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Cost-share program participation and family forest owners' past and intended future management practices☆

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ABSTRACT

Cost-share programs are commonly-used policy tools designed to influence management on privately-owned lands. Widely popular on agricultural lands, these programs and their association with landowner behavior have not been as thoroughly studied on forested lands. Based on a dataset of over 3500 observations and using propensity score matching to reduce possible selection bias, this study found that family forest owners in the U.S. Northern region enrolled in cost-share programs were more actively engaged in both silvicultural and conservation management activities than non-participants. These findings point to the capacity of cost-share public programs to promote better forest management. This study found that cost-share participation varied across size of forest holdings, owners' demographic characteristics, ownership objectives and forest location. Owners of smaller sized forestlands had a lower participation rate and might be a prime target group of future cost-share programs to widen forest and wildlife habitat management.

1. Introduction

Cost-share programs are part of a collection of natural resource policy tools aimed at influencing private land management based on the provision of financial incentives (Cubbage et al., 1993). Numerous federal and state cost-share programs have been established since the 1930s in the U.S. to promote conservation, productivity, and long-term sustainability of forests (Greene et al., 2004; USDA Forest Service Southern Research Station, 2011). Cost-share programs involve the use of financial incentives to support private landowners' initiatives in adopting land conservation practices and sustainable management (Claassen et al., 2008). Increasing amounts of funding have been spent in U.S. cost-share programs in recent years, and federal funding for conservation programs had been 5.5 billion in 2010 (Osteen et al., 2012; USDA Economic Research Service, 1997).

In the particular case of forests, cost-share payment programs have been established by mainly government agencies to promote conversion of non-forest land into forest, maintain forest cover, protect watersheds and wildlife habitat, foster better forest stewardship, and ensure long-term timber supplies (Bullard and Straka, 1988; Jacobson et al., 2009; Siikamäki and Layton, 2007). The Conservation Reserve Program (CRP), Environmental Quality Incentive Program (EQIP), Forest Legacy Program (FLP), Landowner Incentive Program (LIP), Wildlife Habitat Incentives Program (WHIP), and Wetland Reserve Program (WRP) are major federal cost-share programs private forest landowners may be eligible to participate. There are also dozens of state-run cost-share programs, a majority of which were established in the early 1970s (Bullard and Straka, 1988; Jacobson et al., 2009).

While some studies report significant impact of cost-share programs (Drummond and Loveland, 2010; Kilgore and Blinn, 2004; Lee et al., 1992; Mehmood and Zhang, 2002), others have shown that some forest landowners would have adopted conservation or production practices without program participation (Sun, 2007). Furthermore, the reported impact of this type of public support program has been questioned due to the potential bias when the non-random participation of enrollment fails to be accounted for (Bliss and Martin, 1990; Boyd, 1984; Kluender et al., 1999; Zhang and Flick, 2001). Econometrically, it has been argued that estimated effects of program participation using exogenous binary variables are biased (Heckman, 1978, 1990; Heckman et al., 1998a; Rubin, 1974, 1980). This bias is rooted in the fact that cost-share programs are chosen by eligible participants rather than assigned randomly, making participation a non-random treatment and the variable describing participation endogenous. However, the endogenous variable for a public program participation was often treated as exogenous variables in past land owners studies using Ordinary Least Squares (e.g. Brooks, 1985; Hardie and Parks, 1991; Kline et al., 2002; Kula and McKillo, 1988; Lee et al., 1992; Zhang and Flick, 2001), Seemingly Unrelated Equations (e.g. Alig, 1986), Logistic (e.g. Hyberg and Holthausen, 1989; Nagubadi and Zhang, 2005; Royer and Moulton, 1987; Valdivia and Poulos, 2009), and Probit (e.g. Loyland et al., 1995; Nagubadi et al., 1996) models. All of them assumed that participation

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variable was random and independent of other variables (Beach et al., 2005).

The motivation of this study was to examine the association between enrollment in cost-share programs and management of family-owned forests using unbiased estimation methods. We concentrate on family forest owners, defined as individuals, families, trusts, estates, family partnership, and other unincorporated groups (Butler et al., 2005, 2007; Butler, 2008). These family forest owners are the target group of most cost-share programs. Specifically, this study aimed to identify major reasons for family forest owners' participation in cost-share programs and to evaluate their association with forest land management practices for conservation and timber production. Forest land management practices evaluated in this study included (a) stated past forest management operations on existing forest land and (b) intended future forest land changes. Data from the National Woodland Owner Survey (NWOS) for the U.S. Northern region were used in the empirical estimation. The U.S. Northern region as defined by the USDA Forest Service encompasses the 20-state quadrant bounded by Maine, Maryland, Minnesota, and Missouri (Smith et al., 2009). Families account for 94% of the number of private forest owners and own about 73% of all private forest land in this region (Butler, 2008).

The rest of the paper is structured as follows. After a review of the recent literature, a theoretical framework for the application of Propensity Score Matching (PSM) as a tool to reduce non-random induced bias and an empirical model are introduced. The justification for the inclusion of variables of a Probit model is discussed before an explanation of the dataset, econometric estimation and presentation of results. Variables significantly affecting the participation in cost-share programs and associated cost-share effects on past and future forest management practices are then discussed. We conclude with implications of our findings and recommendations for future studies.

2. Review of studies on cost-share programs and forest lands

Numerous studies (e.g. Amacher et al., 2003; Beach et al., 2005) have explored the impact of cost-share programs as tools to promote timber production and the attainment of environmental and natural resource conservation objectives. Flick and Horton (1981) estimated the benefit–cost ratio of Virginia's Reforestation of Timberland Program to be as high as 3.5 for the first six years of its adoption, implying that program benefits substantially exceeded its costs. Cost-share programs in the U.S. South have been reported to have positively affected reforestation (Royer and Moulton, 1987) and increased timber supply (Lee et al., 1992; de Steiguer, 1984). Hardie and Parks (1991) estimated that the Forest Incentive Program, a federal cost-share program that supported silvicultural activities until 2002, might have encouraged about 70% of investments in forest regeneration in the U.S. South from 1971 to 1981 and been an effective instrument in increasing the acreage of pine monocultures. Kilgore and Blinn (2004) suggested cost-share programs to be one of the most effective policy tools for encouraging sustainable timber harvesting practices based on a survey of forest management organizations and state foresters in the U.S. and Canada. Using remote sensing data, Drummond and Loveland (2010) concluded that the CRP had promoted afforestation in the Eastern U.S. in the 20th century. The impact of public cost-share programs has also been evaluated in Europe with positive and statistically significant effects on forest management (Ovaskainen et al., 2006; Siikamäki and Layton, 2007).

Nevertheless, Bastos and Lichtenberg (2001) questioned the claimed success and broader impact of cost-share programs in addressing environmental concerns, and argued that, for instance, cost-share funding in Maryland was mainly used for land productivity and profitability instead of conservation over the 1994–1996 period. Valdivia and Poulos (2009) suggested that CRP payments do not have a statistically significant effect on landowners' attitudes toward adopting riparian buffers, strips of forests or grass land between agricultural land and water sources to reduce agricultural run-off.

3. Analytical framework

PSM has been developed as a methodological approach to correct for bias introduced during treatment selection or program participation process (Heckman et al., 1997a, b; Rosenbaum and Rubin, 1983, 1985). This method uses a quasi-experimental technique to mimic a randomization process through re-sampling (Apel and Sweeten, 2009; Liu and Lynch, 2011). A propensity score corresponds to the estimated probability for a given participant (forest owner) to take part in a treatment (cost-share program participation). The propensity score values are then used to match program participants and non-participants and exclude unmatched ones from the estimation of participation effects (Dehejia and Wahba, 1999). This method has been demonstrated to be an improvement in estimating treatment effects over methods without data re-sampling (LaLonde, 1986; Dehejia and Wahba, 1999, 2002).

In a PSM model, participation in a program refers to a treatment that may influence a vector of output variables Y. In this study the treatment was participation in cost-share programs, and output variables corresponded to stated past forest management operations and intended future forest land changes. Let the value of Y be Y_1 after treatment and Y_0 before treatment, D be a cost-share participation indicator ($D = 1$ for cost-share participation, 0 otherwise), and X be a vector of observable variables affecting both participation of a forest landowner in a cost-share program and Y.

A binary model can estimate the propensity score (Heckman et al., 1998b; Imbens, 2000; Rosenbaum and Rubin, 1985). A probit model for computing propensity scores can be expressed as in Eq. (1).

$$\begin{aligned} D^* &= X'\beta + \varepsilon \\ D &= 1 \text{ if } D^* > 0, \text{ otherwise } D = 0, \end{aligned} \tag{1}$$

where D^* is a latent variable, β is a coefficient vector, and ε is a random error with a normal distribution and mean zero. The propensity score is given by $p(X) = \Phi(X'\beta)$, which denotes a cumulative density function of the normal distribution. The probit model assumes $\varepsilon = D^* - X'\beta$ has a standard normal distribution, and thus β can be estimated by maximum likelihood (Greene, 2002). The marginal effect of X on the propensity score is $dp(X)/dX = \beta'\phi(X'\beta)$, where $\phi(X'\beta)$ is the normal distribution density with argument $X'\beta$.

By PSM, a value of propensity score $p(X)$ was used to match a cost-share program participant with a nonparticipant. One-to-one nearest neighboring matching without replacement has been proposed for estimation with a large sample (Austin, 2007; Dehejia and Wahba, 2002) and was used in this study. Each treated observation was matched with one untreated observation, and the matched untreated observation was only used for one treated observation. Following Dehejia and Wahba (2002), observations were randomly ordered before matching to eliminate order effect, and the first participant were matched with the non-participant whose propensity score is closest to that of the first participant. Both the matched participant and non-participant were excluded from subsequent matches. Such a matching cycle was repeated until all participants were matched. The matched participants and non-participants were then used in the treatment effect estimation. The average treatment effect on a participating landowner is given by:

$$T = \frac{1}{n}\sum_{i=1}^{n}\{[Y_{1i}|p(X_{1i}),\ D = 1] - [Y_{0i}|p(X_{0i}), D = 0]\}, \tag{2}$$

where n is the number of family forest owners participating in a cost-share program, Y_{1i} is the observed Y of the ith participant with an explanatory variable vector X_{1i}, and Y_{0i} is the observed Y of the ith matched non-participant with an explanatory variable vector X_{0i}.

To ensure the similarity of matched forest landowners, common support and covariate balance is essential for the PSM. Common support requires each participant to have a positive probability to be a non-