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Conservation Land Amenities and Regional Economies:

A Post-Matching Difference-in-Differences Analysis of the Northwest Forest Plan

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Abstract: The 1994 Northwest Forest Plan (NWFP) resulted in the protection of over 11 million acres of public forestland in the Pacific Northwest region of the United States. This paper quantifies the amenity effect arising from protected NWFP lands on long-run community economic growth. Using community fixed effects and post-matching panel regression to control for many sources of bias, we find highly localized and positive amenity impacts on the growth in median income, population and property values for small communities close to protected NWFP land, as compared to communities far from the NWFP. We find no effect on medium sized communities.

Keywords: conservation lands, amenities, community economic growth, fixed effects, post-matching regression.

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1. INTRODUCTION

The conservation of land into protected areas is a primary policy tool used for supplying ecosystem services such as clean water, flood protection, outdoor recreation, carbon sequestration, and the provision of habitat for wildlife. Some land conservation programs are local and are used to manage growth and sprawl. Data from the Trust for Public Land indicate that over three billion dollars in local and state-level funds were approved for new programs between 2010 and 2012. Other land conservation programs have more global ambitions. The U.N.'s REDD+ program is aimed at conserving forestland to sequester and prevent global emissions of carbon from entering the atmosphere, while the international Nagoya Protocol of 2010 aims to conserve the planet's biodiversity by increasing the global share of protected land from 12.5 percent to 18 percent.

A primary feature of all land conservation is a restriction on using land for activities such as timber harvest, development, agricultural conversion, or road building. These restrictions have brought repeated questions about whether land conservation has positive or negative effects on human neighbors (Andam et al., 2010). The restriction of certain uses of land may induce an employment effect by reducing the production of land-based market goods such as timber, thereby lowering local employment opportunities that induce some job-seeking individuals to sort away from conservation land. Conversely, restricting the allowable uses of land can also generate an amenity effect for people by providing a place for outdoor recreation, attractive scenery, and protection of local watersheds. Such amenities are weakly complementary with residency in the sense that consumption requires proximity to the amenities. Conservation land may therefore induce those who value such amenities to sort into communities with an abundant stock of nearby conservation land.

This paper quantifies the amenity effect of a large increase in conservation land on long-run community economic growth. The creation of the 1994 Northwest Forest Plan (NWFP) in the Pacific Northwest region of the United States greatly restricted the use of over 11 million acres of publicly owned forestland. The NWFP was created largely to conserve the Northern Spotted Owl and Marbled Murrelet, two bird species listed under the U.S. Endangered Species Act that were threatened by timber harvesting in their primary habitat, old growth forest. Setting such a large amount of land aside from commodity production clearly affected employment opportunities related to the harvest of timber and likely led to a short-run re-sorting of employment seekers away from communities near the NWFP or out of the region entirely (Charnley et al., 2006; Eichmann et al., 2010). In contrast, the restriction of this land from timber harvesting also ensures a forested region with less active harvesting and more standing trees, which could generate amenities that may lead to a re-sorting of amenity seekers into nearby communities. The potential re-sorting of job seekers and amenity seekers out of and into local communities affected by the NWFP has implications for community economic growth (Weber and Chen, 2012; Pender et al., 2014). Our analysis focuses on estimating the long-run community-level treatment effects of being in close proximity to preserved NWFP land on changes in income, population and property values. Our definition of community is equivalent to the census definition of places which includes both incorporated places and census designated places (Census Bureau, 1994) [1]. If amenity seekers who sort into a community are higher income than job seekers who sort out of a community, and if net population change isn't strongly negative, both income and property values could potentially be increased by the increased local amenities arising from the NWFP relative to communities which are further from protected NWFP land.

One literature relevant to our topic of conservation lands and regional economic outcomes consists of regional economic models of growth in population and employment. Dating back to Greenwood and Hunt (1984) and Carlino and Mills (1987), this literature uses county data to specify simultaneous equations models of some combination of population, employment, and/or wage growth as a function of exogenous regional growth drivers. Applying the spatial equilibrium framework (Rosen, 1979; Roback, 1982) which assumes equalization of household utility across locations, researchers have found that locations with higher amenities have lower wages, higher population growth and housing prices (e.g. Rappaport, 2007; Chen and Rosenthal, 2008; Deller, 2009; Rickman and Rickman, 2011; Partidge et al., 2012; Irwin et al., 2014). The analysis is typically conducted at the county level. Another relevant literature is the economics of equilibrium sorting among local jurisdictions (see Kuminoff et al., 2013 for a review). Building on the seminal work of Tiebout (1956), this literature argues that variation in local public goods induces a locational equilibrium where people are sorted by income and their preferences for public goods. The analysis is typically conducted at a neighborhood level within a single labor market. Empirical studies that use the Tiebout framework to examine the effects of neighborhood amenities on sorting outcomes include Bayer et al. (2007), Walsh (2007), Banzhaf and Walsh (2008), Epple et al. (2010), Klaiber and Phaneuf (2010), and Tra (2010).

A weakness of much of the past empirical literature involving conservation is an assumption that the location of conservation land is exogenous. There are many reasons why the siting of conservation lands may be endogenous – i.e. correlated with unobserved determinants of local economic growth. First, local political leaders can play a role in the siting of conservation lands, even when lands are funded at higher levels of government. Local political leadership is difficult to measure but can also impact regional economic growth through firm recruitment. Eichman et al. (2010) tried to address the endogenous location of conservation land due to local political pressures using an instrumental variable based on ecological criteria. Second, conservation siting can be driven by local economic factors and may be more likely to be placed in areas with rugged or remote terrain with little market value (Ferraro and Pattanayak, 2006) or in scenic locales rich with amenities (Zipp et al., 2015). Local economies near remote and rugged terrain may have reduced employment opportunities whether land is conserved or not. Likewise, local economies near amenity-rich scenic locales may draw amenity-seeking migrants whether land is conserved or not. To the extent that features such as remote/rugged terrain or scenic amenities are unobserved or difficult to quantify in an econometric analysis of regional economies, variables representing conservation stocks will be endogenous due to unobserved (or difficult to measure) factors and assuming otherwise will lead to biased estimates of the effects of conservation on local economies.

Our analysis focuses on the effects of the NWFP on community-level re-sorting and the growth of local communities. It contributes to the literature on conservation and regional economies by adopting a difference-in-differences strategy to identify the amenity treatment effects of new conservation land on community economies. Prior county-level analyses may miss an important response to new conservation amenities if amenity-effects are strongly localized or if mobility constraints restrict amenity-induced re-sorting to a scale within rather than across counties. Therefore, the first component of our estimation strategy uses community-level rather than county-level data for the state of Oregon, focusing on growth in income, population and property values over the 1980s (before the 1994 NWFP was adopted) and the

2000s (after the NWFP was adopted). This community scale analysis is consistent with the recent findings in Reynolds and Rohlin (2014) that quality of life can be estimated at small geographic scales. The sheer magnitude of the land base affected by the NWFP produced far-reaching employment effects, as harvested logs are often sent to mills many miles away from where they are harvested. To support this assertion, we present empirical evidence that the probability of closing timber mills in Oregon is unrelated to the distance to protected NWFP land. In contrast, and as argued above, the consumption of amenities from conservation lands is weakly complementary with residency and so communities close to NWFP sites will have a larger amenity shock from the NWFP than communities far from the NWFP. To support this assertion, we present empirical evidence that proximity to protected NWFP lands only affects local economies within five miles of protected NWFP lands. Therefore, Oregon communities close to the protected NWFP lands are 'treated' with a larger amenity shock than Oregon communities further from the protected lands. Since Oregon communities far from the protected NWFP lands were subject to similar regional economic shocks as Oregon communities close to the protected NWFP lands, they provide controls in an econometric analysis of the amenity impacts of the NWFP on growth in local communities.

The second component of our identification strategy uses community fixed effects to control for all factors that affect community economic growth, but were time-invariant across the 1980s and 2000s. This explicit control of all time-invariant determinants of community economic growth is useful in dealing with the endogeneity of the NWFP by breaking the correlation between the location of the protected NWFP lands and unobserved time-invariant determinants of community economic growth. In particular, the protected NWFP lands were systematically sited in remote and rugged areas that contained existing old growth forest that housed the species of primary conservation interest, the Northern Spotted Owl and the Marbled Murrelet. Communities near such rugged and remote land potentially have unobserved – or difficult to measure – amenities or employment costs that can influence local economic growth, with or without land protected under the NWFP. Therefore, community fixed effects help to identify the effects of the NWFP on community economic growth and separate it from unobserved time-invariant community characteristics.

The third component of our identification strategy is the application of post-matching fixed effects regression. This post-matching regression intuitively selects control communities that are not close to protected NWFP land but are otherwise similar to those communities which are treated with close proximity to protected NWFP land. Our integration of propensity score matching and fixed effects regression follows a recent push in the program evaluation literature to develop a treatment effects estimator robust to misspecification of the functional form of the primary regression model (see Imbens and Wooldridge, 2009, p. 38-40). A recent design-replication paper has shown that the combination of matching and linear fixed effects regression on observational data can replicate results from a randomized experimental trial even when matching or fixed effects regression on their own fail to replicate experimental results (Ferraro and Miranda, 2014). Our paper is thus in the spirit of recent efforts to apply program evaluation techniques to regional science problems (Reynolds and Rohlin, 2014; Sjoquist and Winters, 2015).

Our main empirical finding is that the conservation land amenities created by the NWFP increased the growth in median income, population and property values for small communities (100 to 2,500 residents) close to protected NWFP lands relative to communities far from the NWFP. We find heterogeneity in the effects of the NWFP across communities of different size.

Results indicate no statistically significant difference between treatment and control groups for larger communities (2,500 to 20,000 residents). The treatment effects are defined as changes over a ten-year period (2000-2010) between communities that are within five miles of protected NWFP land and other Oregon communities that are further than five miles from protected land. Given our evidence that the NWFP generated short-run regional employment shocks in the 1990s immediately after the implementation, we interpret the treatment effect as a long-run amenity effect of the protected NWFP lands on adjacent communities. The interpretation of the treatment effect as an amenity effect arises from the fact that our control communities include only Oregon communities that were also subject to the same short-run employment shocks from the NWFP as treatment communities. Thus, differences between treatment and control communities provide estimates of the highly localized amenity effects arising from land protection.

2. BACKGROUND AND HYPOTHESES ARISING FROM RELATED LITERATURE

The Northwest Forest Plan and Related Regional Science Literature

Federal forest policy in the Pacific Northwest has been a source of much debate over the past few decades. Much of the controversy grew out of studies of the impact of harvest of old-growth forests on the viability and survival of the Northern Spotted Owl that challenged the adequacy of the forest management plans of the federal agencies to protect the habitat of the spotted owl. As a result of a series of successful lawsuits by environmental organizations against the U.S. Forest Service (USFS) and Bureau of Land Management (BLM), the Northern Spotted Owl was listed as a threatened species in 1990. In 1991, a federal district court issued an injunction against timber sales by the USFS and BLM from owl habitat, which spurred the development of alternative management plans that resulted in the creation of the Northwest

Forest Plan (Marcot and Thomas, 1997). Put into place in 1994, the NWFP officially established a new forest management framework that shifted 11 million acres of federal forest land across Washington, Oregon, and northern California from timber production to old-growth forest protection. Figure 1 illustrates the location of protected NWFP land in Oregon, most of which is in the coast range in the far west of the state, and the Cascade mountain region in the central part of the state. This is some of the most commercially productive timber land in the world. Large job losses and other economic damages have been associated with the NWFP (Charnley et al., 2006; Waters et al., 1994). The most recent analysis was an employment-migration simultaneous equations model conducted at the county level by Eichmann et al. (2010), which found that "the presence of reserved land decreases annual employment growth rates from 1.75 percent to 1.52 percent" (p. 331) during the decade immediately following implementation (1994-2003).

Insert Figure 1 Here

The regional science literature has examined the effects of conservation lands on regional economies in a variety of studies that build off the more general literature linking amenities and regional growth (e.g. Blomquist et al., 1988; Gyourko and Tracy, 1991; Schmidt and Courant, 2006; Huffman and Feridhanusetyawan, 2007; Deller, 2009; Rickman and Rickman, 2011). The conservation literature within regional science has argued that large tracts of conserved lands may restrict local employment opportunities by reducing the opportunities for extractive industries, while also potentially inducing in-migration of amenity seeking residents. Existing studies have shown that natural amenities will induce in-migration (McGranahan, 1999; Deller et al., 2001; Lewis et al., 2002; Lorah and Southwick, 2003; Frentz et al., 2004; McGranahan et al., 2007; Partridge et al., 2007; Rappaport, 2007; Chen and Rosenthal, 2008; McGranahan et al., 2011; Chen et al., 2013) and be capitalized into land prices (Blomquist et al., 1988; Irwin, 2002; Hardie et al., 2007; Rappaport, 2007; Kim and Johnson, 2010; Sharma, 2013). The dwindling internal migration since 2000 (Rickman and Rickman, 2011; Partridge et al., 2012) seems to suggest that interregional migration is gradually approaching a spatial equilibrium (Roback, 1982). In a recent study, Irwin et al. (2014) argue that land preservation can generate both a positive shift in housing demand and a negative shift in housing supply. The negative shift in housing supply is not relevant in our study region since the NWFP removed previously established public land from commodity production. This public land was not part of the land supply for housing before or after imposition of the NWFP.

Testable Hypotheses

Most of the existing regional science literature on the impact of natural amenities on household location decisions builds off the spatial equilibrium model of Roback (1982). The spatial equilibrium model assumes equalization of household utility across locations, which implies that differences in locational amenities should be capitalized into wages and land prices. According to this theory, a worker that values natural amenities would accept lower wages and pay higher land prices in exchange for living in a location with higher amenities. Glaeser and Gotlieb (2009) describe spatial equilibrium as occurring when "real wages" are equalized across regions with identical levels of amenities, where real wages are wages corrected for local land prices.

Now, consider the testable hypotheses that arise from spatial equilibrium theory regarding a change in amenities, such as we have with the creation of the vast tracts of protected NWFP land. First, since households working at locations with higher amenities will accept lower real wages (corrected for local property values), implementation of the NWFP should generate a reduction in real income (corrected for local property values) in treatment communities close to the protected NWFP lands compared to control communities that are further away. The reduction in real income can arise from a reduction in income and an increase in property values, or by an increase in income and a larger increase in property values. Communities with an amenity improvement will attract in-migration and experience population increases that bid up the price of land. Moreover, the increased population and lower wages in these communities will attract more businesses and consequently more in-migration.[2] As a result of these forces, the quality of amenities is capitalized into land prices and wages in equilibrium. An increase in amenities will either lower wages, or raise wages as long as land prices go up faster.

Implicit in the Roback spatial equilibrium model is the assumption that relocation is associated with a change in wage rate (Glaeser and Gottlieb, 2009). This typically occurs when households relocate across different labor markets. The corresponding empirical tests are usually conducted at a county level or across metropolitan areas (e.g. Glaeser and Gottlieb, 2009; Rickman and Rickman, 2011). Our analysis is done at the community level which is defined as including both census designated places and incorporated places in Oregon. Since our study area covers Oregon communities that distribute across several local labor markets, implementation of protected NWFP land likely initiates household relocations among different labor markets. Thus, we test the basic predictions of the spatial equilibrium model that a community's amenity increase will increase population and decrease incomes adjusted for housing values. We devote attention in the next section on our reduced-form econometric strategy for identifying the amenity effect of the NWFP apart from correlated unobservables.

3. ECONOMETRIC ANALYSIS AND IDENTIFICATION STRATEGY

We model the effects of protected NWFP lands on community population and two key indicators of local well-being: median income and total property value. Our model uses community-level panel data for the state of Oregon covering two decades: 1980-1990 and 2000-2010. The 1990s are excluded because this is the decade when the major employment adjustment from the 1994 NWFP occurred. While the implementation of the NWFP prompted an immediate reduction in timber supply from public lands that led to rapid contractions in the timber industry, amenity-induced migration is a longer-term proposition that can entail significant transactions costs (Bayer et al., 2009). Thus our analysis focuses on quantifying the long-run amenity effects of the NWFP that occurred after the initial employment adjustment. Due to the endogeneity among income, property value and population, we specify a set of linear reduced-form equations on these three variables and estimate them separately:

(1) $\Delta\mathbf{Median\ Income}_{\mathbf{c,t,t+10}} = \beta_0 + \beta_1\mathbf{E_{ct}} + \beta_2\mathbf{D_{ct}} + \beta_3\mathbf{Year} + \beta_4\mathbf{NWFP_c} + \beta_5\mathbf{NWFP_c} \cdot \mathbf{Year} + \boldsymbol{\mu}_\mathbf{c} + \boldsymbol{\varepsilon}_{\mathbf{ct}},$

(2) $\Delta\mathbf{Population}_{\mathbf{c,t,t+10}} = \gamma_0 + \gamma_1\mathbf{E_{ct}} + \gamma_2\mathbf{D_{ct}} + \gamma_3\mathbf{Year} + \gamma_4\mathbf{NWFP_c} + \gamma_5\mathbf{NWFP_c} \cdot \mathbf{Year} + \boldsymbol{\theta}_\mathbf{c} + \boldsymbol{\varphi}_{\mathbf{ct}},$

(3) $\Delta\mathbf{Property\ Value}_{\mathbf{c,t,t+10}} = \delta_0 + \delta_1\mathbf{E_{ct}} + \delta_2\mathbf{D_{ct}} + \delta_3\mathbf{Year} + \delta_4\mathbf{NWFP_c} + \delta_5\mathbf{NWFP_c} \cdot \mathbf{Year} + \boldsymbol{\rho}_\mathbf{c} + \boldsymbol{\omega}_{\mathbf{ct}},$

where $\Delta\mathbf{Median\ Income}_{\mathbf{c,t,t+10}}$, $\Delta\mathbf{Population}_{\mathbf{c,t,t+10}}$ and $\Delta\mathbf{Property\ Value}_{\mathbf{c,t,t+10}}$, represent first-differenced growth in income, population and property values for community *c* from *t* to *t*+10.[3] Vectors of independent variables were chosen to represent baseline regional economic conditions ($\mathbf{E_{ct}}$) and local demographics ($\mathbf{D_{ct}}$), which are defined in Section 4 Independent variables are all measured at time *t*. The dummy variable $\mathbf{Year}$ takes a value of one for the second decade (2000-2010) and zero otherwise, and picks up spatially-invariant but time-varying shocks such as macroeconomic fluctuations or changes in trade policy. The independent variable of primary interest is $\mathbf{NWFP_c}$, which represents the proximity of community *c* to land protected under Northwest Forest Plan. We discuss our exact measurement of $\mathbf{NWFP_c}$ below. The unobservables consist of a time-invariant community unobservable ($\boldsymbol{\mu_c}$, $\boldsymbol{\rho_c}$, $\boldsymbol{\theta_c}$) and a time-varying community unobservable ($\boldsymbol{\varepsilon_{ct}}$, $\boldsymbol{\omega_{ct}}$, $\boldsymbol{\varphi_{ct}}$).

This model builds off the voluminous literature on simultaneous equations models of regional economic growth. While each of the dependent variables is simultaneously determined, we solve the simultaneous system and adopt a reduced form specification that allows us to focus our empirical test on the total effect of the protected NWFP land on the three dependent variables. Implicit in our reduced form system is the possibility that there are direct and indirect effects of the protected NWFP land on each of the dependent variables. For example, the protected NWFP land could induce positive population growth into a town. If population growth positively affects median income growth, then the protected NWFP land has indirect effects on income growth through its effect on population growth. Controlling for population growth, the protected NWFP land could also have direct effects on median income growth if higher paying employment sectors increased their presence in such communities. The reduced form parameters on the protected NWPF land implicitly account for all direct and indirect effects of the protected lands on the three dependent variables. We view the reduced form specification as desirable in that identification of the total effect of conservation does not depend on consistent estimation of the simultaneous relationship between the three dependent variables. Our objective in including a set of independent variables is to control for as many exogenous regressors as possible to limit the potential of omitted variable bias with respect to our key independent variable $\mathbf{NWFP_c}$, and to reduce the amount of noise present in the regression error.

A feature of our reduced form model is the set of time-invariant unobservables ($\boldsymbol{\mu_c}$, $\boldsymbol{\rho_c}$, $\boldsymbol{\theta_c}$), hereafter labeled community effects. Despite our inclusion of multiple control variables, there are many reasons why the siting of the protected NWFP land may be endogenous due to correlation between the NWFP proximity variable and the community effects ($\boldsymbol{\mu_c}$, $\boldsymbol{\rho_c}$, $\boldsymbol{\theta_c}$). Given its emphasis on protecting the Northern Spotted Owl and Marbled Murrelet, the protected NWFP land was primarily located near areas with existing populations of both birds (Soules, 2002). Since these birds' primary habitat consists of old growth forest, the location of the protected NWFP land was therefore driven by the presence of old growth forest. Since old growth forests have generally never been harvested, it then becomes difficult to separate old growth location from local economic forces, many of which are unobserved to the econometrician. For example, the lack of harvest can be driven by past wilderness or other recreational designations, and recreational designations in Oregon are predominantly found in areas with high scenic and recreational amenities that are attractive to amenity-seeking migrants irrespective of whether they are covered by the NWFP. Likewise, remaining old growth was also found in rugged and remote regions that were likely too costly to harvest. The remoteness or ruggedness of a region could affect local economic growth by reducing timber opportunities, whether or not the NWFP is in place. Since scenic and recreational amenities and the remoteness/ruggedness of a region are largely time-invariant across the 1980s and 2000s, modeling the community effects ($\boldsymbol{\mu_c}$, $\boldsymbol{\rho_c}$, $\boldsymbol{\theta_c}$) as fixed effects capture important unobservables that would otherwise bias econometric estimates of the effect of the NWFP – which is time-varying across the 1980s and 2000s – on the growth of local economies.

Definition of a Binary Treatment and Difference-In-Differences Interpretation

We first specify the variable representing proximity of community *c* to protected NWFP land ($\mathbf{NWFP_c}$) as the inverse of the Euclidian distance to the nearest protected NWFP land (**nwfp_ distance**). Specifying the Euclidian distance to protected NWFP land as an inverse generates a non-linear relationship between the dependent variables and proximity to protected land that is consistent with the findings from the hedonic property value literature that protected open-space has strongly localized effects (Acharya and Bennett, 2001; Thorsnes, 2002; Irwin, 2002; Walsh, 2007). After estimating (1)–(3) using fixed effects and calculating the marginal effects of the distance variable (**nwfp_ distance**) on the change in income, population and property value, the absolute values of these marginal impacts are found to be gradually decreasing as distance increases. When the distance to protected NWFP land is approximately five miles, the marginal effects become statistically insignificant (five percent level). As a robustness check, we also tried cut-off values other than five miles. For cut-off values less than five miles, the estimated treatment effects are qualitatively similar. For cut-off values higher than five miles, the treatment effects become insignificant. For simplicity and ease-of-interpretation, we proceed with our primary treatment variable being a binary variable defined as **nwfp_near**, which is set to one for communities within five miles of the protected NWFP lands and zero otherwise.

The difference-in-differences interpretation of Equations (1) – (3) can be seen as follows. Consider Equation (1) as an example. The expected difference in median income growth between the treatment and control communities after treatment is equal to $\beta_4 + \beta_5$. The difference between the treatment and control communities before treatment is equal to β_4. Thus, the difference-in-differences between treatment and control communities is $(\beta_4 + \beta_5)$ minus β_4, which yields β_5. Thus, differencing out the pre-treatment difference between treatment and control communities is central to identifying the effects of the treatment itself, as distinct from the pre-existing differences between treatment and control communities.

Propensity Score and Matching Methods

Estimation of (1)-(3) using regression methods will generate results derived under the assumption that the conditional expectation of changes in community-level economic growth are a linear function of our primary treatment variable (**nwfp_near**) and the set of other community-level observable independent variables. If the treatment variable is correlated with the other independent variables, then any misspecification in how the other observables enter the conditional expectation could spill over and induce bias in our estimated treatment effect. Intuitively, this type of omitted variable bias arises if the treatment communities (within five miles of protected NWFP land) have significantly different distributions of the observable independent variables than the control communities (further than five miles from protected NWFP land), in which case there would be correlation between the treatment variable and the other observables.

Our use of a binary treatment allows us to exploit the many methods developed in the program evaluation literature (Imbens and Wooldridge, 2009) in recent years to compare treatment and control groups. Ideally, treatment assignment is randomized, allowing for the treatment effect to be discerned from simple differences in means. Our data on the observational assignment of communities near protected NWFP land requires an assumption of unconfoundeness for identification – upon adjusting treatment and control groups for observed differences and fixed effects, bias is removed in comparing outcomes across treated and control groups. We follow much of the program evaluation literature and make use of the propensity score – the probability that each observation is treated – as a function of observable independent variables. A recent push in the literature has emphasized combining propensity score matching methods and regression for the reason that "although local linearity of the regression functions may be a reasonable approximation, in many cases the estimated average treatment effects based on regression methods can be severely biased if the linear approximation is not accurate globally" (Imbens and Wooldridge, 2009, p. 24). For our study, we use the propensity score to select good control communities – communities that are not close to protected NWFP land but are otherwise similar to those communities treated by being close to protected NWFP land.

We pre-process data with matching methods to construct a sample of treated and control communities that are similar in *pre-treatment* observable attributes, then use conventional regression analyses on the matched sample. Recent panel data studies that pre-process data with matching typically match on the levels of pre-treatment independent and dependent variables before using conventional fixed or random effects regression (e.g. Arriagada et al., 2012; Wendland et al., 2015; Ferraro and Miranda, 2014). Intuitively, matching on pre-treatment variables creates a sample of control and treatment communities that are balanced in their observables, mimicking what one would find if the treatment were randomized. Our propensity score is estimated with a binary Logit model where the dependent variable is a one if the community is (ever) treated by being within five miles of protected NWFP land, and zero otherwise. The estimated propensity score represents the probability that community *c* is treated by having protected NWFP land within five miles of the community and is

$$\mathbf{P_c} = f(\mathbf{E_{c1980}}, \mathbf{D_{c1980}}, \Delta\mathbf{Med\ Income_{c,1980,1990}}, \Delta\mathbf{Pop_{c,1980,1990}}, \Delta\mathbf{Prop\ Value_{c,1980,1990}};\ \boldsymbol{\omega}),$$

where **ω** is a vector of parameters to be estimated via maximum likelihood and $f(\cdot)$ is the logistic function. The estimated propensity scores are used to match treatment communities with control communities using nearest neighbor one-to-one matching without replacement (Rubin, 2006). The maximum distance between matches is restricted using a caliper size of a quarter of the standard deviation of the estimated propensity score (Guo and Fraser, 2010). Post-matching regression with community fixed effects is then run on the sample of matched communities to control for all time-invariant unobserved determinants of our dependent variables that may also be correlated with treatment status.

4. DATA DESCRIPTION AND EMPIRICAL SPECIFICATION TESTS

Data Description

The data used in this study are explained in Table 1, along with the data source for each variable. It is worth noting that the total real property values include the values of both residential properties and commercial/industrial real properties.[4] The explanatory variables used are classified into three major categories. The first category includes variables that are directly related to the protection of forest land under the NWFP. This category includes the treatment variable reflecting whether a community is within five miles of the nearest protected NWFP land (**nwfp_near**), the number of mills closed in each decade, and the county-level timber harvest. The second category includes other economic variables including industry mix growth index and occupation mix growth index. The construction of the industry and occupation mix growth indices follows the procedure described in Partridge et al. (2012). The industry (or occupation) mix index is constructed by summing the products of industry (or occupation) shares and the corresponding national U.S. growth rates. The growth index represents the overall growth in jobs that would be available to community residents if all of the industries (or occupations) in which they were employed grew at the national rate. [5] The last category includes demographic variables like age structure, education level, and race/ethnic composition.

Insert Table 1 Here

Covariate Balancing, Common Trends and Overlap of the Propensity Score

The summary statistics for both treatment and control communities are reported in Table 2. We check for covariate balance before and after the pre-treatment matching on the propensity score. Following Imbens and Wooldridge (2009, p. 24), for each covariate, we calculate the difference in the mean from the treated group and the mean from the control group, normalized by the square root of the sum of the variances across both the control and treatment groups. The rule of thumb from Imbens and Wooldridge is that normalized differences in means that are greater than 0.25 indicate that linear regression methods will be sensitive to the linear specification. Matching moderately reduces the difference in normalized means across treated and control communities, with the most important reduction arising from a better balance associated with the mill closure variable – now treatment and control communities have a similar number of closed timber mills.

Insert Table 2 Here

An important assumption in all difference-in-differences exercises is known as the common (or parallel) trends assumption – trends in the dependent variable would be the same on control and treatment communities in the absence of treatment, and it is treatment that induces deviation from a common underlying trend (Angrist and Pischke, 2009). In our difference-in-differences setup, the 1980s are the before treatment decade and the 2000s are the after treatment decade. Therefore, we plot the trends in each of our dependent variables across the 1980s and the 1990s to assess whether treatment and control communities had common trends. Figure 2 illustrates similar but not identical trends across treatment and control communities for the full sample without matching. For the matched sample, we see that the trends between treatment and control communities become much more similar with nearly identical trends for both the median income and population variables. Thus, the assumption of common trends is quite reasonable for our empirical exercise, especially for the matched sample.

Insert Figure 2 Here

Identification of treatment effects with observational data requires overlap in the propensity score of the treatment (Imbens and Wooldridge, 2009). Overlap implies that for all possible values of the covariates, there are both treated and control units. In practice, overlap is assessed by plotting histograms of the propensity score of treatment for both treatment and control units and visually inspecting whether the two histograms overlap. Figure 3 presents histograms of the propensity score, and shows substantial overlap for our sample of communities for the matched sample when the propensity score is estimated with pre-treatment levels.

Insert Figure 3 Here

Evaluating Whether the NWFP Created a Regional Employment Shock

The implementation of the NWFP is expected to reduce timber harvest and affect timber related employment in addition to local amenities. In the model description, we argue that the employment effect is regional in that it affects both the communities nearby and further away from the protected NWFP lands. The assumption is critical in the common trends analysis implicit in all difference-in-differences analyses: control communities (those far from the protected NWFP lands) were subject to the same underlying trends as the treatment communities (those close to the protected NWFP lands). To test the validity of this assumption, we investigate whether the timber mills closer to the protected NWFP lands are more likely to close than mills further from the protected NWFP lands. Figure 1 illustrates the location of all mills closed in Oregon in the 1990s, and indicates a wide regional geographic spread of closures.

To further investigate, we estimate a binary Probit model of the annual probability of mill closure as a function of distance from the mill to the nearest protected NWFP land and time dummy variables representing the decade of the 1990s and 2000s. We use a panel dataset and estimate the annual probability that each timber mill closes. We define a binary variable **MillClose** as equal to zero in all the years that the mill operates and equal to one in the year that the mill closes Mills are dropped from the dataset after mill closure has occurred. Our binary Probit model on mill closure is specified in Equation (4) to test whether mills closer to the protected NWFP lands are more likely to be closed.

$$\textbf{(4)}\ \mathbf{MillClose_{m,t}} = a_0 + a_1\mathbf{Year_{1990s}} + a_2\mathbf{Year_{2000s}} + a_3\mathbf{MillDist_m}$$

$$+a_4\mathbf{MillDist_m} * \mathbf{Year_{1990s}} + a_5\mathbf{MillDist_m} * \mathbf{Year_{2000s}} + \boldsymbol{\varepsilon}_{\mathbf{mt}}\ ,$$

where $\mathbf{Year_{1990s}}$ and $\mathbf{Year_{2000s}}$ are dummy variables for years in 1990s and 2000s respectively. The results are reported in Table 3. The significance of time-dummies illustrates that region-wide forces (such as the implementation of NWFP) affected closure probabilities for all the mills in Oregon such that mills are more likely to close in the 1990s and 2000s as compared to the 1980s. However, the marginal effect of the variable representing distance of the mill to the protected NWFP lands is not significantly different from zero at any reasonable significance level. Further, a likelihood-ratio test of the joint null hypothesis that all three parameters on the mill distance variables and interactions (a_3, a_4, a_5) are jointly zero fails to reject the null hypothesis (five percent level). This validates our assumption that the employment impact of the NWFP was region-wide and helps support the common trends assumption implicit in our difference-in-differences model.

Insert Table 3 Here

5. RESULTS AND DISCUSSION

The estimated treatment effects of being within five miles of protected NWFP land on community income, population and property value are summarized in Table 4 and Table 5. To investigate heterogeneity in the impacts of the protected NWFP lands on small and medium-sized communities, we split our dataset into two sub-samples: small communities with populations between 100 and 2,500 (Table 4) and medium-sized communities with population between 2,500 and 20,000 (Table 5). The first column reports the estimated treatment effects from OLS estimation of Equations (2)-(4) without introducing the community fixed effects and using all the Oregon communities in the dataset. The second column reports the estimated treatment effect when community fixed effects are included and the "within" estimator is used for the full sample of Oregon communities.

For the post-matching estimators, the third column in Tables 4 and 5 (post-matching fixed effects I) presents fixed effects estimation on the subsample created by matching treatment and control communities on pre-treatment levels. The control communities are constructed using all the communities not within five miles of protected forest under NWFP. One concern with the definition of control communities from post-matching fixed effects I is that, rather than capturing the causal effect of being near protected NWFP lands, the estimated treatment effects simply reflect the more general trend of moving toward natural amenities which has recently occurred in the US. As a robustness check, we construct an alternative control group which selects controls from the set of communities that are within five miles of other public forests (e.g. State Forests, Federal forests not protected by NWFP). In this way, the only difference between the treatment and control groups is the conservation change due to the implementation of NWFP. The estimation results are reported in the fourth column (post-matching fixed effects II). The last column presents a falsification test. In this falsification test, we create a treated group within five miles of other public forest lands not protected by the NWFP, and a control group from the set of communities that are not within five miles of either protected NWFP lands or other public forest. This falsification test examines whether the treatment effect in the post-matching fixed effects models are really due to changes in forest management or simply an artifact of being close to public forest land.[6] All standard errors are robust to arbitrary forms of heteroskedasticity.[7] The complete summary of all estimated parameters in Equations (2)-(4) are reported respectively in Tables A1−A6 in the appendix. Our preferred estimator is the Post-Matching Fixed Effects I estimator since it i) has better balance in key independent variables such as mill closure and more plausibly common trends than the unmatched sample, and ii) has better quality matches than the restricted control set from post-matching fixed effects II.

Insert Table 4 Here

Results in table 4 investigate the treatment effects of being within five miles of protected NWFP land for small communities between 100 and 2,500 residents. There are three primary findings. First, results show that whether to include the community fixed effects is a critical decision related to model specification because it directly affects the magnitude and statistical significance of the estimated treatment effects. The large differences in treatment effect estimates with and without community fixed effects confirms our concerns that variables indicating proximity to protected NWFP lands are likely endogenous in our estimation equations because of correlation with time-invariant community-level unobservables. The within-estimator corrects for this endogeneity problem by differencing out community fixed effects because it places every variable in differences-in-means form. The second primary finding from Table 4 is that results are qualitatively robust across the three estimators that account for community fixed effects, though the point estimates vary. The size of the estimated amenity effect is quite large for small communities. Our results suggest that the long run amenity effect of conservation lands on median income in small communities is between $1,133 and $2,964. With a mean income of $39,023 in small Oregon communities in 2000, the amenity effect implies a very significant boost (3-8 percent) to incomes in the small communities near the NWFP reserved lands.[8] Since mean population size of small Oregon cities in 2000 was around 1000, an amenity effect on population growth of between 57 and 170 people implies a boost of around 5-17 percent over the base population.[9] With the mean property value of small communities being around $62 million, the amenity effect on real property value is $18 to $63 million, a 29-100 percent increase.[10] The very similar findings between the two post-matching estimators shows that results are robust to restricting the set of controls to be within five miles of other non-NWFP public forests or not, suggesting that we're picking up the amenity effect from the protected NWFP lands rather than a more general amenity shift to forested communities. The insignificance of the falsified treatment effect further supports our interpretation of the treatment effects as causal.

The treatment effects in this study are defined as changes over a ten-year period (2000-2010) between communities that are within five miles of protected NWFP land and other Oregon communities in the control group, although definitions differ. [11] Given our argument and evidence from section 5 that the NWFP generated regional employment shocks, we interpret the treatment effect as a long-run amenity effect of the protected NWFP lands on adjacent communities. The interpretation of the treatment effect as an amenity effect arises from the fact that our control communities include only Oregon communities that were also subject to the same employment shocks from the NWFP in the 1990s as treatment communities. Further indication of common employment shocks is that the average number of timber mill closures is close between the treated (0.35) and matched control communities (0.27). Thus, differences between treatment and control communities provide estimates of the localized amenity effects arising from land protection.

These findings are consistent with the findings in the existing literature about amenity-related migration. The enhanced natural amenity increases the demand for natural amenity services. This increased demand can manifest itself either through increased in-migration into the region or through the increased local sales in tourism related goods and services. According to Shumway and Otterstrom (2001), households that are attracted to locations with high natural amenities tend to have higher income. In-migration can therefore lead to an increase in median household income. Alternatively, the increased demand for tourism related goods and services may provide additional employment opportunities and sources of income to local residents, which can also lead to an increase in household income. These increases in local demand are directly confined to the adjacent communities as they are tied directly to the in-migrating households or the increased consumption of natural amenities. The complete summary of all estimated parameters in Equations (2)-(4) using post-matching regression are reported respectively in Tables A4, A5 and A6 in the appendix.

Results in table 5 investigate the treatment effects of being within five miles of protected NWFP land for medium size communities between 2,500 and 20,000 residents. In contrast to the findings for small communities in table 4, none of the treatment effects are statistically significantly. Thus, comparing the treatment effects of proximity to the protected NWFP lands on small and medium-sized communities, we find that the NWFP has larger impacts on small adjacent communities than on medium-sized communities. It is interesting that the small nearby communities experienced faster population growth in the 2000s while the population growth in medium-sized communities near the protected NWFP lands is not significantly different from that of communities farther away. The insignificant treatment effect might be due to the small sample size used in estimation. Or it might be a simple manifestation of Newton's second law of motion: when the same force is applied to two objects, the effect is less evident on the one with larger mass.

6. CONCLUSION

In this paper, we estimate the amenity effect of protected NWFP land. The estimated positive treatment effects suggest that small communities (population between 100 and 2,500) close to the protected land under the NWFP experienced higher growth in income, population and property values, compared with the communities further away. Since property values grew more than income, these results are consistent with the Roback (1982) spatial equilibrium hypothesis that an increase in a community's amenities will lower real incomes (adjusted for housing price) and raise population. However, our results do not imply that the implementation of the NWFP raised income, population, and property values in total, because both the treatment and control communities in this study were subject to the negative employment shock of the NWFP. An estimated total effect of the NWFP must include both the amenity effect and the employment effect. The estimated treatment effects in this study only capture the relative difference between the nearby communities and those further away from the protected NWFP lands. This relative difference measures the highly localized long-run amenity effect only.

This research is the first regional science study on the impact of a major new land conservation effort at the community scale, an observational scale that is much smaller than a county and larger than a neighborhood. Our study shows that the amenity impacts of the protected NWFP lands are highly localized, a finding which is consistent with the hedonic literature that focuses on the effects that small parcels of protected open space have on nearby land prices (Acharya and Bennett, 2001; Thorsnes, 2002; Irwin, 2002; Walsh, 2007). The localized amenity impacts found in this study suggest that spatial resolution is an important factor to consider in the design of regional science research aimed at capturing the amenity effects of land conservation policies. Larger spatial units of observation like counties have dominated the prior literature, but the localized amenity effect may be missed when analyzing counties.

This study strongly suggests that conservation siting of protected NWFP lands was endogenous and that protected NWFP lands were placed in areas with time-invariant unobservables that influenced community economic outcomes. Such endogeneity of conservation lands is likely to plague other analyses. The inclusion of community fixed effects is important both practically and statistically, because it helps to control for time-invariant unobservables and reduce omitted variable bias. Further, combining matching and fixed effects regression can generate different treatment effects estimates than fixed effects regression alone. Matching generates treatment and control groups that are more similar in observable characteristics. For example, matching ensures that our treatment and control communities had similar average timber mill closures, thus making our assumption of a common employment effect from the NWFP more palatable. Combining matching with fixed effects estimation makes results robust to functional form assumptions and has a future role to play in regional science applications that use treatment and control regions that differ in observable characteristics and in time-invariant unobservable characteristics.

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[1] "The Bureau of the Census defines a place as a concentration of population; a place may or may not have legally prescribed limits, powers, or functions. … A place either is legally incorporated under the laws of its respective State, or a statistical equivalent that the Census Bureau treats as a census designated place (CDP)"(Census Bureau, 1994, Chapter 9 p.1).

[2] The improvement in natural amenities may also increase income through increased local demand due to in-migration or due to the increase in amenity-related consumption associated with tourism (Deller et al., 2001; Lewis, Hunt and Plantinga, 2002; Weiler and Seidl, 2004; Monchuk et al., 2006; McGranahan and Wojan, 2007; Rappaport, 2007; McGranahan et al., 2011). This may mitigate but not reverse the income decreases in high amenities communities in spatial equilibrium. In our case, the implementation of the NWFP also reduced local timber-related jobs, which resulted in a decrease in local income. This combination of the employment and amenity effects makes the net policy impact on local income ambiguous.

[3] Our results are robust to specifying the dependent variables as first-difference in logs or as percentage changes; see section 5.

[4] Place-level accounting reports do not separate residential properties from the commercial/industrial properties. This complicates the interpretation of the results on property value. The inclusion of commercial and industrial property implies that apart from household location decisions, firm locations also affect the changes in the real property value. Reduced timber harvest and consequent mill closures decreased commercial/industrial properties region-wide but might not lead to systematic difference between the treated and control groups. Increased amenity

migration increases the local demand. If firms follow population, the real commercial/industrial property will increase in the treated group. So we expect that the inclusion of commercial/industrial properties will result in higher estimated growth in property value due to firm location decisions.

[5] The industry mix and occupational mix are calculated in our study using the place-of-residence data from the Census, since place-of-work data are not available at the community level. We believe that place-of-residence data better capture the employment opportunities available for the resident households, which are not just the jobs in the local community. The relevant industry and occupational mixes for the households in our study are not the mixes of industries and occupations in the local community (as in the Partridge et al. (2012) county-level studies) but rather the mixes of industries and occupations in which the residents are employed.

[6] We thank an anonymous reviewer for suggesting Post-Matching Fixed Effects II and the Falsification test.

[7] We also estimated standard errors by clustering at the county level since there are multiple communities within a county. Inference using these cluster-robust standard errors is robust to any form of heteroskedasticity or spatial correlation across communities within a county. All inference regarding the primary treatment effect is identical with cluster robust standard errors.

[8] The preferred estimated treatment effect when the dependent variable median income is specified as a log (percentage) difference is nine percent (eight percent) with a p-value of .072 (.109).

[9] The preferred estimated treatment effect when the dependent variable population growth is specified as a log (percentage) difference is six percent (eight percent) with a p-value of .183 (.136).

[10] The preferred estimated treatment effect when the dependent variable property value is specified as a log (percentage) difference is 17 percent (34 percent) with a p-value of .009 (.002).This big estimated increase in real property value is partly due to the housing bubbles in the early 2000s. The national Case-Shiller home price index increased about 50 percent from 2000 to 2010. There was a similar increase in Oregon. The mean property value of small Oregon communities increased from $62.46 million to $103.44 million in 2010. Moreover, the changes in real property value of the small communities in the control group are very similar to those in the treatment group in the 1980s and 1990s. For instance, property value increased by $41.22 million for the control group, while that of the treatment group increased by $47.28 million in 1990-2000. In 2000-2010, the property value of the control group increased by another $34.98 million. However, that for the treated communities increased much more dramatically

by $71.64 million. Our estimated impact on property values captures this difference, but controls for observable characteristics and community fixed effects.

[11] This definition of the treatment and control communities does not consider the potential spillover effects from the treated communities to the nearby control communities. Intuitively, the presence of spillover effects tends to benefit the control communities close to the treated community because the increase in population, income and tourism in the treated community gets spilled over to its neighbors. Therefore, *ceteris paribus*, the presence of spillover effects tends to reduce the estimated treatment effect. Consequently, our results are conservative estimates of the amenity treatment effect – less than they would be without any spillover. As a robustness check, we construct the control group using only communities locating at least eight miles from the protected NWFP lands. This ensures that the control and the treatment communities are at least three miles apart. Note that distance to the protected NWFP is the distance from the community boundary to the nearest point of the protected NWFP land. The actual distance between the control and the corresponding treatment community can be much larger. The results are qualitatively and quantitatively similar to the results reported in this paper. For detailed results, please contact the authors.

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TABLE 1: Definition of Variables and Data Sources

Variable	Definition (unit)	Source
Dependent variables		
Δ Median Income	change in income ($)	Census, ACS
Δ Population	change in population (persons)	Calculated
Δ Property Value	change in real property value (millions of $s)	Calculated
NWFP-related variables		
nwfp_distance	distance to NWFP reserved land (miles)	NWFPREO
nwfp_near	=1 if nwfp_distance<5 miles, 0 otherwise	NWFPREO
mill_closure	number of mill closures	ODF
Economic variables		
occupation mix	occupation mix growth rate (%)	Calculated
industry mix	industry mix growth rate (%)	Calculated
Demographic variables		
pop_65pl	population 65 + (%)	Census
bachelor	bachelor degree and above (%)	Census
black	African American (%)	Census
native	Native American (%)	Census
hispanic	Hispanic population (%)	Census
asian	Asian population (%)	Census

Note: ACS: American Community Survey;
NWFPREO: Northwest Forest Plan Regional Ecosystem Office
ODF: Oregon Department of Forest

TABLE 2: Summary Statistics

Variable	Unmatched			Matched		
	treated	control	normalized difference	treated	control	normalized difference
Dependent variables						
Δ Median Income	-92.3	286.2	-.05	-231.8	403.2	-.08
	(5202.9)	(6167.8)		(5045.2)	(6199.6)	
Δ Population	489.7	483.9	.00	372.3	603.9	-.12
	(925.1)	(1678.7)		(835.8)	(1734.8)	
Δ Property Value	91.4	69.9	.07	73.9	102.6	-.09
	(205.6)	(238.1)		(193.1)	(232.0)	
NWFP related variables						
nwfp_near	1	0		1	0	
	(0)	(0)		(0)	(0)	
mill_closure	0.40	0.15	.246	0.35	0.27	.07
	(0.88)	(0.51)		(0.70)	(0.84)	
Economic variables						
occupation mix	0.08	0.08	-.07	0.08	0.08	.01
	(0.04)	(0.04)		(0.04)	(0.04)	
industry mix	-0.68	-0.66	-.02	-0.66	-0.73	.06
	(0.92)	(0.91)		(0.92)	(0.93)	
Demographic variables						
pop_65pl	14.52	14.80	-.03	14.84	14.24	.07
	(6.36)	(8.30)		(6.19)	(6.20)	
bachelor	14.67	17.41	-.20	15.60	17.72	-.14
	(7.99)	(10.95)		(8.30)	(12.10)	
black	0.23	0.30	-.10	0.24	0.30	-.09
	(0.37)	(0.61)		(0.51)	(0.42)	
native	1.96	1.67	.03	1.33	2.81	-.15
	(4.43)	(7.19)		(1.16)	(9.89)	
hispanic	4.23	6.86	-.23	4.45	4.04	.05
	(4.79)	(10.60)		(6.56)	(4.53)	
asian	0.73	0.86	-.08	0.67	1.13	-.23
	(0.82)	(1.48)		(0.78)	(1.84)	

Note: normalized difference for variable x is calculated as: $\frac{\bar{x}_{treat}-\bar{x}_{control}}{\sqrt{var(x_{treat})+var(x_{control})}}$.

TABLE 3: Explaining the Probability for Mill Closures (Standard Errors in Parenthesis)

Variables	Estimates
$Year_{1990s}$	0.38 ***
	(0.07)
$Year_{2000s}$	0.25 ***
	(0.08)
MillDist	-2.48E-07
	(7.27E-06)
$MillDist*Year_{1990s}$	-2.97E-08
	(9.68E-07)
$MillDist*Year_{2000s}$	1.35E-06
	(1.06E-06)
Constant	-1.95 ***
	(0.05)
F-test:	2.38
MillDist = MillDist*Year1990s = MillDist*Year2000s = 0	(0.50)
Marginal effect of distance to NWFP	1.02E-07
evaluated at k miles (k=1,2, …, 10)[a]	(2.14E-07)
Observations	7493

Note:

a. The marginal effects and standard errors are same for k=1,2,…,10.

b. *, **, and *** denote that significance level of ten percent, five percent and one percent respectively.

TABLE 4: Estimated Treatment Effects of Being within 6 Miles of Protected NWFP Land on Income, Population and Property Value for Small Communities (Less than 2,500 Residents)

Dependent variable	Full Sample No Fixed Effects	Full Sample Fixed Effects	Post-Matching Fixed Effects I	Post-Matching Fixed Effects II	Falsification
ΔMedian Income					
estimate	583.6	1132.8	2964.0	3584.3	3034.1
standard error	(1315.0)	(470.3)	(1609.8)	(2198.8)	(2190.4)
p-value	.657	.017	.068	.107	.171
# communities	152	152	109	73	60
ΔPopulation					
estimate	109.5	57.20	100.6	170.1	-58.56
standard error	(67.34)	(30.39)	(49.54)	(61.77)	(48.81)
p-value	.104	.062	.045	.007	.235
# communities	152	152	109	73	60
ΔProperty Value					
estimate	22.43	17.84	54.57	63.44	11.52
standard error	(13.89)	(8.077)	(11.84)	(15.08)	(12.39)
p-value	.107	.029	.000	.000	.356
# communities	152	152	109	73	60

Notes: standard errors in parentheses. Post-Matching Fixed Effects I defines the set of eligible control communities as Oregon communities further than 5 miles from protected NWFP lands. Post-Matching Fixed Effects II defines the set of eligible control communities as Oregon communities within 5 miles of non-NWFP public forests but not within 5 miles of protected NWFP lands. Falsification defines treatment communities as within 5 miles of non-NWFP public forests and eligible control communities as not within 5 miles of any public forestland.

TABLE 5: Estimated Treatment Effects of Being within 6 Miles of Protected NWFP Land on Income, Population and Property Value for Medium Sized Communities (between 2,500 and 20,000 Residents)

Dependent variable	Full Sample No Fixed Effects	Full Sample Fixed Effects	Post-Matching Fixed Effects I	Post-Matching Fixed Effects II	Falsification
ΔMedian Income					
estimate	715.2	58.71	308.6	-940.6	5283.4
standard error	(1037.6)	(323.7)	(1509.9)	(2881.2)	(7790.2)
p-value	.491	.856	.839	.746	.504
# communities	92	92	63	40	25
ΔPopulation					
estimate	-77.01	-209.3	-545.0	-203.6	-6229.6
standard error	(504.2)	(267.4)	(728.4)	(241.9)	(3435.0)
p-value	.879	.436	.457	.405	.082
# communities	92	92	63	40	25
ΔProperty Value					
estimate	18.04	15.72	-8.820	-39.67	-1217.5
standard error	(65.91)	(55.22)	(129.9)	(116.7)	(637.8)
p-value	.784	.776	.946	.736	.068
# communities	92	92	63	40	25

Notes: standard errors in parentheses. Post-Matching Fixed Effects I defines the set of eligible control communities as Oregon communities further than 5 miles from protected NWFP lands. Post-Matching Fixed Effects II defines the set of eligible control communities as Oregon communities within 5 miles of non-NWFP public forests but not within 5 miles of protected NWFP lands. Falsification defines treatment communities as within 5 miles of non-NWFP public forests and eligible control communities as not within 5 miles of any public forestland.

TABLE A.1: Regression Result for the Equation of Δ**Median Income**

ΔMedian Income	Small Sized Communities				Medium Sized Communities			
	No fixed effects		Fixed effects		No fixed effects		Fixed effects	
nwfp_near	1311.1	*			-1118.5	*		
	(671.9)				(574.4)			
nwfp_near*year	583.6		1132.8	**	715.2		58.71	
	(1315.0)		(470.3)		(1037.6)		(323.7)	
year	-57.96		-395.3	**	-100.3		145.5	
	(835.6)		(187.0)		(787.7)		(196.9)	
mill_closure	-951.8		-1044.6		252.4		-122.3	
	(672.1)		(1539.7)		(262.3)		(358.3)	
occupation mix	42789.8	***	-13839.3		35374.2	**	111266.2	**
	(15483.0)		(36907.1)		(16717.0)		(43493.9)	
industry mix	-670.3		1699.9		-664.0		-3091.3	*
	(688.2)		(1625.4)		(759.1)		(1835.1)	
pop_65pl	-75.41	**	-103.8		-21.37		383.6	**
	(38.30)		(124.6)		(39.60)		(175.0)	
bachelor	-35.55		-165.8		65.97		-203.4	
	(36.80)		(113.8)		(40.13)		(211.2)	
black	-436.9		136.9		-168.6		1028.9	
	(510.6)		(1117.0)		(431.1)		(765.6)	
native	-118.8	*	11.45		109.2		1367.9	*
	(65.55)		(352.9)		(261.1)		(760.0)	
hisp	-34.75		-63.81		26.53		91.42	
	(33.77)		(97.51)		(24.85)		(135.5)	
asian	-683.1	*	-1056.8	*	-1261.3	***	-1234.2	
	(378.4)		(607.9)		(232.1)		(1072.0)	
constant	-1400.6		7466.8	*	-3019.9	*	-14932.3	**
	(1647.8)		(4282.6)		(1674.0)		(6413.2)	
# communities	152		152		92		92	
Adj. R-square	.0433		.119		.144		.297	

Note: *, ** and *** denote significance level of ten percent, five percent and one percent respectively.

TABLE A.2: Regression Result for the Equation of Δ**Population**

ΔPopulation	Small Sized Communities				Medium Sized Communities			
	No fixed effects		Fixed effects		No fixed effects		Fixed effects	
nwfp_near	54.97				-114.6			
	(34.41)				(278.3)			
nwfp_near*year	109.5		57.20	*	-77.01		-209.3	
	(67.34)		(30.39)		(504.2)		(267.4)	
year	-90.36	**	-47.18	***	-80.84		37.63	
	(42.79)		(17.93)		(382.3)		(232.7)	
mill_closure	6.778		16.21		324.4	**	298.2	***
	(34.42)		(51.35)		(127.5)		(79.67)	
occupation mix	-401.8		-1462.6		-31606.0	***	-20220.1	*
	(792.9)		(962.7)		(8127.5)		(11426.3)	
industry mix	-5.579		12.35		875.9	**	15.89	
	(35.24)		(45.24)		(368.9)		(343.5)	
pop_65pl	-0.258		-2.258		-38.40	**	-70.30	**
	(1.961)		(4.727)		(19.25)		(34.40)	
bachelor	1.739		4.203		112.7	***	-10.09	
	(1.885)		(3.602)		(19.50)		(31.32)	
black	18.09		43.30		23.42		265.1	
	(26.15)		(91.91)		(209.5)		(167.3)	
native	-3.745		0.415		-302.3	**	-346.0	*
	(3.357)		(10.84)		(126.9)		(189.5)	
hisp	8.782	***	8.991	*	-2.051		-19.80	
	(1.729)		(5.316)		(12.08)		(32.73)	
asian	161.2	***	210.3	**	176.1		11.68	
	(19.38)		(86.60)		(112.8)		(238.2)	
constant	-19.16		33.71		3326.0	***	4423.2	***
	(84.38)		(99.61)		(813.7)		(1605.3)	
# communities	152		152		92		92	
Adj. R-square	.189		.265		.255		.310	

Note: *, ** and *** denote significance level of ten percent, five percent and one percent respectively.

TABLE A.3: Regression Result for the Equation of Δ**Property Value**

ΔProperty Value	Small Sized Communities				Medium Sized Communities			
	No fixed effects		Fixed effects		No fixed effects		Fixed effects	
nwfp_near	17.88	**			-13.38			
	(7.099)				(36.39)			
nwfp_near*year	22.43		17.84	**	18.04		15.72	
	(13.89)		(8.077)		(65.91)		(55.22)	
year	-5.232		-0.859		33.80		35.25	
	(8.828)		(3.341)		(49.98)		(47.46)	
mill_closure	-4.496		-1.167		24.60		14.48	
	(7.101)		(8.483)		(16.67)		(17.60)	
occupation mix	-23.04		-473.2		-3350.6	***	-6653.2	***
	(163.6)		(301.4)		(1062.5)		(2308.8)	
industry mix	-22.72	***	-4.848		-50.69		50.73	
	(7.271)		(15.48)		(48.22)		(99.40)	
pop_65pl	1.198	***	0.420		0.465		-8.230	
	(0.405)		(1.330)		(2.517)		(6.436)	
bachelor	3.636	***	3.470	***	19.79	***	18.55	**
	(0.389)		(1.153)		(2.550)		(8.581)	
black	-7.215		4.472		-18.99		-14.61	
	(5.395)		(9.249)		(27.39)		(31.45)	
native	-0.491		-1.618		-16.31		-4.870	
	(0.693)		(2.549)		(16.59)		(37.10)	
hisp	1.130	***	0.865		-2.109		-4.694	
	(0.357)		(0.759)		(1.579)		(4.883)	
asian	2.263		9.731		38.27	***	42.04	
	(3.998)		(13.45)		(14.75)		(37.70)	
constant	-71.28	***	-7.589		54.05		529.2	*
	(17.41)		(30.39)		(106.4)		(283.1)	
# communities	152		152		92		92	
Adj. R-square	.264		.303		.477		.598	

Note: *, ** and *** denote significance level of ten percent, five percent and one percent respectively.

TABLE A.4: Post-Matching Fixed Effects Regression Result for the Equation of Δ**Median Income**

ΔMedian Income	Small Sized Communities		
	Post-Matching Fixed Effects I	Post-Matching Fixed Effects II	Falsification
nwfp_near*year	2964.0 *	3584.3	3034.1
	(1609.8)	(2198.8)	(2190.4)
year	8073.5	9251.9	19394.5 ***
	(7956.6)	(9327.9)	(7078.7)
mill_closure	-1002.4	-1368.8	1232.6
	(1664.9)	(2028.4)	(2685.9)
occupation mix	-1118.0	-17687.4	39938.6
	(44353.2)	(61056.0)	(48017.6)
industry mix	6577.4	7239.8	12570.7 ***
	(4139.2)	(4879.0)	(3445.6)
pop_65pl	47.98	-160.3	-218.9
	(131.0)	(179.7)	(173.7)
bachelor	-102.6	-231.7	21.38
	(154.2)	(175.8)	(127.8)
black	-1001.9	-2800.0 **	-955.8
	(1523.2)	(1282.2)	(1301.6)
native	167.7	388.5	-162.5
	(523.4)	(616.4)	(830.5)
hisp	39.89	56.15	-9.628
	(130.7)	(136.3)	(133.6)
asian	-848.2	-1416.3	-262.4
	(1063.7)	(1247.5)	(1103.3)
constant	291.7	7108.1	-2317.0
	(5134.2)	(6761.6)	(5250.7)
# communities	109	73	60
Adj. R-square	.09	.15	.35

Note: *, ** and *** denote significance level of ten percent, five percent and one percent respectively.

TABLE A.4: Post-Matching Fixed Effects Regression Result for the Equation of Δ**Median Income** (Continued)

ΔMedian Income	Medium Sized Communities					
	Post-Matching Fixed Effects I		Post-Matching Fixed Effects II		Falsification	
nwfp_near*year	308.6		-940.6		5283.4	
	(1509.9)		(2881.2)		(7790.2)	
year	12046.5	**	20052.1	**	20728.0	
	(6025.8)		(8133.3)		(18861.4)	
mill_closure	-388.6		293.8		290.6	
	(673.8)		(475.0)		(981.7)	
occupation mix	92624.3		184911.0	*	279382.5	*
	(60206.7)		(107906.9)		(150192.8)	
industry mix	3535.0	*	4389.5	**	2764.7	
	(2065.8)		(2122.0)		(4481.8)	
pop_65pl	525.8	**	524.9	*	-65.34	
	(219.6)		(271.4)		(586.7)	
bachelor	130.7		205.2		-435.6	
	(196.0)		(212.5)		(627.8)	
black	890.1		-438.1		5191.9	
	(689.9)		(3098.7)		(7691.4)	
native	933.8		696.1		-1071.2	
	(1097.3)		(1080.8)		(1177.0)	
hisp	33.12		338.5		95.12	
	(155.5)		(215.3)		(305.0)	
asian	-737.3		-228.5		2223.6	
	(959.2)		(1822.2)		(2379.4)	
constant	-22080.0	***	-37255.8	**	-27763.2	
	(7545.7)		(15394.6)		(26999.3)	
# communities	63		40		25	
Adj. R-square	.28		.37		.47	

Note: *, ** and *** denote significance level of ten percent, five percent and one percent respectively.

TABLE A.5: Post-Matching Fixed Effects Regression Result for the Equation of Δ**Population**

ΔPopulation	Small Sized Communities		
	Post-Matching Fixed Effects I	Post-Matching Fixed Effects II	Falsification
nwfp_near*year	100.6 **	170.1 ***	-58.56
	(49.54)	(61.77)	(48.81)
year	-28.59	-67.16	189.9
	(171.4)	(199.3)	(177.1)
mill_closure	-36.77	-72.00	-16.69
	(35.44)	(46.41)	(65.12)
occupation mix	-534.3	451.0	584.3
	(825.8)	(1380.2)	(967.5)
industry mix	-17.01	-83.34	35.45
	(92.08)	(118.5)	(79.17)
pop_65pl	-1.217	-5.068	0.424
	(4.603)	(8.084)	(3.380)
bachelor	1.443	-2.659	4.084
	(4.259)	(6.744)	(2.517)
black	-14.92	-5.388	-54.77
	(34.37)	(44.02)	(35.60)
native	12.84	-6.167	0.237
	(12.94)	(17.11)	(10.28)
hisp	-0.977	-4.127	3.326
	(2.767)	(3.680)	(3.900)
asian	-27.73	-23.82	-25.84
	(25.76)	(31.82)	(21.69)
constant	124.4	177.5	-117.0
	(108.9)	(215.4)	(106.1)
# communities	109	73	60
Adj. R-square	.187	.263	.159

Note: *, ** and *** denote significance level of ten percent, five percent and one percent respectively.

TABLE A.5: Post-Matching Fixed Effects Regression Result for the Equation of Δ**Population**

(Continued)

ΔPopulation	Medium Sized Communities					
	Post-Matching Fixed Effects I		Post-Matching Fixed Effects II		Falsification	
nwfp_near*year	-545.0		-203.6		-6229.6	*
	(728.4)		(241.9)		(3435.0)	
year	5558.9	***	3673.6	***	16572.9	*
	(1886.7)		(1026.9)		(8912.9)	
mill_closure	362.4	**	330.8	***	-179.3	
	(179.7)		(66.28)		(516.1)	
occupation mix	11358.2		23391.9	*	66501.0	
	(17179.1)		(12479.7)		(74789.9)	
industry mix	1451.6	**	529.8	*	1263.1	
	(624.3)		(277.1)		(1973.6)	
pop_65pl	-96.84	**	-29.89		326.0	
	(40.79)		(33.48)		(254.1)	
bachelor	6.033		-46.97		321.7	
	(56.81)		(31.26)		(257.4)	
black	-80.51		28.45		-6306.1	*
	(326.1)		(383.4)		(3431.0)	
native	-270.9		-150.2		-5.548	
	(254.1)		(128.1)		(789.3)	
hisp	-45.66		42.01		-223.3	
	(35.41)		(28.22)		(143.3)	
asian	-109.6		-101.2		-686.5	
	(278.0)		(176.2)		(971.9)	
constant	445.9		-1449.0		-15775.9	
	(1999.1)		(1601.9)		(13892.0)	
# communities	63		40		25	
Adj. R-square	.320		.759		.593	

Note: *, ** and *** denote significance level of ten percent, five percent and one percent respectively.

TABLE A.6: Post-Matching Fixed Effects Regression Result for the Equation of Δ**Property Value**

ΔProperty Value	Small Sized Communities					
	Post-Matching Fixed Effects I		Post-Matching Fixed Effects II		Falsification	
nwfp_near*year	54.57	***	63.44	***	11.52	
	(11.84)		(15.08)		(12.39)	
year	-158.5	**	-143.9	**	-92.25	
	(65.43)		(70.21)		(88.75)	
mill_closure	-7.002		-18.90		-8.410	
	(10.26)		(12.90)		(6.853)	
occupation mix	-966.4	***	-965.5	**	-810.5	
	(277.4)		(376.6)		(518.9)	
industry mix	-63.47	*	-58.05		-31.20	
	(36.15)		(42.44)		(46.98)	
pop_65pl	-0.0757		-0.486		1.997	
	(1.363)		(2.483)		(1.812)	
bachelor	2.140	*	1.273		3.611	**
	(1.246)		(1.877)		(1.698)	
black	9.495		32.00	**	-4.442	
	(9.002)		(14.85)		(8.148)	
native	-3.675		-4.836		3.222	
	(3.373)		(4.461)		(5.611)	
hisp	0.507		-1.546		0.949	
	(0.605)		(1.156)		(0.792)	
asian	-3.130		-13.87*	*	-16.90	
	(7.361)		(7.894)		(10.33)	
constant	101.3	***	127.0	**	23.58	
	(29.02)		(53.77)		(33.66)	
# communities	109		73		60	
Adj. R-square	.557		.596		.401	

Note: *, ** and *** denote significance level of ten percent, five percent and one percent respectively.

TABLE A.6: Post-Matching Fixed Effects Regression Result for the Equation of ∆**Property Value** (Continued)

∆Property Value	Medium Sized Communities					
	Post-Matching Fixed Effects I		Post-Matching Fixed Effects II		Falsification	
nwfp_near*year	-8.820		-39.67		-1217.5	*
	(129.9)		(116.7)		(637.8)	
year	-1065.1	**	-1653.5	***	2223.9	*
	(522.0)		(470.5)		(1223.4)	
mill_closure	41.09		27.04		-42.20	
	(33.68)		(21.97)		(112.1)	
occupation mix	-7295.2	**	-8300.1	**	4143.3	
	(2795.9)		(3252.4)		(13926.3)	
industry mix	-538.4	**	-724.6	***	42.43	
	(227.7)		(195.2)		(380.9)	
pop_65pl	-16.82	*	-1.409		68.25	
	(8.657)		(8.599)		(50.15)	
bachelor	4.932		5.850		63.24	
	(10.74)		(10.56)		(31.63)	
black	-26.85		182.0	*	-1070.5	*
	(71.83)		(107.5)		(553.0)	
native	-6.587		83.43		80.55	
	(67.15)		(61.93)		(202.1)	
hisp	-5.711		3.193		-41.69	**
	(7.195)		(9.779)		(18.40)	
asian	-26.60		-66.43		-313.6	
	(54.27)		(64.83)		(220.7)	
constant	1184.6	***	1004.1	*	-2045.4	
	(395.3)		(520.3)		(2484.8)	
# communities	63		40		25	
Adj. R-square	.666		.857		.774	

Note: *, ** and *** denote significance level of ten percent, five percent and one percent respectively.

FIGURE 1: Location of Protected Land under the Northwest Forest Plan (NWFP) and Timber Mill Closures in Oregon (Source: Oregon Department of Forest).

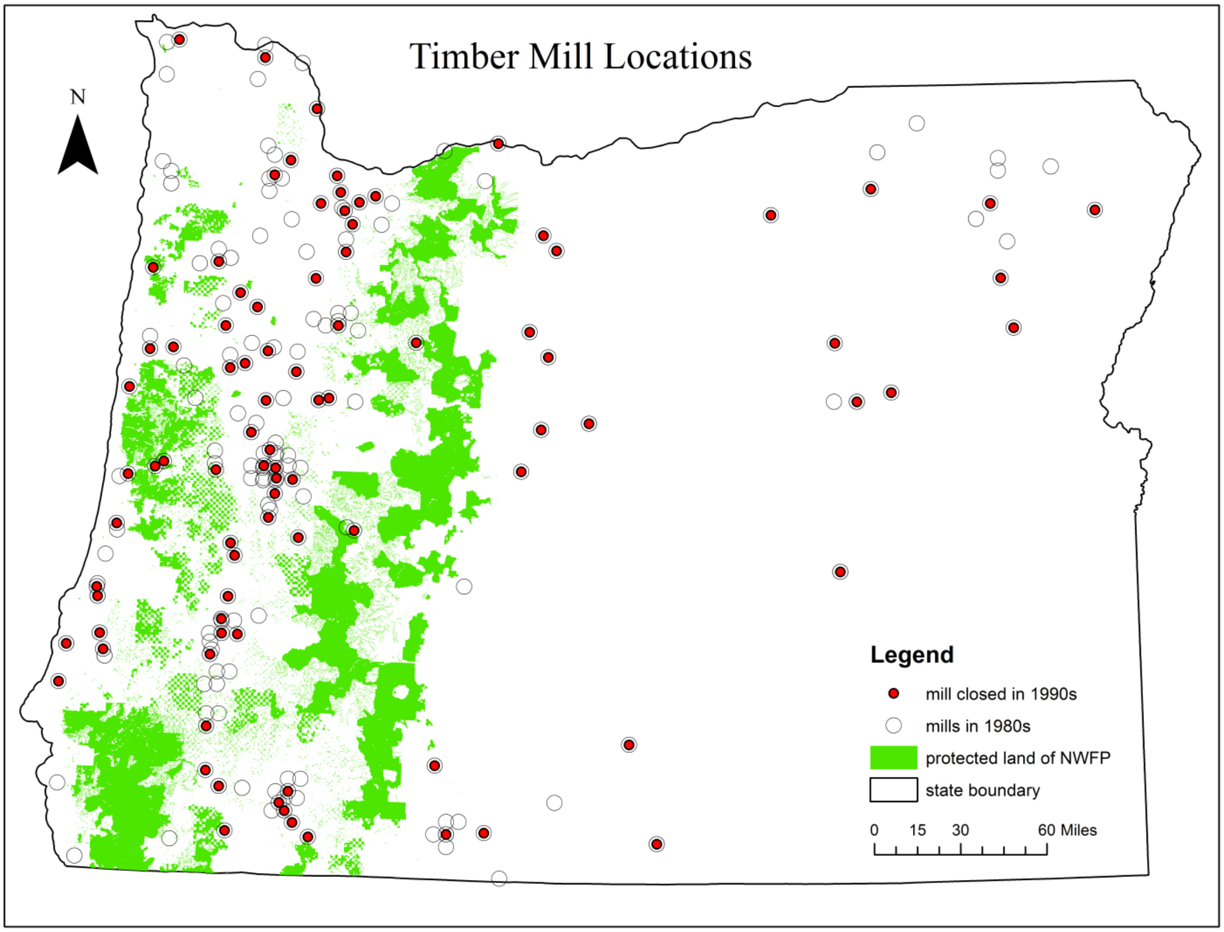

FIGURE 2: Common trends in median income, population, and property values prior to the 2000s for communities treated with proximity to protected NWFP land and control communities.

Full Sample

Matched Sample

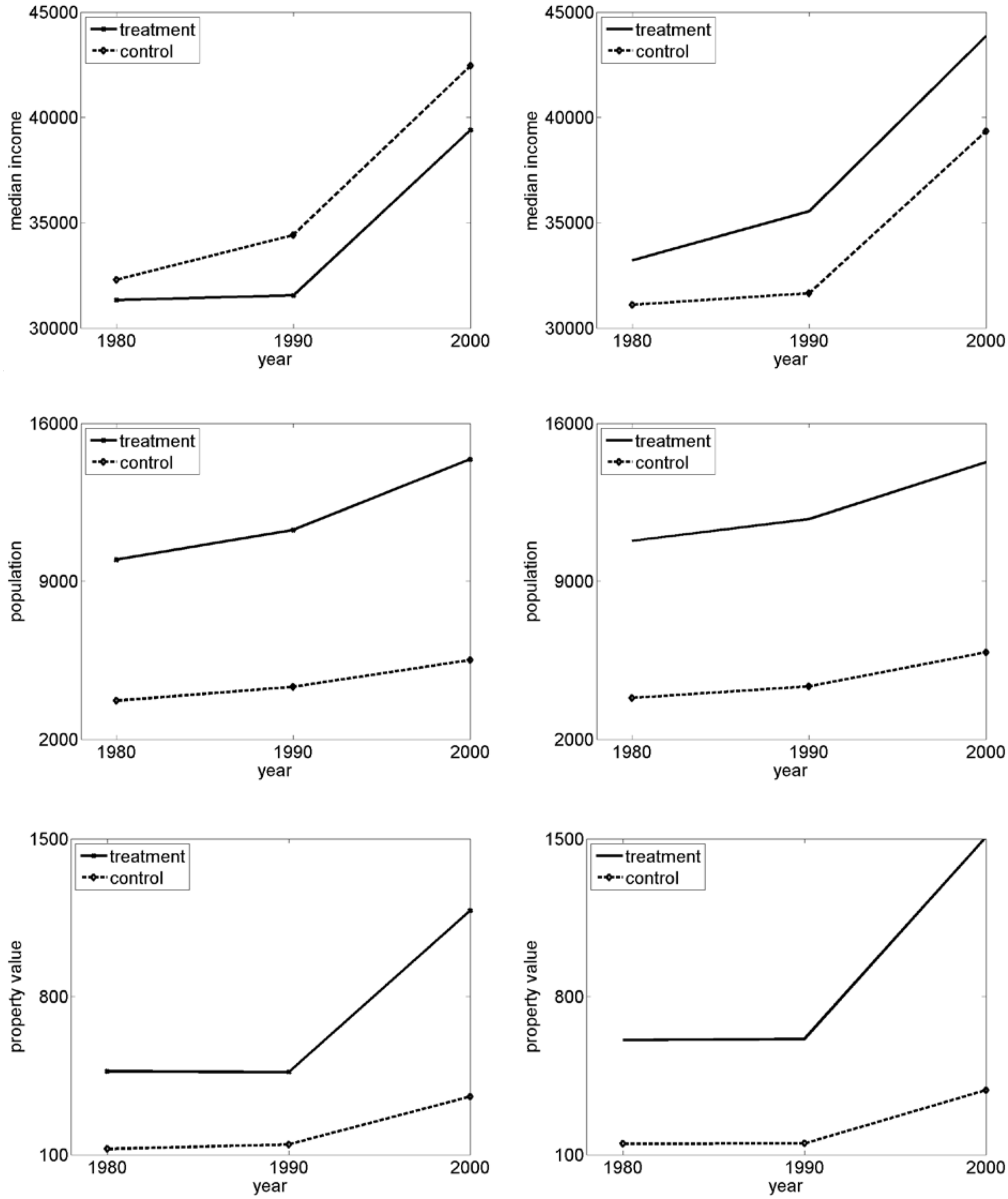

FIGURE 3: Overlap in the estimated propensity score of having protected NWFP lands within five miles of the community.