 (0.000)	0.000	0.000	0.562 (0.500)	0.000	1.000
Home Ownership	68.242 (4.797)	54.000	77.600	66.132 (4.842)	51.900	76.700
College Graduate Percentage	14.908 (5.310)	6.900	36.600	16.753 (6.335)	9.400	41.300
Metro County	0.301 (0.462)	0.000	1.000	0.356 (0.482)	0.000	1.000
Adjacent Metro County	0.534 (0.502)	0.000	1.000	0.644 (0.482)	0.000	1.000

[a] Calculated for counties with strictly positive, reserved, or unreserved NWFP land allocations.

Table 3. Northwest Forest Plan Land Classifications and Acreage

Classification	Definition [a]	Acres
Congressionally Reserved Areas [b]	Reserved by act of Congress, e.g., wilderness areas, wild and scenic rivers	7,320,600
Late Successional Reserves	Dedicated to maintaining a functional, interactive, late-successional and old-growth forest; designed to serve as habitat for old-growth related species including the northern spotted owl	7,430,800
Adaptive Management Areas	Designed to develop and test new management approaches to integrate and achieve ecological, economic, and other social and community goals	1,521,800
Administratively Withdrawn Areas	Identified in current forest and district plans, or draft plan preferred alternatives and include recreation and visual areas, back country, and other areas not scheduled for timber harvest	1,477,100
Managed Late Successional Reserves	Either delineated or mapped, known spotted owl activity centers or unmapped protection buffers, or designated to protect certain rare and locally endemic species	102,200
Riparian Reserves [c]	Areas along all streams, wetlands, ponds, lakes, and unstable areas where conservation of aquatic and riparian-dependent terrestrial resources receives primary emphasis	2,627,500
Matrix	USFS and BLM land outside of the six categories above; the area in which most timber harvest and other silvicultural activities will be conducted; also contains non-forested areas and forested areas not technically suited for timber production	3,975,300

[a] Quoted from or a summary of Espy and Babbitt (1994).

[b] No new lands in this classification were allocated by the Northwest Forest Plan.

[c] See text narrative for further discussion on the area of riparian reserves.

or managed as wilderness study areas. The NWFP initiated a fundamental shift in management strategy from timber extraction to species conservation for lands allocated to late successional reserves, managed late successional reserves, and riparian reserves.[3] We refer to lands placed in these three categories as NWFP reserved lands and denote county share as *Reserved NWFP Percentage*. Lands allocated to matrix and adaptive management categories continued to be available for timber harvesting and were expected to produce 90% of future USFS and BLM harvests (Charnley, 2006). We refer to lands in these two categories as NWFP unreserved lands and denote the corresponding county share as *Unreserved NWFP Percentage*. For the 1994–2003 period, we redistribute the sum of *USFS Percentage* and *BLM Percentage* to the *Reserved NWFP Percentage* and *Unreserved NWFP Percentage* variables based on their reclassification by the NWFP.

The percentage of county land managed by the National Park Service (and not classified as wilderness) is expected to be an amenity for households. We denote this variable as *National Park Percentage* and expect it to be positively related to the net migration rate and inversely

[3] The Northwest Forest Plan Regional Ecosystem Office combines the matrix and riparian reserves categories, though lands in these two classifications are managed very differently. Espy and Babbitt (1994) report the total area of riparian reserves (table 1), but none of the available documentation provides a source for this figure. Thus, we calculate county-specific riparian reserve acreage. We use available GIS data to compute the length of rivers and streams found within the matrix/riparian reserves classification. We then use NWFP default buffer widths (300 feet for perennial streams and 100 feet for intermittent streams) to compute the area of stream buffers. We find the area of riparian reserves is 1,242,238 acres, about one-half of the value reported by Espy and Babbitt. We calculate matrix land acreage by subtracting the calculated acreage of riparian reserves from the area in the combined matrix/riparian reserves category.

related to county employment growth because of National Park restrictions on commodity production. In our examination of alternative specifications, we evaluated a variable measuring the share of federal land designated as wilderness. This variable was statistically insignificant across all specifications and thus is omitted from reported results.

Potential Endogeneity of NWFP Variables

During development and implementation of the NWFP, it was widely perceived that conserving land to protect biodiversity would result in job losses (Anderson and Olsen, 1991; Bueter, 1990; Charnley, 2006; Niemi, Whitelaw, and Johnson, 1999; Phillips, 2006). Consequently, there may have been political pressure to reserve less land in counties with stagnant economies or high timber dependency. If true, the NWFP policy variables—*Reserved NWFP Percentage* and *Unreserved NWFP Percentage*—would be endogenous. To address this potential problem, we estimate models with predicted values of these variables. The instrumental variables are the number of northern spotted owl and marbled murrelet centers (*Northern Spotted Owl Center*, *Marbled Murrelet Center*) in the county and an indicator variable for the presence of a key watershed (*Key Watershed*) within the county.[4]

Our instrumental variables contain ecological criteria used to reclassify land under the NWFP and were found by Soules (2002) to be strong predictors of the NWFP allocations. When *Reserved NWFP Percentage* and *Unreserved NWFP Percentage* are regressed on the three ecological variables (and a constant term), each one has a statistically significant coefficient at the 5% level. Tests for the overall significance of the regressions produce $F = 242.5$ and $F = 198.1$, respectively, each with a p-value equal to 0.000. In contrast, the ecological variables are found to be orthogonal to employment growth. When we regress county employment growth rates on these three ecological criteria variables, each coefficient is statistically insignificant (with p-values of 0.53, 0.58, and 0.68, respectively), and the test for overall significance of the regression yields $F = 0.29$ (with $p = 0.83$). Similar results are obtained when using a log-odds transformation of *Reserved NWFP Percentage* and *Unreserved NWFP Percentage*.

The three ecological variables appear to be very good instruments for assessing the endogeneity of the NWFP policy variables, but Hausman test results fail to reject the exogeneity of these variables at conventional levels. Given the serious consequences of endogeneity for estimation of the NWFP's effects, we also estimate all models with the NWFP variables treated as endogenous. The estimation results (available from the authors upon request) are similar to those presented below.

Other Regressors

Numerous factors other than public land management can affect county employment growth and net migration. We retained explanatory variables in the model based on three considerations. First, explanatory variables in each equation had to be reasonably related to utility (in the net migration equation) and profitability (in the employment growth equation), and the signs of the estimated coefficients had to be economically plausible. Second, exogenous regressors used to form instrumental variable estimates had to pass two validity tests:

[4] Michael Soules obtained data on spotted owl and marbled murrelet locations and key watershed areas from the Northwest Forest Plan Regional Ecosystem Office. He then allocated them to counties and summed the number of occurrences using standard GIS mapping methods. We thank Mr. Soules for making these data available to us. (Details can be found in Soules, 2002.)

instrument relevance and instrument exogeneity (Stock and Watson, 2007, pp. 439–445). Instrument relevance relates to instruments having sufficient information to form effective estimates. Instrument exogeneity concerns the statistical consistency of such estimates (and therefore the meaningfulness of overidentifying exclusion restrictions assumed for each equation). Third, statistically irrelevant regressors were excluded to preserve estimate precision and instrument relevance. Wald tests for joint significance of additional regressors determined which regressors could be excluded.

Multiple regressors were investigated but not reported here, including indicator variables for whether a county is adjacent to a NWFP county; whether a county is in the Portland or Seattle metropolitan areas; whether the county is on the coast; whether Interstate 5 runs through the county; whether the county is in California, Oregon, or Washington; the county crime rate; shares of public expenditures for education and health; federal government expenditures in the county; the number of sunny days in January; the relative humidity in July; road density; proportions of county earnings in manufacturing and wood products sectors; and county population and employment densities. We also explored the possibility of using McGranahan's (1999) overall natural amenity index, but found it did not meet the above criteria. Variables closely related to elements of McGranahan's index that did meet the criteria (rain, sunshine, Metropolitan Statistical Area status) are included in the reported results. In all regressions, the independent variables are lagged with respect to the jointly dependent variables (i.e., they are measured in time t, while employment growth and net migration rates are measured over the period t to $t + n$).

Employment growth in timber-dependent county economies may be affected by international exports of Pacific Northwest logs. Since 1974, federal law banned log exports from western federal lands and the processing of logs from federal lands in private sawmills if the enterprise exported its privately owned logs. Oregon and California imposed similar restrictions on logs produced on state-managed lands. Federal legislation passed in 1990 restricted export of unprocessed logs from all western state-owned lands so that only timber supplied by private landowners was eligible for export from the Pacific Northwest (Daniels, 2005, pp. 28–29). We construct the variable *Log Export Potential* based on the gravity model of trade which predicts that bilateral trade flows will vary directly with economic size and inversely with distance. Economic size is expressed as the percentage of county land area in private forest and Washington state forest land during 1980–1990, and the percentage of county land area in private forest during 1994–2003. We divide economic size by the square of the distance from the county seat to the nearest seaport suitable for international export of logs (Warren, 1989).

Given the importance of human capital in local growth (e.g., Higgins, Levy, and Young, 2006), we construct the variable *College Graduate Percentage*, representing the share of the population with a college degree. This variable is included in the employment growth equation.

Amenities play a prominent role in firm profitability and household utility in local areas in spatial general equilibrium theory (e.g., Roback, 1982). This theory applies in our study given its focus on county economies. We tested multiple climatic amenities (disamenities). In the employment growth equation, the average rainfall in January (denoted *January Rain*) met inclusion criteria. In the net migration equation, variables were retained for average daily high temperature during January and July (denoted *January Temperature* and *July Temperature*, respectively).

It is difficult to statistically estimate all individual contributions to a county's attractiveness given that amenity effects may have high dimensionality. Deller et al. (2001) employ principle components to reduce the high dimensionality of amenities. We use home ownership rates by county (*Home Ownership*) to proxy the joint attractiveness of other unspecified amenities in the net migration equation.

The urban and regional economics literature recognizes the role of agglomeration economies in increasing productivity of firms through labor market pooling, input sharing, and knowledge spillovers (Rosenthal and Strange, 2001). Agglomeration can also enhance household utility through increased availability of urban cultural and social amenities (Glaeser, Kolko, and Saiz, 2001). We control for such agglomeration effects in the net migration equation by including a dummy variable (*Metro County*) for counties within a Metropolitan Statistical Area (MSA), and a dummy variable for non-MSA counties adjacent to an MSA (*Adjacent Metro County*). We also include the *Metro County* variable in the employment growth equation to control for agglomeration effects on firm profitability.

Estimation

The statistical model is estimated with generalized method of moments (GMM) applied to the two-equation system. This procedure permits us to statistically test for instrument relevance and exogeneity, and for the validity of the exclusion restrictions used to identify the model parameters. Our county-level panel data set introduces several potential sources of heteroskedasticity. One source is from differences in economic conditions across the two decades and across adjacent areas (e.g., housing bubbles in two counties in northern California; Deschutes County, OR; and counties in the Seattle and Portland areas). Another potential source involves demographic differences across counties (age distributions, income, high school graduation, and graduate education rates). Although we do not explicitly control for these effects, we use White's (1980) heteroskedasticity-consistent covariance matrix. Instrument relevance is tested by observing whether the value of the F-statistic in the reduced-form equation is greater than 10 (Stock and Watson, 2007). Instrument exogeneity is tested with the J-statistic, which is distributed chi-square under the null hypothesis that the over-identifying exclusion restrictions are correct.

Results

In this section, we present and discuss the simultaneous GMM estimates of the employment growth and net migration rate equations. We begin by discussing the model's statistical veracity and specification test results regarding instrumental relevance and identification. Parameter estimates are then described for variables affecting firm profitability and household utility, including a discussion of direct effects of the NWFP policy variables (table 4). Finally, we discuss the total effects of the policy variables, accounting for the simultaneous relationship between employment growth and net migration (table 5).

Estimation Results for Employment Growth and Net Migration Rate Equations

As observed from table 4, our model explains slightly more than 50% of county variations in employment growth rate ($R^2 = 0.506$) and net migration rate ($R^2 = 0.513$). More importantly, strong support is found for joint determination of employment growth and net migration. The

Table 4. Joint Estimates of the Employment Growth Rate and Net Migration Rate Equations by Generalized Method of Moments ($N = 146$)

	Employment Growth Rate		Net Migration Rate	
Variable	Coefficient	Asymptotic *t*-Ratio	Coefficient	Asymptotic *t*-Ratio
Net Migration Rate	1.355	8.326		
Employment Growth Rate			0.357	5.862
Reserved NWFP Percentage	−0.021	−2.301	0.008	1.380
BLM Percentage + USFS Percentage + State Forest Percentage + Unreserved NWFP Percentage	0.002	0.474		
Log Export Potential	6.028	1.910		
College Graduate Percentage	0.001	4.957		
National Park Percentage	−0.298	−1.987	0.267	1.996
January Rain	−0.001	−4.081		
Metro County	0.005	3.671	0.005	3.381
Adjacent Metro County			0.005	3.381
Home Ownership			0.001	4.479
January Temperature			0.000	3.605
Constant	0.006	2.751	−0.055	−5.036
R^2	0.506		0.513	
Wald (*W*) and *J*-Statistics Tests:				
W: Instrument Irrelevance *F*-Statistic (*p*-value)	10.0 (0.000)		5.44 (0.000)	
J: Overidentifying Restrictions (*p*-value)	0.101 (0.996)		0.101 (0.996)	
W: (*BLM* + *USFS*) = *NWFPU* = *STFOR* (*p*-value)	0.368		N/A	
W: METRO = *ADJMETRO* (*p*-value)	N/A		0.337	

Note: Estimates are robust for any heteroskedasticity.

estimated effect of net migration rate on employment growth rate is 1.355 and highly significant ($t = 8.33$). The estimated effect of employment growth rate on net migration rate is 0.357 and also highly significant ($t = 5.86$). Instrumental irrelevance is strongly rejected in both equations, with *p*-values effectively equal to zero. These findings confirm the fundamental relationship underlying the employment-migration model. In addition, we do not reject the overidentifying restrictions, implying each specification is identified econometrically and the instruments are exogenous in both equations.

Public land devoted to commodity production positively influences employment growth, though the effect is not significantly different from zero. We tested and cannot reject the hypothesis that this effect is the same regardless of ownership and time period. Specifically, the restriction that the parametric effects of *BLM Percentage*, *USFS Percentage*, *State Forest Percentage*, and *Unreserved NWFP Percentage* are identical cannot be rejected (*p*-value = 0.68). This result is not unexpected as the primary function of the lands was, or was expected to be, timber production. To increase the precision of our estimates, this restriction is imposed in our reported results.

In contrast, BLM and USFS land reserved for species preservation was found to have a negative effect on employment growth during the 1994–2003 period. The estimated coefficient on *Reserved NWFP Percentage* is −0.021 ($t = -2.30$) in the employment growth equation, indicating the direct effect of setting aside BLM and USFS land for conservation uses was to reduce employment growth by 0.2% for each 1% of total county land area that is reserved.

While reserved land for species preservation reduced employment, it had a positive effect on net migration. In the net migration equation, the coefficient on *Reserved NWFP Percentage* is 0.008 and is marginally significant (p-value = 0.08), following the proposition that amenities of conserved public land attract migrants or retain current residents (e.g., Power, 1996; Power and Barrett, 2001).

In the employment growth equation, *Log Export Potential* positively affects employment growth rate and the parameter estimate (6.03) is significant ($t = 1.91$). A 1% increase in *College Graduate Percentage* results in a 0.001% increase in annual employment growth rate ($t = 4.96$), confirming the importance of human capital in local growth. Counties with larger shares of land in national parks experienced less annual employment growth directly, with a parameter estimate of −0.298 ($t = -1.99$). This is a direct effect only and is offset by the effect of national parks on net migration. Our finding of a negative correlation between employment growth and *January Rain* (parameter estimate = −0.001, $t = -4.08$) is consistent with Beeson, DeJong, and Troesken (2001), who reported evidence of negative effects on county growth from greater levels of rainfall. As expected, counties within an MSA had higher employment growth (parameter estimate = 0.005, $t = 3.67$).

Variables influencing household utility have the expected influence on net migration rate. *National Park Percentage* directly influences net migration with a parameter estimate of 0.267 ($t = 2.00$). This positive effect serves to offset the negative effect of national parks on employment through simultaneous determination. However, results for national parks should be interpreted with caution, as only three counties in our study contain national park land and these coefficients could be measuring the effect of other county-specific factors. Ceteris paribus, counties within MSAs experienced higher net migration (parameter estimate = 0.005, $t = 3.38$). We tested and cannot reject the hypothesis that the effect of *Adjacent Metro County* is identical to the effect of *Metro County* on net migration rate. *Home Ownership*, our proxy for attractiveness of multidimensional amenities, also positively affects net migration rate in a statistically significant manner (parameter estimate = 0.001, $t = 4.48$). Finally, higher *January Temperature* positively and significantly influences net migration.

Total Effects of NWFP Policy on County Employment Growth

Employment growth equation estimates indicate that the direct effect of reserving land was to reduce county employment during the 1994–2003 period. These estimates also provide weak evidence that the policy's implementation increased net migration over the same period. Because of the positive relationship between employment growth and net migration, increases in net migration partially offset the direct negative effects of the NWFP on employment.

To compute the total effect of the NWFP policy on county *EGR*, we substitute (2) into the right-hand side of (1). Solving for employment growth rate identifies the combined effects of *Reserved NWFP Percentage* and *Unreserved NWFP Percentage* on employment growth: direct effects on employment growth, indirect effects transmitted through the migration channel, and the sum of all subsequent induced interactions between employment growth and net migration. Similar calculations yield the estimated total effects of the NWFP policy variables on net migration rates. Computed total effects and standard errors (computed with the Delta method) are presented in table 5.

The estimated total effect of reserved lands on employment growth is −0.019 and is statistically significant (p-value = 0.05), indicating that each percentage point increase in NWFP reserved land lowered the average annual employment growth rate by 0.0002. Since

Table 5. Total Effects of NWFP Variables on Employment Growth Rate and Net Migration Rate

Variable	Total Effect	$\chi^2_{[1]}$	*p*-Value
Employment Growth Rate:			
Reserved NWFP Percentage	−0.019	3.790	0.052
Unreserved NWFP Percentage	0.003	0.226	0.634
Net Migration Rate:			
Reserved NWFP Percentage	0.002	0.053	0.812
Unreserved NWFP Percentage	0.001	0.219	0.639

the direct effect of reserved land is −0.021 and the total effect is −0.019, the offsetting effect of reserved land through net migration is not substantive.[5]

To illustrate how this affects an average county's employment growth during 1994–2003, consider the hypothetical average county with 12% reserved land and 1.75% annual employment growth rate. Compared to a county with no reserved land, the total effect predicts that the reserved land resulted in slower employment growth by 0.23% [$=100 \times (-0.019 \times 0.12)$], or a reduction from 1.75% to 1.52%. For a second illustration, consider Curry County, OR, which has the largest reserved NWFP percentage (37.5%). The total effect predicts that employment would have grown by 2.85% annually in the absence of reserved land, instead of the actual 2.14% ($2.85 - 2.14 = 0.019 \times 0.375 \times 100$).

A third way to illustrate the total effect is to predict changes in total employment. The difference between 2003 total employment with and without reserved land is equal to (*Employment in 1994* × 9 × −0.019 × *Reserved NWFP Percentage*). Predicted county-specific differences are given in table 6 for the 53 sample counties with NWFP land allocations. The estimate of 88,259 jobs lost between 1994–2003 is about mid-range of instantaneous losses predicted from ex ante input-output models (Anderson and Olsen, 1991; Beuter, 1990) and nearly twice the losses projected by Phillips' (2006) ex post study. Over one-half of employment differences occur in four metropolitan counties—Clackamas, OR; Lane, OR; Multnomah, OR; and King, WA—containing the cities of Portland, Eugene, Salem, and Seattle. Conversely, the largest employment percentage differences occur in rural counties—Curry, OR; Josephine, OR; Lincoln, OR; and Skamania, WA—where employment declines exceed 4%.

Table 5 also provides evidence that NWFP policy implementation had no other significant total effects. The effect of *Unreserved NWFP Percentage* on employment growth is not statistically significant (*p*-value = 0.634). This result is consistent with previous studies that failed to find evidence linking federal timber harvests with local economic indicators (Daniels, Hyde, and Wear, 1991; Burton and Berck, 1996; and Burton, 1997). Similarly, these results provide no evidence that either reserved or unreserved shares had statistically significant total effects on net migration.

[5] The total effects reported in table 5 indicate how employment growth and net migration rates vary across counties with differing shares of land allocated to reserved and unreserved uses. To compute the effect *within* a county of reallocating land between these categories, it must be recognized that the sum of the reserved and unreserved shares is fixed. Therefore, a percentage point increase in the reserved share must be accompanied by a percentage point reduction in the unreserved share, implying, in the case of employment growth, a total effect of −0.022 (= −0.019 − 0.003).

Table 6. Estimated Employment Differences With and Without Reserved Land, 1994–2003

County	Reserved NWFP Percentage	Unreserved NWFP Percentage	Employment Difference	Percent of 2003 Employment
Benton, OR	0.135	0.039	995.9	1.9
Clackamas, OR	0.195	0.217	5,049.6	2.5
Clatsop, OR	0.000	0.000	0.3	0.0
Columbia, OR	0.016	0.012	35.8	0.2
Coos, OR	0.142	0.085	710.0	2.2
Curry, OR	0.375	0.087	583.5	5.4
Deschutes, OR	0.056	0.070	526.8	0.6
Douglas, OR	0.255	0.201	2,045.7	3.8
Hood River, OR	0.218	0.173	441.6	3.2
Jackson, OR	0.169	0.299	2,497.0	2.3
Jefferson, OR	0.067	0.023	86.7	1.0
Josephine, OR	0.333	0.241	1,679.8	4.7
Klamath, OR	0.039	0.051	196.9	0.6
Lane, OR	0.255	0.207	7,223.4	3.8
Lincoln, OR	0.260	0.036	1,015.7	4.1
Linn, OR	0.116	0.174	979.1	1.9
Marion, OR	0.121	0.105	2,958.0	1.8
Multnomah, OR	0.216	0.018	17,999.8	3.3
Polk, OR	0.078	0.009	258.3	1.0
Tillamook, OR	0.135	0.057	249.9	2.0
Wasco, OR	0.034	0.063	65.3	0.5
Washington, OR	0.008	0.017	291.1	0.1
Yamhill, OR	0.065	0.062	382.5	1.0
Chelan, WA	0.207	0.138	1,526.3	3.1
Clallam, WA	0.110	0.054	543.0	1.6
Clark, WA	0.001	0.000	32.7	0.0
Cowlitz, WA	0.003	0.008	25.5	0.1
Grays Harbor, WA	0.082	0.022	428.9	1.3
Jefferson, WA	0.087	0.015	163.3	1.2
King, WA	0.085	0.041	17,419.0	1.3
Kittitas, WA	0.138	0.087	370.3	2.0
Klickitat, WA	0.002	0.005	2.2	0.0
Lewis, WA	0.116	0.089	642.7	1.9
Mason, WA	0.147	0.035	392.6	2.1
Okanogan, WA	0.058	0.041	217.9	0.9
Pierce, WA	0.073	0.005	3,728.1	1.1
Skagit, WA	0.147	0.036	1,229.2	2.0
Skamania, WA	0.299	0.283	143.0	5.0
Snohomish, WA	0.192	0.039	7,916.5	2.8
Thurston, WA	0.002	0.000	26.5	0.0
Whatcom, WA	0.131	0.009	1,854.8	1.9
Yakima, WA	0.052	0.037	967.2	0.8
Del Norte, CA	0.221	0.073	369.0	3.4

(continued . . .)

Table 6. Continued

County	Reserved NWFP Percentage	Unreserved NWFP Percentage	Employment Difference	Percent of 2003 Employment
Glenn, CA	0.043	0.108	82.2	0.7
Humboldt, CA	0.109	0.042	1,200.8	1.7
Lake, CA	0.123	0.200	416.5	1.8
Mendocino, CA	0.065	0.042	486.8	1.0
Napa, CA	0.000	0.001	0.7	0.0
Shasta, CA	0.075	0.092	974.5	1.1
Siskiyou, CA	0.145	0.177	517.9	2.3
Sonoma, CA	0.001	0.002	22.3	0.0
Tehama, CA	0.035	0.028	119.9	0.5
Trinity, CA	0.198	0.277	166.3	3.3
Estimated employment losses, 1994–2003 = 88,259				

Conclusions

Controversies over conserving land for endangered species often stem from differing views on local economic effects. The traditional view is that setting aside public lands will reduce commodity inputs, resulting in lower local employment growth and higher out-migration rates. More recently, others have argued that conserving public lands may stimulate local economies by producing amenities that attract firms, workers, and migrants. Existing empirical evidence suggests public land preservation has little or no effect on local economic indicators; however, many studies evaluate policies that were put in place long before the analyzed period or that applied to unproductive or small areas of land. In contrast, we study impacts of the NWFP, a massive experiment in reallocating public land from timber production to conservation. The NWFP affected 11.5 million acres of highly productive federal timberland, and our study examines local growth in employment and net migration in periods before and after its implementation.

In contrast to earlier studies, we find statistically significant and robust negative effects of the NWFP policy on employment growth after 1994. Our results indicate these effects were strong and offset only slightly by positive migration-driven effects. For an average county, we find that the presence of reserved land decreases annual employment growth rates from 1.75% to 1.52%. Employment losses are concentrated in metropolitan counties, but percentage declines are higher in rural counties.

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