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An evaluation of the impact of the Natural Forest Protection Programme on Rural Household Livelihoods

by

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Abstract

In this paper, we estimate the impact on local household livelihoods of the Natural Forest Protection Programme (NFPP), the largest logging ban programme in the world that aims to protect watershed and conserve natural forests. In doing so we use a series of policy evaluation micro-econometric techniques to assess the impacts of the NFPP on two interrelated facets of household livelihoods, namely income and off farm labour supply. We find that the NFPP has had a negative impact on incomes from timber harvesting but has actually had a positive impact on total household incomes from all sources. Further, we find that off farm labour supply has increased more rapidly in NFPP areas than non-NFPP areas. This result is strongest for employment outside the village. On the basis of these results policy implications for household livelihoods are drawn.

Keywords: Natural Forest Protection Programme, policy evaluation, difference in differences, propensity score matching, China, income impacts, off farm labour

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1 Introduction

Assessing the impacts of ecological restoration programmes on the livelihoods of local residents, is imperative for two main reasons. First, such programmes have severe equity impacts and these should be understood and mitigated when designing such policies. High biodiversity areas are often also home to poor, rural communities, while the benefits of conservation may go to wealthier residents of the same, or other, countries. In developed countries, conflicts between conservation policy and land use also occur (see, e.g., Innes et al (1998) on the US Endangered Species Act), but those deriving income from the land are much more likely to have secure property rights to that land than households in developing countries who may be affected by similar policies. The second reason for accounting for the impacts of conservation programmes on local residents is that a failure to do so may lead to conflict over the resources, reducing the potential effectiveness in environmental terms (Ferraro 2002, Kramer 1996).

In this paper, we estimate the impact on local household livelihoods of the Natural Forest Protection Programme (NFPP), which is the largest logging ban programme in the world that aims to protect watershed and conserve natural forests. Existing studies that have attempted to evaluate the impacts of this programme have concluded that while it has been effective in reducing logging and increasing reforestation, these benefits have come at a significant cost in terms of the impacts on household livelihoods. In this paper, we focus on evaluating the impacts f the NFPP on two important facets of the livelihoods in the affected areas, namely those of household income and employment opportunities. We argue that it is important to understand these particular impacts as the NFPP is part of a process of more general Chinese forest policy reform which involves a shift from focussing simply on timber output, to new objectives of: i) enhancing the role of forests in ecological rehabilitation and environmental protection; ii) increasing timber supply through commercial investment; and iii) promoting rural wellbeing and poverty reduction through agro-forestry (Wang, Han et al. 2004). This means that even if the NFPP is contributing to the first objective, it cannot be considered successful if it undermines objectives ii) and iii) through negative impacts on household incomes and on their incentives to invest in future forest activities.

Measuring the impacts of the NFPP on household incomes and labour opportunities is not a straightforward matter, mainly because the Chinese economy has been undergoing huge changes during the period that the programme has been in place. Further, we cannot observe household income and labour decisions both in the presence and the absence of the programme, and therefore face an identification problem. To address this, we treat the NFPP as a natural experiment, using panel survey data to compare the changes in income and labour opportunities over time in the areas where the programme was in place with changes in the areas where it was not introduced. In order to ensure the robustness of our results, we estimate the changes in income resulting from the programme using various parametric and non-parametric policy evaluation technique and we find that the NFPP has had a negative impact on incomes from timber harvesting. However, it has actually had a positive impact on total household incomes from all sources. Further, as the increase in total income appears to be driven by an increase in income from off-farm employment, we also estimate the impact of the NFPP on household participation in off-farm labour markets. We predict that the reduction in the marginal return to labour in forest activities resulting from the ban on logging would lead to a reallocation of labour from forestry to off-farm occupations. Using similar evaluation methods as for the income impacts, we estimate the effect on off-farm employment, and find that it has increased more rapidly in NFPP areas than non-NFPP areas. This result is strongest for employment outside the village. We note that the increase in total household income may not correspond to an increase in household welfare because if that were the case, non-NFPP households would be expected to participate in the off-farm labour market to a greater extent as well.

2 Background to the NFPP

2.1 Description of programme

The Natural Forest Protection Programme (NFPP) was introduced by the Chinese government in response to serious drought in the Yellow River area in 1997 and flooding of the Yangtze River in 1998. Both of these events were understood to have been brought about by poor agricultural practices and the removal of natural forests. The Sloping Land Conversion Programme (SLCP) was intended to address the former problem, while the NFPP addressed the latter. The NFPP applies to 17 provinces and autonomous regions in the upper reaches of the Yangtze River and the upper and middle reaches of the Yellow River. These provinces contain 73 million hectares of natural forests, which amount to 69% of the total natural forest area in China (Zhang, Swanson et al. 2005).

The objectives of the programme are: to restore natural forests in ecologically sensitive areas, protecting and enhancing biodiversity; to plant forests for soil and water protection; to increase timber production in forest plantations to meet national demands for timber and contribute to economic development of rural areas; and to protect existing natural forests from excessive cutting (Zhang, Shao et al. 2000). These objectives are being pursued with the use of, firstly, a ban on logging in natural forests across many parts of the country; and secondly, measures to encourage the development of new plantation forests which should increase timber supplies while reducing pressure on natural forests. These activities have been supported with funds from the Chinese government, directed specifically at: i) afforestation and forest protection, including mountain closure, tree planting, construction of sapling bases, payments for forest tending and forest fire prevention; ii) compensation for unemployed state forest workers, retirement pensions for state forest staff and some compensation to local governments for losses of forest taxation revenues (Xu, Katsigris et al. 2002).

2.2 Existing studies

The NFPP is the largest of its kind in the world, and therefore there is considerable interest in its impacts. The most significant study so far has been carried out by Xu et al (2002) and found that while there have been positive impacts on forest cover, there have been certain negative effects such as losses in employment in the state forest sector; reductions in local government finances; and losses of employment and income for households dependent on the state and collective forest sectors. Other studies have largely been case studies of forest management by households within a small number of villages or townships, for example Shen (2001), Weyerhauser et al (2006), and Demurger and Fournier (2003).

General findings

The NFPP is largely accepted to have reduced timber harvesting in natural forest areas (Xu, Katsigris et al. 2002; Demurger and Fournier 2003). As it has been implemented in important watersheds of the major rivers of China, and in areas of high biodiversity, this is expected to have positive environmental impacts, in particular on soil erosion and water conservation (Yang 2001). However, two key environmental issues have been identified: the first is that there are suggestions from case studies that the programme has reduced the incentives to actively manage forest land by monitoring against illegal logging and forest fires and by thinning and maintaining the timber stands, particularly where the ban has been applied to village plantations (Miao and West 2004; Weyerhaeuser, Wen et al. 2006). The second issue is that the reduction in timber supply within China is expected to have negative effects on neighbouring countries (Weyerhaeuser, Wen et al. 2006). This raises concerns because much of the imported timber originates in Asia-Pacific countries where unsustainable harvest practices and illegal logging are common (Katsigris, Bull et al. 2004).

Much of the research into the impacts of the NFPP has focussed on the impact on the state forest sector as this was initially targeted in the programme (Zuo 2002). During the early stages, it was estimated that around 1 million employees would have to be laid off (Yang 2001). Many of these have been re-employed in forest stewardship, while those who were not re-employed were offered compensation of three times their average salary for the previous year (Yang 2001). While there are some case in which compensation has not been paid in full, and where state enterprises are unable to pay full pensions for retired workers, greater losses in state forest areas have been experienced by those who were not formally employed by the state sector (Katsigris 2002). There have also been impacts on the provision of public services by local governments as their revenues have dropped significantly in areas where forestry played an important role in the local economy (Katsigris 2002). For example, in some counties in Sichuan Province, timber revenues represent more than 80% of total income from taxation; as timber production falls, these revenues will fall accordingly (Yang 2001).

Yang (2001) also highlights economic benefits from the NFPP. He argues that the 1998 floods affected hundreds of millions of people and caused extensive damage, and that the result of this was major expenditures on flood defences against future disasters, including 7.8 billion Yuan on embankments along the Yangtse. The financial and social costs of both the floods themselves and of protection against future events are real costs that should be included in an evaluation of the programme. A further benefit he suggests is diversification of economic activities, giving the example of Aba Prefecture which has promoted tourism as an alternative to logging. The prefecture experienced increases of around 130% in both numbers of tourists and tourist revenues between 1997 and 1998 and now receives 30% of GDP from tourism.

Findings relating to collective forests

The NFPP was primarily targeted at state forest areas, but in many places it has been extended to cover collective forests as well (Zuo 2002). A number of studies have argued that where households and communities are prevented from accessing collective forest land, this infringes their existing rights to use that land, and their ownership of the trees on the land (e.g. (Shen 2001; Katsigris 2002). There is little in the way of quantified economic impacts on collective forest communities. Katsigris (2002) looks just at Sichuan Province, and finds that timber output from collective forests had fallen to 6% of previous levels by 2000, resulting in revenue losses of approximately 1 billion Yuan for the whole sector. She also found a 65% reduction in the number of forestry related township enterprises, with a corresponding fall in employment and output of 53% and 30% respectively. The same study also finds losses in tax revenues and increases in employment, and reductions in overall economic growth rates in some counties with collective forest areas, although those with alternative development opportunities were observed to recover quickly from 2000 onwards.

Chen *et al* (2001) measure income changes for three townships in Li County, Sichuan Province. In one of the townships, they observe a 17.6% reduction in per capita income between 1998 and 2000. In the other two townships, per capita incomes fall by around 1/3. These reductions are explained by losses of employment in the timber harvesting or processing sectors, or loss of revenues from provision of services to temporary migrants who were previously working in the forest sector. Shen (2001) studies two villages in Aba Prefecture, Sichuan Province and finds that households have not only lost income from the timber sector, but also through loss of access to non-timber forest products, including fuelwood, and access to grazing land for livestock. In general, the NFPP does not prohibit the collection of non-timber products, but in some cases is has either been disallowed by the local government or access has been prevented by the closure of transport routes to forest areas (Zuo 2002).

2.3 Contribution of this study

Despite the number of studies that have been carried out into the impacts of the NFPP, there has been an absence of analysis using quantitative information to assess these impacts, as those cited have relied on qualitative case study information. Case studies such as those carried out for the Xu *et al* (2002) study; and by Shen (2001), Weyerhauser et al (2006), and Demurger and Fournier (2003), were each focused on a small number of villages, and based on interviews with key members of state forest enterprises and forest communities. Their conclusions have raised considerable concerns about the NFPP but have as yet not been investigated more widely. Therefore, this paper attempts to evaluate the impacts of the programme, and revisit some of the conclusions of the existing studies, using a survey of 285 households in 40 villages in the south of Guizhou Province. The existing case studies are largely based in the southwestern region of Sichuan and Yunnan Provinces. So far there has been no research into the impacts in the southern collective forest areas. As the forest sector in the southwest is rather different in character to the forest areas in the south of China (Rozelle, Huang et al. 2000), data from Guizhou will be the only assessment of the impacts of the ban in the southern provinces. Finally, the existing studies of the NFPP are based on information that was collected shortly after the logging ban was introduced, so this paper supplements those findings by using data from

2005, when some adjustment to the ban will have taken place and the medium term impacts are more apparent.

The findings of the existing studies, in particular that the NFPP has resulted in losses of employment and income for rural households, are concerning for a number of reasons. The first is that as discussed above, current forest policy in China is aimed in part at improving standards of living in forest areas so if the NFPP is having the opposite effect, the overall objectives may not be met. In addition, the southern, south-western and north-eastern forest areas of China, where the NFPP has been applied are remote from the major centres of economic activity and growth and contain the poorest provinces of China. Even within these provinces, the forest locations are largely in inaccessible mountain areas, where alternative income generating options are limited. Therefore, if the NFPP reduces incomes in these areas, it will contribute to increasing poverty in already poor regions and will exacerbate the growing inequality between these regions and the rapidly growing urban centres in other parts of China.

This paper focuses specifically on the impacts of the NFPP in collective forest areas. There are two reasons why these areas are of particular interest and concern. The first is that, unlike in the state forest areas, where the employees of the forest sector have received compensation for lost income, there has been no compensation for households in collective forest areas. The second reason is that, as argued by Shen (2001), the NFPP has infringed on the rights to forest land that were allocated to households in the early 1980s, and that this has occurred without any compensation for those households. We use data from collective forest areas to examine the impacts of the programme and whether compensation should have been paid for infringements on property rights.

3 Evaluation strategies

3.1 The policy evaluation problem

The objective of this chapter is to find out the impact of the NFPP on household incomes and off farm labour decisions in affected areas. In order to this, we take advantage of the growing literature on econometric methods for policy evaluation, for example, Heckman and Robb (1984), Ashenfelter and Card (1985), Heckman, Ichimura and Todd (1997) etc.

All of these methods deal with the identification problem faced when attempting to determine the impacts of a policy intervention: if there are two potential outcomes, Y_1, the outcome when the individual participates in a programme; and Y_0, the outcome when the individual does not participate, then the impact of participating in the programme is simply given by:

$$\Delta = Y_1 - Y_0 \qquad \text{Eq. 1}$$

However, estimating this requires information on both Y_1 and Y_0 for each individual, which is not obtainable because we cannot observe the outcome of participation for non-participants or the outcome of non-participation for participants. Therefore, estimation of the causal effect of the programme is equivalent to solving a missing data problem (Heckman, Ichimura et al. 1997), and requires the use of techniques that allow the identification of the relevant impacts in the absence of the data. In the case of the NFPP, we want to know the difference between the level of household income and labour supply when a household is in the programme and when they are not, but we only have data on one situation or the other.

For any individual, the observed outcome (Y), following Roy (1951), Quandt (1972) and Rubin (1978), is defined as:

$$Y = DY_1 + (1-D)Y_0 \qquad \text{Eq. 2}$$

where D denotes participation in the programme, and takes the values 1 (if the individual participates/is treated) or 0 (if the individual does not participate/ is not treated). This is commonly written as a function of observables (X) and unobservables (U_1, U_0):

$$Y_1 = g_1(X) + U_1 \qquad \text{Eq. 3}$$
$$Y_0 = g_0(X) + U_0$$

The literature mentioned above use various methods to estimate a counterfactual outcome against which the outcome for treated individuals can be compared. In the social sciences where truly randomised policy experimental data is hard to find, alternative methods have been developed that account for the fact that those participating in a programme will have different expected outcomes from those not participating. This is either because they choose to participate in the programme on the basis of their expected returns from it; or as in the case of the NFPP, because the programme impacts on all individuals in a particular area or of a particular segment of the population so the control group must necessarily have different observable or unobservable characteristics and therefore different expected outcomes.

For the purposes of this paper in order to determine the impact of the NFPP on household incomes and labour decisions, we will use three identification methods: difference-in-differences with covariates; Heckman *et al's* (1997) matched difference-in-differences; and Abadie's (2005) propensity score weighted difference-in-differences. Those living in the counties where the programme was implemented are considered to be 'treated', while those living in the areas where it was not implemented are 'untreated'. All of these approaches allow us to account for both observable and unobservable variation between households in the NFPP and non-NFPP areas, but comparison of the results from the three methods will also indicate how sensitive those results are to the specification of the functional form of the econometric model. We first provide a brief overview of these methods before we turn to the discussing the data used and the econometric results.

3.2 Difference in Differences

The NFPP can be viewed as a natural experiment, with data available for a period before the policy reform and a period after the reform, and also data for two counties where it was implemented and one similar county where it was not implemented. Therefore a relevant method of evaluation would appear to be the difference-in-difference (DID) estimator used by Ashenfelter and Card (1985). They use a components of variance framework in which the unobservable variation is decomposed as follows:

$$U_{it} = \phi_i + \theta_t + \mu_{it} \quad \textbf{Eq. 4}$$

where ϕ_I is an individual effect that remains constant over time; θ_t is a time specific effect that varies over time but is the same for all individuals e.g. common macroeconomic effects; and μ_{it} is a temporary individual specific effect that varies across time and across individuals. The relationship between treatment and outcomes is therefore given by:

$$Y_{i,t} = \alpha D_{i,t} + \phi_i + \theta_t + \mu_{it} \quad \textbf{Eq. 5}$$

If D is independent of μ_{it} then comparing pre- and post-treatment outcomes for participants and controls allows identification of α, the treatment effect.

The DID estimator compares the changes in outcomes for the group of treated individuals with changes in outcomes for a control group. The basis for the estimator is that trends in the outcome variable over time, and time-invariant individual specific variation, are cancelled out. The former is based on the assumption of common trends, in other words, that the group participating in the programme would have experienced the same change in the outcome variable between time period t_0 (before the programme) and t_1 (after the introduction of the programme) as those not participating. The validity of this assumption will be discussed further below, but if it is accepted, then the difference between the change in the outcome variable for the participating group and the change in the outcome variable for the control group will give an estimate of the impact of the programme:

$$\boldsymbol{\alpha_{DID} = E(Y_{i1} - Y_{i0}|D=1) - E(Y_{i1} - Y_{i0}|D=0)} \qquad \textbf{Eq. 6}$$

An advantage of using difference-in-differences is that it removes a significant part of unobservable variation that may affect outcomes regardless of the effect of the programme or policy. However, if participation is related to μ_{it}, then it will not be possible to estimate the treatment effects separately from the temporary individual specific effects. A commonly quoted example of this is the 'Ashenfelter dip' (Ashenfelter 1978) whereby an individual is more likely to enter a training programme if they experience a temporary dip in earnings just before the training programme is introduced, indicating a relationship between individual transitory shocks that affect pre-treatment earnings and programme participation. A more serious problem in the context of the NFPP is that the results will be biased if common macroeconomic trends have different impacts on the treatment and control groups due to their observable or unobservable characteristics (Blundell and Costa Dias 2000).

In order to deal with this particular problem, Abadie (Abadie 2005) suggests that one way to control for observed characteristics that could affect the dynamics of the outcome variable is to include a vector of these characteristics in the difference-in-difference model. They may be introduced in a linear fashion so that the model becomes:

$$Y_{it} = \alpha D_{i,t} + X\beta + \phi_i + \theta_t + \mu_{it} \qquad \text{Eq. 7}$$

and the treatment effect becomes:

$$\alpha_{DID} = E(Y_{i1} - Y_{i0}|X, D=1) - E(Y_{i1} - Y_{i0}|X, D=0) \qquad \text{Eq. 8}$$

Alternatively, the variables may be included using interaction terms, which allows for heterogeneous treatment effects across individuals.

3.3 Propensity score matching

A drawback of the DID model with covariates to control for observable characteristics is that a particular functional form must be imposed on the model in order to estimate the parameters. In order to overcome this, two methods of semi-parametric difference-in-difference estimation have been suggested. The first method was developed by Heckman, Ichimura and Todd (1997). They use propensity score matching to create a control sample with the same observable characteristics as the treatment sample. If the dynamics of the outcome variable are based on these observable characteristics, then, as with the use of covariates within the OLS framework, this would mean that the common trends assumption of difference-in-differences could be accepted.

The basis of the Heckman *et al* (1997) method is that, conditional on X, (Y_1, Y_0) and D are independent.

$$(Y_1, Y_0) \perp D|X \quad \text{[1]} \qquad \textbf{Eq. 9}$$

This means that if we condition on observable characteristics, non-participant outcomes have the same distribution that the participants would have experienced if they had not participated in the programme:

$$F(y_0 \mid X, D=1) = F(y_0 \mid X, D=0) \qquad \textbf{Eq. 10}$$

A further requirement is that $0 < \Pr(D=1|X) < 1$. If these assumptions hold, then matching can be used to construct a control sample from the outcomes of non-participants that would be equivalent to the control group in a random experiment. The conditional independence assumption underlying the matching method is a strong one as it assumes that all selection into the programme is on observable characteristics. In reality, it may be that a set of observable variables for which the condition holds do not exist. In

[1] In fact, only the assumption that $Y_0 \perp D|X$ is necessary to estimate the average treatment effect on the treated using matching techniques.

other words, selection may occur on unobservables. The second assumption ensures that a common support region exists. If there is a combination of X variables for which Pr(D=1)=1, then it is not possible to construct a control sample with the same characteristics from the non-participant observations.

The matching method generates a control sample by using the outcome for a single untreated individual (j), or weighted group of untreated individuals, to represent the outcome that would have been attained by a treated individual (i) if they had not been treated. The comparison individual, or group of individuals, is selected on the basis of the similarity of their observable characteristics to each treated individual (i).

$$\mathbf{ATT = \Sigma_{i\in\{D=1\}} w_{N0, N1} (i) [Q_{1i} - \Sigma_{j\in\{D=0\}} W_{N0, N1} (i , j) Q_{0j}]} \qquad \textbf{Eq. 11}$$

Each participant may be matched with a single non-participant, as in the case of nearest-neighbour matching, or they may be matched with a weighted average of some or all of the non-participant observations, using e.g. kernel or local linear regression.

Rubin and Rosenbaum (1983) have shown that if it is possible to match on values of X, it is also possible to match on a function of X. They use the propensity score, which is an estimate of the probability that an individual is in the treated group, given their values of X.

$$\mathbf{P(X) = Pr(D=1 \mid X)} \qquad \textbf{Eq. 12}$$

This can be estimated using a probit or logit model. Matching is then carried out on the individuals with the most similar propensity scores.

3.4 Extensions to matching and DID

Propensity score matching has been widely used as a way to estimate counterfactual outcomes for participants in various policies and programmes. However, Heckman et al (1998) extend the original framework of Rosenbaum and Rubin (1983) in two ways. The first is to match using panel data, generating a semi-parametric conditional difference-in-difference estimator. If the following assumption holds:

$$\mathbf{E(Y^0_1 - Y^0_0|X, D=1) = E(Y^0_1 - Y^0_0|X, D=0)} \qquad \textbf{Eq. 13}$$

where Y^0_1 is the outcome in the post-treatment periods in the absence of treatment and Y^0_0 is the outcome in the pre-treatment period in the absence of treatment, then the average treatment effect on the treated is:

$$ATT = E(Y^1_1 - Y^0_0|X, D=1) - E(Y^0_1 - Y^0_0|X, D=0) \qquad \text{Eq. 14}$$

This has the advantage that we can control for both observable differences between the two groups that affect the outcome variable, and any unobservable differences that remain constant over time or are related to the observable characteristics of the individual (Abadie 2005). For this method, propensity score matching is carried out as described above, but instead of using $Q_{1i} = Y_{1i}$ and $Q_{0j} = Y_{0j}$ to estimate the matched treatment effect, we set $Q_{1i} = (Y_{1it} - Y_{0it'})$ and $Q_{0j} = (Y_{0jt} - Y_{0jt'})$.

Abadie (2005), following Hirano, Imbens and Ridder (2001), proposes an alternative method to balance the treatment and control samples with respect to observable characteristics before carrying out difference-in-difference estimation of treatment effects. This is done by weighting the control observations on the basis of the similarity of their propensity score to the propensity scores of the treatment group so that the untreated observations that have similar observable characteristics are weighted more than those that are very different. The result is that the same distribution of the observable characteristics is imposed on the treated and control samples. As with other DID models, this version assumes that:

$$E(Y^0_1 - Y^0_0|X, D=1) = E(Y^0_1 - Y^0_0|X, D=0) \qquad \text{Eq. 15}$$

i.e. that conditional on observables, the treated and control samples would have experienced the same outcome dynamics in the absence of treatment. Also in line with the other models, we assume that the support of the propensity score for the treated sample is a subset of the support of the propensity score for the control sample. The basis of this model is:

$$E[Y^1_1 - Y^0_1|X, D=1] = E[\rho_0 (Y_1 - Y_0|X)] \quad \text{where} \qquad \text{Eq. 16}$$

$$\rho_0 = \frac{D - P(D=1|X)}{P(D=1|X)(1 - P(D=1|X)} \qquad \text{Eq. 17}$$

The average treatment effect on the treated is then given by:

$$ATT = E\left[\frac{Y_1 - Y_0}{P(D=1)} \cdot \frac{D - P(D=1|X)}{1 - P(D=1)|X)}\right] \qquad \text{Eq. 18}$$

Abadie (2005) describes how this imposes the same distribution of covariates on the treated and untreated samples by weighting down the distribution of $Y_1 - Y_0$ for the untreated whose values of the covariates are over-represented, and weighting up $Y_1 - Y_0$ for the observations whose values of the covariates are under-represented.

4 Impact of NFPP on household incomes

4.1 Econometric methods

The impact of the NFPP on incomes will be estimated using three different methods. The methods all take advantage of the panel data available by differencing out the time-invariant unobservable heterogeneity between the participating and non-participating households. However, they use different approaches to controlling for observed heterogeneity.

4.2 Descriptive statistics

Using the methods described, we estimate the impact of the NFPP on net income per household; net income per head; and income per household from timber, forest products, and employment. Table 1 gives the values of these variables in 1997 and 2004, for all households and separately for NFPP and non-NFPP households. All the income values include income in cash and in kind i.e. products harvested by the household for their own use. Where crops, livestock or forest products are consumed by the household, we have used imputed prices based on the average received by those households that have sold the product.

[INSERT TABLE 1]

From the descriptive statistics, we can see that total household incomes have risen across both the treated and control groups between 1997 and 2004, as have incomes from employment. Over the same period, incomes from forest products have remained approximately constant and incomes from timber have fallen for NFPP households and risen slightly for non-NFPP households. Clearly changes in the magnitude and structures of incomes have been occurring, some of which will be due to the NFPP and some of which will be due to wider changes across the rural economy. Because of this, it is necessary to isolate the impacts of the NFPP from other types of variation. As discussed above, we do this by controlling for both observable and unobservable factors that are expected to contribute to changes in income from different sources, and that may vary between the treated and control samples. This is done either through the use of covariates in the DID models, or by estimating a propensity score for participation in the NFPP which is then used to weight the observations for estimating the impacts of the NFPP on income.

The same observable variables are used for the estimation of the propensity score and as covariates in the parametric DID model. Following the recommendations of Caliendo and Kopeining (2006), only variables that may affect both participation and outcomes are included, and variables that are potentially affected by participation or the anticipation of participation are excluded. Heckman *et al* (1997) also stress that the data for the treated and control groups should come from the same survey, which holds for the dataset used in this study.

[INSERT TABLE 2]

4.3 Propensity score

For the matching and weighting methods, the propensity score was estimated with a probit model, using the same variables as the controls in the parametric estimation. The results of the probit estimation are shown in Table 3, and the distribution of the scores for NFPP participants and non-participants is shown in Figures 1 and 2.

[INSERT TABLE 2]

These results show that at a 5% level of significance, households in NFPP areas are more likely to be from the relatively prominent Dong or Han ethnic groups than smaller minority groups, and they have higher levels of education; NFPP households tend to have fewer adults, but more forest land, and are relatively remote from their county town.

[INSERT FIGURES 1 AND 2]

These densities show that the households in the NFPP areas have higher propensity scores than those outside the NFPP areas, which is as we would expect. An impact of this is that in the matching process, the NFPP households with higher propensity scores will be compared with a relatively small number of control observations. However, there are at least some control observations with high propensity scores, and related to this, there is a large area of common support on which to estimate the impacts of the policy.

The balancing properties of the propensity score were estimated using the 'blocking' method of Dehejia and Wahba (1999). The purpose of this is to ensure that the propensity score has effectively balanced the distribution of the covariates in the treated and control groups. More specifically, we test whether, after conditioning on the propensity score, treatment is independent of the observable covariates, X.

$$D \perp X \mid p(X) \qquad \textbf{Eq. 19}$$

The method of Dehejia and Wahba (1999) investigates an approximation of whether $f(X \mid D=1) = f(X \mid D=0)$ by dividing the sample into blocks based on the estimated propensity score, and testing whether the means and standard deviations of each covariate in each block are equal. Using the STATA programme *pscore* (Becker and Ichina, 2002), we find that at a 1% level of significance, the treated and control groups are balanced for all covariates, in all blocks.

4.4 Results

In order to test the impact of the NFPP on household incomes from different sources, we estimate DID models, with and without covariates, a weighted propensity score model, and carry out propensity score matching, using kernel and local linear regression. All the models are estimated on changes in income between 1997 and 2004, with the covariates described in the previous section[2]. The results are shown in Table 4.

[2] All estimation is carried out in STATA 9. The matching estimates use an Epanechnikov kernel for the kernel matching process, and a bandwidth of 0.1 for both the kernel and local linear matching. Alternative matching specifications were also estimated to assess robustness, and these did not significantly affect the results. The propensity score weighting procedure was carried out by weighting each observation by the propensity score, and then calculating the average of these weighted estimates. The standard errors for the matching and propensity score weighting methods are estimated using bootstrapping with 500 repetitions. Lastly, all the models were estimated only within the region of common support.

Looking first at the results of the DID model without any covariates, we find that the NFPP had no significant impact on income from timber. However, this specification suggests significant negative effects on income from non-timber forest products, and significant positive effects on income from employment and total income. This model controls for unobservable variation that has the same impact on both treated and control groups over time. However, it does not control for observable variation between the two samples that may affect the impact that general trends have on the two groups. For example, general trends that were occurring between 1997 and 2004, such as increasing off-farm employment, rapid income growth, and a switch away from fuelwood (a key non-timber product) towards other fuels, may have affected different households in different ways. If these are related to observable characteristics of the household, the inclusion of covariates or use of the propensity score should control for them, and therefore better isolate the impacts of the NFPP from other macroeconomic changes.

[INSERT TABLE 4]

This is supported by examination of the results of the remaining specifications, all of which incorporate variation in observable characteristics. The results obtained using DID with covariates, PS matching, and PS weighting give broadly similar conclusions in terms of the direction and significance of the impacts of the NFPP. In all of the conditional specifications, participation in the NFPP is found to have a significant negative impact on household income from timber. Based on the estimates of the DID model with covariates, and the PS matching models, households in the NFPP experienced a reduction in timber income of around 300 CNY between 1997 and 2004, relative to what they would have experienced if they had not participated in the programme. The PS weighting model suggests a greater impact on timber incomes, of around 500 CNY.

The impact of the NFPP on non-timber forest products is negative in all of the models, but small and not significantly different from zero. We would not expect a significant negative effect on non-timber products as collection is still permitted in our survey areas. Regarding fuelwood, although its collection is still allowed under the NFPP, there has been some reduction in quantities collected in both NFPP area and non-NFPP areas which is due to increasing use of alternative forms of energy such as biogas and electricity. It is possible that the NFPP could increase the availability of certain non-timber products in the longer term, but we would not expect to observe this type of impact at this stage.

All of the specifications used show a positive, and significant impact of the NFPP on total household incomes. The increase in total household incomes amounts to around 3000 CNY on average in the DID and matching models, while the PS weighting again gives somewhat different results, with a lower impact on total incomes, which is not significantly different from zero. The results suggest that per capita incomes have increased by approximately 450 CNY between 1997 and 2004, although this effect is not significant at 10%. Possible explanations for the finding that incomes have increased as a result of the NFPP will be discussed in the following section.

Finally, income from employment has increased by around 1000 CNY in NFPP areas than non-NFPP areas according to the PS weighting model, while the other models suggest a difference in the change in income from employment of 2000 CNY between the treated and control groups. However, this effect is not significantly different from zero, apart from in the DID model where the significance is borderline at 10%.

5 Impacts of NFPP on off-farm employment

5.1 Theoretical Impacts

The results of the previous section indicated that the NFPP has resulted in a drop in income from timber, but an average increase in total income. The first of these effects is in line with a logging ban policy. However, the positive effect on total incomes appears to be somewhat counterintuitive because we might expect households affected by the NFPP to be worse off overall. In fact, previous studies on the impacts of the NFPP have suggested that this is the case, although largely not on the basis of quantitative information. As income from off-farm employment has increased faster in NFPP areas than non-NFPP areas, while income from other sources has declined or remained unchanged, it appears that the change in total income is primarily driven by changes in income from employment. We therefore examine the effect that the NFPP has had on household participation in off-farm employment. In particular we consider how falling incomes from timber would affect the labour allocations decisions of households who do potentially have access to off-farm labour markets, but were not previously choosing to participate in them.

Following the standard model of farm household decision making (e.g. Singh, Squire and Strauss, 1986) households affected by the NFPP will allocate labour to forest activities, agricultural production and off-farm labour until the marginal products of labour in forest activity and agriculture are equal to the wage rate in off-farm employment. If the return to labour in forest production falls as a result of the ban on logging, the total household labour allocation to forest activities will be reduced to the point where the marginal product of labour again equals the off-farm wage rate. Under standard assumptions that the agricultural production function exhibits diminishing returns to land and labour and a constant wage rate in the labour market then we would expect that labour will move from forest production into off-farm employment rather than into agriculture. In this case we would, therefore, expect the NFPP to increase participation in the off-farm labour market.

5.2 Empirical Results

We now empirically evaluate the impact of the NFPP on off-farm employment. We estimate the impact on total off-farm employment, and also look separately at work that requires household members to migrate away from the village on a temporary or permanent basis. The amount of employment is measured as the number of household members participating, and as the total number of days spent in a particular activity. The same estimation methods are used as for the previous income impacts evaluation, and the variables used to estimate the propensity score are also the same.

[INSERT TABLE 5]

Looking at the results in Table 5 the impact of the NFPP on the numbers of household members working off-farm is positive, but not significantly different from zero. The impact on the total number of days worked off-farm by all household members is also positive. This impact is significant in the DID models with and without covariates, but not in the PS matching or weighting models. Across all the models, the average impact of the NFPP on total days worked off-farm ranges between 50 and 100 days per household.

The impact on the number of household members leaving the village for employment purposes is again positive, with mixed evidence on the significance of the effect, although it is borderline at a 10% significance level in the PS-based models. Finally, the results indicate that households in NFPP areas increased the number of days worked outside the village by an extra 80 to 130 days, compared with households in non-NFPP areas. This finding is significant in all except the PS weighting model, which is more conservative across all the specifications.

Overall, the results suggest that, while there may be some positive impact of the NFPP on overall employment, the evidence for it is not strong. In contrast, there is a clearer positive impact on the number of days that household members spend as migrant workers. Based on the discussion in the previous section, these findings indicate that the extent to which households can increase their participation in local labour markets may be more limited than the extent to which they can increase their employment in labour markets outside the village. If many households are simultaneously trying to increase their off-farm labour allocations in villages affected by the NFPP, it is likely that within these individual villages, either wages would diminish rapidly or jobs would be rationed. In contrast, the regional or national labour market, which is mainly located in urban areas, would be much less affected by the increase in labour supply resulting from the ban on logging.

5.3 Relationship between employment impacts and income impacts

So far in this section we have discussed why the off-farm labour allocation of households might be expected to increase in response to the ban on harvesting timber, and the empirical results have shown that an increase in off-farm employment outside the home village has occurred in areas affected by the NFPP. However, we would not expect an increase in income to occur as a result of the shift of labour from forest activities to off-farm employment. With sufficient demand for off-farm labour, total income may remain constant if household members who are no longer required for timber harvesting are re-employed elsewhere at a wage that is equal to the previous return to their labour in forest activities. Nevertheless, it does not provide an explanation for the observed increase in total income. This is because if the off-farm wage rate was higher than the return to labour in forest activities before the logging ban, we would expect households to have already allocated more labour to off-farm employment. As the NFPP does not alleviate any constraints in relation to labour market access, then if household income could be increased by moving from forest activities to off-farm employment, such a change in labour allocation should be observed in both NFPP and non-NFPP households.

An explanation for the increase in income resulting from the NFPP is that households are not simply comparing the returns to labour in alternative occupations. Instead, there are a range of further factors that are accounted for in the decision making process.

The first of these factors is the potential cost involved in seeking off-farm employment. This is likely to be particularly important in relation to employment outside the village. Rather than directly comparing earnings from farm and off-farm activities, households will compare expected income net of expenditure. The income data used in this paper are net of expenditure on inputs to agriculture and forest activities, but do not include the costs of seeking off-farm employment. Where individuals look for work outside the village, these costs may include travel expenses and a higher cost of living at the destination. Because the income data do not account for these costs, the empirical finding of increased income in NFPP areas may disguise a reduction in consumption by households because a greater proportion of their total income is spent on enabling household members to live and work outside the village.

Another category of additional factors consists of non-monetary reasons why household members prefer to work in forest or agricultural activities on household land rather than seek off-farm employment. These reasons may include preferring to work for themselves rather than someone else, or perceived riskiness of off-farm income, as employment may not be secure. As with the financial costs of seeking employment, non-monetary factors are likely to be more significant for employment outside the village. The standard Harris-Todaro model of migration (Harris and Todaro, 1970) involves the comparison of the expected wage at the destination with the return to labour at home. However, there have been many related models that emphasise additional variables. In fact, Todaro (1969) stresses that real incomes, taking account for differences in the costs of living, should be compared, rather than nominal incomes. He also acknowledges that factors such as relative living conditions will affect the migration decision as well as earnings differences.

More specifically, Sjastaad (1962) describes how the ‘psychic costs’ of migrating mean that there will be a minimum level of earnings at the home location that will leave an individual indifferent between migrating and not migrating. If home earnings fall below that level, the earnings differential will persuade the individual to migrate. ‘Psychic costs’ are the negative welfare effects of leaving family and friends, and they imply earnings differentials that are larger than the monetary costs and benefits of migration would suggest. Importantly, such earnings differentials do not suggest misallocation of resources because they are the result of the preferences of individuals or households. Mundlak (1979) analyses migration based on comparisons of expected income, as in the Harris-Todaro model. However, he also includes a measure of ‘quality of life’ in the model used. ‘Quality of life’ may be assumed to be higher in rural or in urban areas. In the former case, a premium is required in addition to urban (off-farm) wage rates to encourage migration, while in the latter case, urban wage rates may be lower.

If non-monetary factors such as differences in quality of life or ‘psychic costs’, in combination with earnings differentials, affect the decision to migrate we would expect to see an increase in off-farm employment in response to a fall in income from forest activities, as discussed previously. However, the increase in off-farm employment could in this case lead to an increase in the total income of the household. In this context, the rise in total income would not necessarily indicate an increase in the overall welfare or utility of the household because it may be accompanied by a reduction in non-monetary benefits or an increase in non-monetary costs associated with migration. Similarly, if migrating to earn the higher income involves expenditure on travel costs and living costs, with a resulting reduction in consumption, welfare may not rise along with income.

6 Conclusion

The initial driver behind this paper was the recognition that while much effort frequently goes into valuation of the benefits of forest conservation policies, the negative impacts or costs for individual households living in affected forest areas are often not accounted for. Furthermore, existing studies and reports on the NFPP suggested that the ban on logging was having serious detrimental impacts on the livelihoods of such households. We therefore made use of programme evaluation methods to identify the impacts of the NFPP on two interrelated facets of household livelihoods, namely income and off farm labour supply decisions.

Overall, our results show that the NFPP has had a significant, although fairly small, negative impact on the income earned from timber harvesting by households in collective forest areas. More surprisingly, it has had a positive impact on total household incomes in villages affected by the NFPP. These are potentially very important findings because view that the NFPP has been damaging for forest-based households, and has increased levels of rural poverty by denying access to a key source of income, has led to calls for its removal, despite evidence of environmental benefits. If the impacts of the programme are in fact less harmful than previously thought, then the case for its removal is significantly weakened. However, the difference between the results of this study and the conclusions of other studies raise two questions. The first of these is why the impacts of the NFPP on timber incomes are small. The second question is why the loss of timber incomes has not resulted in reduction in overall incomes, and in fact led to an overall increase.

The main explanation for the small change in incomes from timber resulting from the NFPP is that prior to the ban on logging, timber incomes were already low in both NFPP and non-NFPP areas. There are two reasons for this: firstly, previously high rates of deforestation meant that most households only have access to poor quality, inaccessible or immature timber. The rapid deforestation in the Southern collective forest provinces has been documented by Rozelle *et al* (2000), and the responses to our household survey also indicated that much of the timber on the respondents' forest land had already been harvested. The second reason for the low share of timber in total incomes was that structural changes were already occurring in the rural economy, with the result that increasing proportions of household incomes were coming from off-farm employment. This has meant that although increases in income from employment have been greater in NFPP areas, timber also contributed to a smaller share of total household income by 2004 in non-NFPP areas.

The impact of previous deforestation on initial timber incomes may also provide a partial explanation for the difference between our findings and those of previous studies. Guizhou Province, where our study took place, is fairly representative of the southern collective forest provinces in China, in terms of forest management and past harvesting patterns. However, many of the other studies were carried out in the southwestern provinces of Sichuan and Yunnan, which have historically had different patterns of forest management and land use. In particular, deforestation and forest degradation have been more severe in the southern provinces. In the southwestern provinces, forest cover remains higher therefore the potential for households to earn income from timber activities, and correspondingly the potential losses from a ban on those activities, is greater. The findings of this study therefore can to some extent be extrapolated to other southern forest provinces, but the impacts may be different in the southwest provinces. The impacts in the forest region of northeast China are expected to be yet more different because the forests are state, rather than collective, owned and managed and because alternative employment opportunities are much more limited.

The other difference between this study and previous studies is that total incomes are found to increase as a result of the NFPP instead of fall. This is contrary to the qualitative studies cited in Section 2 and also to the views held, for example by county level forestry officials who were interviewed as part of this project. One factor is likely to be that those interviewed in a case study setting about what they believe to be the impacts of the programme assume that there must have been income losses because households are no longer able to undertake income generating activities that they were previously allowed. However, this does not take account of the alternative uses for the labour that was previously used for forest activities. An important implication of this is that in order to understand the equilibrium effects of a programme on household incomes as opposed to simply the direct effects, it is necessary to collect data on total sources of income as the final impacts may be different to the timber income impacts in isolation.

Lastly, in this paper we considered how labour that is no longer required for timber management and harvesting is reallocated into alternative activities. We find that the reduction in forest activities has been associated with a rise in off-farm employment, specifically outside the village. The standard model of labour allocation would predict the effect on employment, but would not suggest an increase in overall household income. However, where households make labour allocation decisions, in particular those relating to migration out of the village, factors other than relative earnings in alternative activities will be taken into consideration. Households are assumed to compare all monetary and non-monetary costs and benefits of migrating versus not migrating. If expenditure on travelling to sources of off-farm employment, higher costs of living in the destination locations, or poorer living conditions away from the village are important, household members may not migrate even with the potential for higher earnings. However, a drop in forest-related income would lead to migration by members of marginal households, and in this context, would result in an increase in overall income. Despite this increase in income, we cannot assume that the overall welfare of the household has been increased.

There are a number of final caveats to bear in mind. The first of these is that the results in this paper represent average impacts across households. Some households are likely to have been affected to a greater extent than suggested, either because they have previously specialised timber production and have lost investments, or because their alternative income generation opportunities are more limited. The first of these may have implications for the long term environmental impacts of the programme. If the ban creates disincentives to invest in timber plantations then forest cover will not increase over time without the continuous involvement of the state. The second factor is important in relation to poverty alleviation in rural areas such as those where the NFPP has been implemented.

Another caveat is that these results pertain to a specific province in China. We have argued that they may be broadly representative of the southern collective forest areas. However, the different socio-economic, institutional and environmental conditions in the southwest and northeast forest areas of China mean that the effects of the ban may have been different.

A final issue is that even if the ban on logging does not reduce household incomes overall, it can be argued to infringe on the rights that the households hold to forest land. Through the Household Responsibility System, they were allocated the rights to harvest timber on their plots of forest land, and in many cases provided contracts for 30 years or more. That land use rights have been removed without compensation may have implications in terms of equity or in terms of incentives to sustainable manage forest or other types of land in future. The next chapter will consider the question of whether households should have been compensated for their loss of property rights. It also includes estimation of the welfare impacts of the logging ban.

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Table 1 - Descriptive statistics for dependent variables

Income measure		1997		2004	
		Mean	**S.D.**	**Mean**	**S.D.**
Total income per household	Total	6,933	8,846	13,258	12,697
	NFPP	6,960	6,598	14,109	13,863
	non-NFPP	6,877	12,046	11,473	12,343
Total income per head	Total	1,390	1,504	2,593	2,322
	NFPP	1,458	1,507	2,822	2,387
	non-NFPP	1,246	1,494	2,113	2,114
Income from timber	Total	225	1,158	85	331
	NFPP	275	1,256	64	263
	non-NFPP	118	919	129	441
Income from non-timber forest products	Total	713	1314	732	1,346
	NFPP	586	876	533	874
	non-NFPP	981	1,913	1,151	1,945
Income from employment	Total	3,040	7,120	8,130	11,736
	NFPP	3,196	5,776	9,089	11,394
	non-NFPP	2,715	9,364	6,117	12,244

All values in RMB per year

Table 2 - Descriptive statistics for independent variables

Variable		Mean	Median
Ethnic group dummy - Miao	Total	0.29	0.45
	NFPP	0.23	0.42
	non-NFPP	0.40	0.49
Ethnic group dummy – Han	Total	0.15	0.36
	NFPP	0.18	0.39
	non-NFPP	0.09	0.28
Ethnic group dummy – Dong	Total	0.51	0.50
	NFPP	0.57	0.49
	non-NFPP	0.38	0.50
Whether HH head has more than primary education (Dummy var)	Total	0.42	0.49
	NFPP	0.45	0.50
	non-NFPP	0.35	0.48
Age of HH head (years)	Total	47.66	11.31
	NFPP	48.77	10.80
	non-NFPP	45.32	12.02
Number of adults in the household (number)	Total	2.95	1.17
	NFPP	2.88	1.12
	non-NFPP	3.10	1.27
Share of income from forests (%)	Total	0.14	0.14
	NFPP	0.12	0.14
	non-NFPP	0.16	0.16
Area of household forest land (mu)	Total	37.89	105.82
	NFPP	48.26	123.39
	non-NFPP	16.13	46.03
Distance from village to county town (in km, as crow flies)	Total	29.67	14.06
	NFPP	30.67	15.09
	non-NFPP	27.64	11.43

Table 3 - Estimation of propensity score

Variable	Coefficient	Standard errors	P value
Dong	1.450	0.386	0.000
Miao	0.686	0.398	0.085
Han	1.654	0.449	0.000
Age	0.015	0.008	0.063
Education	0.490	0.179	0.006
No. of adults	-0.142	0.074	0.054
Share of income from forests	-0.705	0.579	0.223
Area of forest land	0.006	0.002	0.001
Distance from village to county town	0.018	0.006	0.006
Intercept	-1.738	0.591	0.003
Log likelihood	-147.95		
Pseudo R^2	0.175		
Number of observations	285		

Table 4 - Impacts of NFPP on income from different sources

	DID no covariates	DID with covariates	PS matching, kernel regression	PS matching, local linear regression	PS weighting
Total income per HH	2694 (1337)**	3043 (1502)**	2871 (1590)*	2794 (1529)*	1141 (2917)
Total income per capita	510.8 (269.6)*	466.4 (308.4)	468.9 (326.3)	442.3 (336.5)	32.04 (702.6)
Income from timber per HH	-224.5 (157.7)	-270.1 (162.3)*	-266.2 (109.9)**	-313.0 (123.2)**	-498.9 (275.2)*
Income from NTFPs per HH	-227.7 (98.9)**	-37.65 (106.44)	-31.01 (183.2)	-27.38 (180.5)	-104.3 (155.9)
Income from employment per HH	2548 (1293)*	2399 (1443)*	1965 (1423)	2019 (1351)	1031.8 (2140)

Note: * significant at 10%; ** significant at 5%

Table 5 - Impact of NFPP on off-farm employment

	DID no covariates	DID with covariates	PS matching, kernel regression	PS matching, local linear regression	PS weighting
Number of HH members in off-farm employment	0.130 (0.150)	0.235 (0.164)	0.0907 (.166)	0.137 (0.151)	0.177 (0.196)
Total days off-farm employment per HH	85.30 (47.14)*	101.83 (51.08)**	55.09 (50.65)	69.02 (52.36)	71.13 (59.32)
Number of HH members working outside village	0.281 (0.142)**	0.369 (0.157)**	0.247 (0.162)	0.251 (0.156)	0.283 (0.178)
Total days worked outside village per HH	105.15 (45.55)**	129.88 (49.18)***	83.10 (47.72)*	84.23 (49.38)*	85.77 (55.90)

Note: * significant at 10%; ** significant at 5%

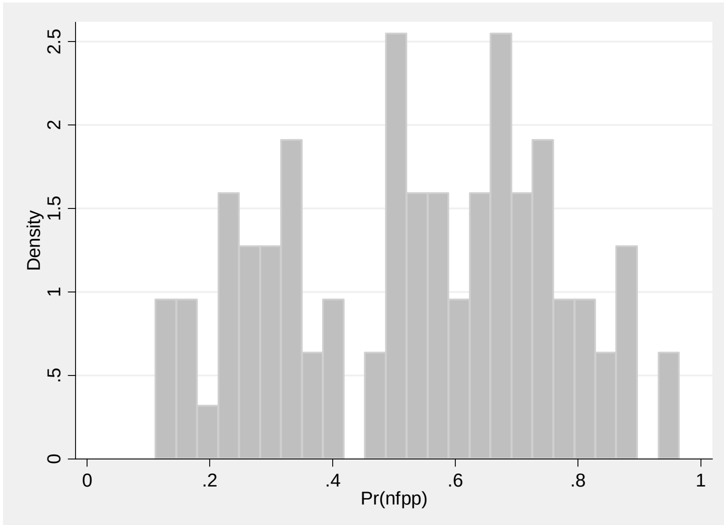

Figure 1. Propensity scores for non-NFPP households

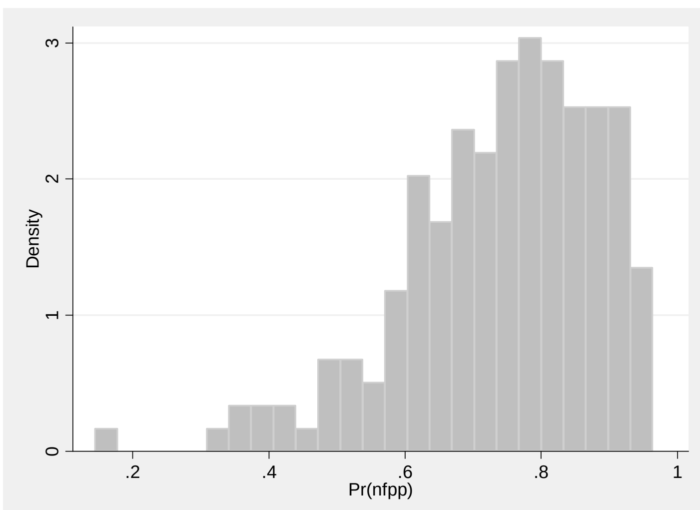

Figure 2. Propensity scores for NFPP households