Ecosystem Services 29 (2018) 116–127

Contents lists available at ScienceDirect

Ecosystem Services

journal homepage: www.elsevier.com/locate/ecoser

Analysing the impacts of PES programmes beyond economic rationale: Perceptions of ecosystem services provision associated to the Mexican case

Rodrigo Arriagada [a], Adrián Villaseñor [b,*], Eliana Rubiano [c], David Cotacachi [d], Judith Morrison [d]

[a] Department of Ecosystems and Environment, Center for Intercultural and Indigenous Research (CIIR), Center for Applied Ecology and Sustainability (CAPES), Centre for the Socioeconomic Impact of Environmental Policies (CESIEP), Pontificia Universidad Católica de Chile, Avenida Vicuña Mackenna 4860, Macul, Santiago, Chile
[b] Centre for the Socioeconomic Impact of Environmental Policies (CESIEP), Pontificia Universidad Católica de Chile, Avenida Vicuña Mackenna 4860, Macul, Santiago, Chile
[c] The World Bank, 1818 H Street, NW Washington, DC 29433, USA
[d] Inter-American Development Bank, Gender and Diversity Division, 1300 New York Avenue, N.W. Washington, D.C. 20577, USA

ARTICLE INFO

Article history:
Received 4 April 2017
Received in revised form 28 November 2017
Accepted 14 December 2017
Available online 19 December 2017

Keywords:
Impact evaluation
Payment for environmental services
Socio-economic
Ecosystem services
Conservation
Mexico

ABSTRACT

Payments for Ecosystem Services programmes represent an important conservation policy worldwide. Despite their popularity, there is still a shortage of evidence regarding whether or not these schemes improve quality of life and generate desired behavioural changes. In this paper, we use a dataset from participants that enrolled in a conservation program on 2007, and from non-participants in the same program. Mexican indigenous communities were interviewed to evaluate program impacts on a range of land use and socio-economic variables between 2007 and 2013. In response to the theory that perceptions of ecosystem services mediate changes in behaviour regarding conservation, we seek to test whether participation in the programme makes it more likely for respondents to identify a higher number of ecosystem services obtained from the forest. Our results are in line with recent socio-economic evaluations of these programmes that conclude that, at best, such conservation programmes do not harm their participants. However, we are also able to provide evidence that participation in the Mexican programme increases participants' perception of the provisioning, regulating and cultural ecosystem services obtained from the forest. These results add more evidence to the thin literature on the behavioural dimensions of ecosystem services and the kind of responses of program participants to the conservation of those services.

1. Introduction

Payments for Environmental Services (PES) have been a popular incentive-based instrument for encouraging landowners to maintain and/or increase the provision of ecosystem services (ES) by promoting land management behaviour that secures ecosystem conservation and restoration. Typically, these programmes make conditional financial transfers to landowners, which are subject to the fulfilment of conservation and land use goals. These schemes currently constitute one of the most important incentives-based conservation policies worldwide (Engel et al., 2008; Jack et al., 2008; Martin Persson and Alpízar, 2013; Wunder, 2007, 2015).

Evaluating the impact that PES programmes have on forest conservation has traditionally required an assessment of deforestation in the absence of the programme (i.e., the counterfactual scenario) (Arriagada et al., 2015; Costedoat et al., 2015; Ferraro and Simpson, 2002; Zhang and Pagiola, 2011). However, an increasing number of PES programmes now explicitly include economic development objectives in addition to their conservation goals (Muradian et al., 2010). Despite this new interest in the socio-economic impacts of these initiatives, the evidence of a causal relationship between PES programmes and socio-economic outcomes is scarce (Pattanayak et al., 2010). In 2014, Samii et al. (2014) conducted a systematic review of socio-economic impact evaluations of PES programmes and found that only two articles met their inclusion criteria of "...well-designed experimental or quasi-experimental studies that use robust methods to construct approximations to the counterfactual for the areas or individuals subject to a PES programme." (p. 25). One of these articles evaluated a PES programme in Mozambique (Hegde and Bull, 2011) and found an average increase of 4% in household consumption using matching methods, but no impact when considering poor households. The second article reviewed a PES programme in China (Liu et al., 2010) and

* Corresponding author.
E-mail address: luvillasenor@uc.cl (A. Villaseñor).

https://doi.org/10.1016/j.ecoser.2017.12.007
2212-0416/© 2017 Published by Elsevier B.V.

identified a 14% increase in household income using multiple regression analysis, but without addressing the potential influence of confounding factors. In addition, Börner et al. (2017) reviewed evidence of PES impact on welfare outcomes and found no impact in Costa Rica (Arriagada et al., 2015) and positive impacts in China (Caliendo and Kopeinig, 2005)[1]. For the case of Mexico, Börner et al. (2017) review two recent articles that look at both welfare and environmental outcomes. Alix-Garcia et al. (2015) evaluate the impact of the PSAH on consumption goods. Using a household survey and a fixed effects model, they find small positive impacts of the PSAH on durable goods for those households in private property and no impacts for those in common property. When analysing poverty at the locality level however, they do find a reduction in their poverty index as a result of enrolment in the PSAH. This result coincides with Sims and Alix-Garcia (2017) who compare the impact of protected areas versus the PSAH in Mexico. They find that the PSAH causes an increment in their poverty alleviation index at the locality level. Notably, both articles find statistically significant impacts of the PSAH programme either in avoided deforestation (Alix-Garcia et al., 2015) or forest change (Sims and Alix-Garcia, 2017).

The lack of sizeable socioeconomic impacts raises the question of why landowners continue to participate in PES programmes. Arriagada et al. (2015) conclude that a complete understanding of the socio-economic impacts of PES "…requires looking beyond simple economic rationales and material outcomes" (p. 13).

Mexico provides an interesting case study for two reasons. First, the Mexican PES programme, *Pagos por Servicios Ambientales e Hidrológicos* ("Payments for Environmental and Hydrological Services", or PSAH), has been in place since 2003 as part of a larger policy, *Pro Árbol* (Caro-Borrero et al., 2015), with the objective of improving hydrological services, avoiding land erosion and sedimentation, diminishing flood risks, and protecting biodiversity by avoiding deforestation (Bruijnzeel, 2004; Muñoz-Piña et al., 2008). The PSAH programme now constitutes one of the largest PES programmes in the world, both in terms of coverage and funding (Caro-Borrero et al., 2015). Second, over 85% of the beneficiaries of the Mexican PSAH programme are communal landowners, and the programme has prioritised funding for municipalities with high indigenous populations (Sims et al., 2014).

Indigenous communities are particularly relevant for study because of their complex relationship with nature (Muller, 2008; Zander et al., 2013). On one hand, these communities are amongst the most marginalised social groups in Mexico and present high rates of financial dependence on forests and other natural habitats. At the same time, these communities possess a strong cultural and traditional relationship with nature (Figueroa et al., 2016), which may lead to forest conservation even in the absence of formal conservation programmes. This trade-off between conservation and economic motivations in indigenous communities and the impacts of the PSAH programme on the well-being of these communities are not well understood (Rodríguez-Robayo et al., 2016).

For this investigation, we used a unique dataset of beneficiaries and non-beneficiaries of the Mexico PSAH programme. Following similar investigations that have sought to empirically attribute changes in outcomes to similar programmes (Alix-Garcia et al., 2012, 2015; Arriagada et al., 2015), we employ matching techniques and difference in differences (DID) estimation to evaluate the impact of the programme in Mexico on a range of land use and economic indicators.

Additionally, we integrate Asah et al. (2014)'s conceptualisation of ES as the primary process driving behavioural changes in favour of conservation. Understanding ES as the benefits individuals derive from nature, the psychological theory of motivational functionalism (Katz, 1960) predicts that ES will stimulate changes in attitudes and behaviours regarding conservation (Asah et al., 2014). In order for environmental policies to achieve these changes, these policies must therefore focus on public perceptions of the functions of ES in PES programme participants' lives (Asah et al., 2014).

We seek to assess the impact of the PSAH programme in Mexico on changing ES perceptions. If the programme succeeds in increasing perceived ES, in addition to motivating future participation in the programme, acquired knowledge of the forest may motivate conservation even in the absence of the programme. Indeed, previous findings indicate that environmental knowledge has an impact on conservation behaviours. For example, Dolisca et al. (2009) analyse the determinants of forest evaluation behaviour in Haiti, and conclude that "…strengthening environmental knowledge in Haiti is a promising approach to promoting conservation behaviour" (p.444). Case studies in Switzerland (Frick et al., 2004) and a forest stewardship education programme for children in the United States (Broussard et al., 2001) reach similar conclusions. Notably, Agarwal (2009) argues that women's participation in forest governance is particularly beneficial because of women's unique knowledge of the forest.

The main contribution of this paper is twofold. First, we evaluate the impact of the Mexican PSAH programme on environmental and economic outcomes specifically among indigenous communities. Secondly, we investigate whether the PSAH generates changes in ES perception among its participants. Additionally, with this investigation, we expand the body of literature providing rigorous assessments of the socio-economic impacts of PES programmes (Börner et al., 2017; McKinnon et al., 2016). In this way, we hope to broaden the range of plausible outcomes identified for PES and similar programmes, in order to support understanding of the motivations behind continuous participation in PES schemes and propose a mechanism for behavioural changes surrounding conservation.

2. PES conceptual framework and related literature

In this section, we outline the definition of PES (Section 2.1) we will use throughout the paper, as well as the typical conceptual framework for conservation programmes (Section 2.2). We also explain why we might expect the Mexican PES programme to have an impact on ES.

2.1. PES definition

While PES programmes can operate under multiple structures, most share certain common elements. In general, PES programmes are incentive-based policies where an organisation offers an incentive to environmental services providers, conditional upon increasing or maintaining the provision of an environmental service (Wunder, 2005, 2007). Porras et al. (2013) and Wunder (2015) conceptualise PES programmes as policies in which environmental service providers voluntarily apply to enter the programme and must meet a series of requirements in order to be entitled to the incentive.

In the case of the Mexican PSAH, Mexico's National Forestry Commission (CONAFOR) is responsible for managing the programme and establishing the requirements for participation. Incentives are cash transfers subject to forest land evaluation to determine deforestation risk. Beneficiaries agree to avoid land

[1] Note that there exist other evaluations that look at the relationship between PES and socioeconomic outcomes (inter alia (Gross-Camp et al., 2012; Van Hecken and Bastiaensen, 2010; Pagiola et al., 2005, 2007)), but these reviews have concentrated on the articles that use quantitative analyses that seek to assess causal effects attributable to the PES programme being analysed, which is the methodology we follow in this paper

changes, conserve forest cover, avoid overgrazing, monitor and fight forest fires, and produce yearly plans to improve land management practices (DOF, 2013).

One defining characteristic of the Mexican programme is its participants. More than 70% of the covered forest is located on communal lands, mainly *ejidos*[2], which is a form of common property created by the redistribution of nearly 50% of the country's agricultural land after the Mexican Revolution in 1910 (Muñoz-Piña et al., 2003). *Ejidatarios* hold access to individual parcels, which they cannot rent or sell, and share access and management of the forest (Caro-Borrero et al., 2015). According to the terms of reference of the PSAH programme, *ejidos*, or 'work groups' within *ejidos* can choose to apply to participate in the PSAH as long as they are able to demonstrate that participation was authorized by the *ejidatarios* assembly. These assemblies normally meet once a month to make decisions regarding the use of common land and other issues affecting the community (Caro-Borrero et al., 2015; Muñoz-Piña et al., 2008, 2003).

2.2. Theoretical framework

The typical conceptual framework for conservation programmes is presented in Fig. 1 (Alix-Garcia et al., 2015). For simplicity, the *X*-axis represents hectares of land ordered by agricultural productivity from low to high, and the *Y*-axis presents agricultural rent. According to this framework, forest owners will participate in a PES programme if the opportunity cost of participating is low, for example if the gains from transforming forest to agricultural production or producing and selling the timber are less than the payment from the programme. Nevertheless, some lands have such low agricultural productivity or the value of their timber is low enough, that they will not be deforested even in the absence of a PES programme. This 'additionality' problem (Pattanayak et al., 2010; Wunder, 2015) complicates the construction of the counterfactual scenario of deforestation in the absence of the programme.

Furthermore, as conceptualised in Section 2.1, PES programmes are often voluntary, and the motivations for enrolment in these schemes are complex. Economic factors such as opportunity cost and income gains play an important role in determining participation (Arriagada et al., 2009; Corbera et al., 2009; Zanella et al., 2014). Economic factors alone, however, do not fully explain PES participation rates. Zanella et al. (2014) in Brazil and Figueroa et al. (2016) in Mexico find that a previously existing interest in forest conservation also increases the likelihood of participation. Interestingly, the latter conclude that communities that participated in the Mexican PSAH programme "...may perceive welfare as a complex ensemble of elements beyond income, such as living in a conserved forest, heritage and patrimony, or the pride derived from the recognition of society for their forest conservation" [Figueroa et al., 2016, p. 48]. PSAH and similar programmes are in this way expected to generate long-term behavioural change in their participants (Alix-Garcia and Wolff, 2014). However, further research is required to understand how such programmes change participants' perceptions of ES obtained from the forest, and of regulating and cultural ES.

The Mexican PES programme may increase participants' awareness and understanding of forest ecosystem services in several

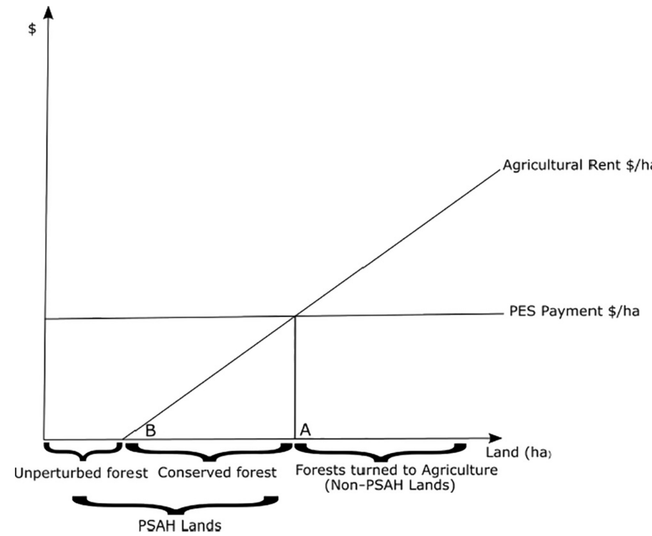

Fig. 1. Typical conservation conceptual framework.

ways. For example, in addition to the payments received by beneficiaries of the PSAH, participants also receive access to capacity building activities such as training and workshops on topics related to forest management and forest certification. Furthermore, the Mexican Forest Council performs technical evaluations of forestry land in order to determine participation eligibility (SEMARNAT, 2003). Finally, as part of their contract, beneficiaries are required to employ a "technical consultant" to assist in the preparation of annual reports on forest stewardship activities (i.e. fire brigades and breaks, forest keeping, reforestation, etc.) and conservation practices (DOF, 2013).

These activities help to increase participants' knowledge and insight regarding the forest and the benefits it provides to humans (Pham et al., 2010). Interestingly, Van Hecken and Bastiaensen (2010) found that farmers who participated in a PES-like programme in Nicaragua described that although the programme payments were of value, one of the main motivating factors for changed land use practices in favour of conservation was the technical assistance received from the programme. In our sample, over 70% of PSAH participants reported having attended technical training provided by the National Forest Commission, and we provide evidence that training increased PSAH impact on ES perceptions.

3. Methods

In this section, we describe the household survey we use along with its data collection framework, study site, and distribution of surveys (Section 3.1). In Section 3.2, we describe our quantitative estimation strategy, which we argue allows us to attribute impact to the PSAH; we then describe the sensitivity test we perform to strengthen this claim. Finally, we present pre and post matching descriptive statistics for our control covariates.

3.1. The study site

We use a dataset collected by the Inter-American Development Bank (IDB) in 120 indigenous communities from the Mayan Cultural Region located in three States of Southern Mexico (Yucatán, Quintana Roo and Campeche) and several cultural regions from the state of Oaxaca. The distribution of questionnaires in these States was determined by weighting the total number of questionnaires by the percentage of indigenous population and the percentage of PSAH contracts among these States. Subsequently, eligible

[2] There are other forms of communal land like *comunidades* or *colonias agrícolas*, but constitute only around 8% and 0.6% of the land in Mexico according to the last agricultural census; http://www.beta.inegi.org.mx/proyectos/agro/amca/ (accessed on 2nd of September 2017). According to Alcorn et al. (1995), "while the *ejido* is a creation of the Mexican revolution that enables groups of people to petition for access to resources to which they have no prior claim, the *comunidad* is a pre-existing corporate entity whose rights are recognized if its members can demonstrate prior, longstanding, community-based use of the land and waters."

Table 1
Household Surveys and Free Lists Samples by State.

State	Household survey		Free lists
	PSAH	Non-PSA	
Campeche	184	175	45
Quintana Roo	151	325	62
Yucatán	54	671	90
Oaxaca	315	573	107
Total	1744	704	307

communal properties were identified and selected based on geographical proximity and accessibility. The sample included an average of 20 household questionnaires per communal property; interviews with community leaders and "free-listing" were also performed. The "free-listing" methodology consists of asking respondents to list all of the elements they are aware of regarding a specific subject (Bernard, 2006; Boster, 1994) and has been applied widely in anthropological and psychological research (Berlin and Berlin, 1996; Keller et al., 2016; Koster et al., 2016; Ryan et al., 2000). Due to resource limitations, free lists were only applied for a random sample of the households who responded to the household questionnaire. Unfortunately, different identification sequences were used for the household surveys and free lists and we were therefore unable to match the two datasets.

We use data from the main household survey to conduct our impact evaluation for environmental and socio-economic variables, and then use the free lists section to validate our approach to impacts on ES perceptions. A total of 2472 household questionnaires and 304 free lists were collected, as displayed in Table 1.

Data was collected between November and December of 2013. Electronic tablets were used for data collection to reduce input errors. Given the geographic dispersion of the population in several of the communal lands, meetings with representatives from each community were convened to increase the efficiency of questionnaire application. PSAH participants that enrolled into the programme in 2007 and non-participants that never have participated into the programme were randomly selected. Questionnaires included questions about demographics, knowledge and participation in the PSAH, economic status, and forest related activities. For the economic indicators section, the questionnaire also included questions regarding 2007 baseline information and the situation at the time of the interview in 2013.

3.2. Impact evaluation strategy

In order to construct counterfactual scenarios and to be able to attribute changes in outcomes to the PSAH programme, we employed an ex-post, quasi-experimental design, including DID estimators and matching methods to correct for selection bias. Our methods relate closely to similar investigations of causal relationships between PES programmes and socio-economic and environmental outcomes. For example, Alix-Garcia et al. (2012, 2015) use matching and post matching techniques as estimation strategies; Arriagada et al. (2015) use matching and post-regression matching with DID estimators and conclude there were no significant socio-economic impacts attributable to the Costa Rican PES.

If y_i is our interest variable for individuals $i = 1,\ldots,N$ belonging to either a beneficiaries group (treated) or a non-beneficiaries group (control); then d_i is a dichotomous variable which takes the value of 1 to indicate treatment status (i.e. participation in the PSAH programme) or 0 otherwise. The DID estimator can be formally defined as:

$$y_i = d_i y_{1i} + (1 - d_i) y_{0i} \tag{1}$$

which is the average treatment effect (ATT). In other words, (1) is econometrically estimated as:

$$\delta_T = ATT = [E(y_1|d_1 = 1) - E(y_1|d_1 = 0)] - [E(y_0|d_1 = 1) - E(y_0|d_1 = 0)] \tag{2}$$

where its corresponding sample estimator is:

$$\bar{\delta} = (\bar{y}|_{i\in B,t=1} - \bar{y}|_{i\in B,t=0}) - (\bar{y}|_{i\in NB,t=1} - \bar{y}|_{i\in NB,t=0}) \tag{3}$$

The first term indicates the difference in the expected outcome value $\bar{y}$ for the treated (B) group after intervention ($t = 1$), while the second term expresses differences for the control group (NB). An identification problem arises because the first term in Eq. (3) is fully observable, while the second is not, given that information for the non-treated after treatment is by definition, not available.

Our main identification strategy rested on the key assumption of the DID method, which asserts that:

$$E(y_0|d = 1) = E(y0|d = 0) \tag{4}$$

In other words, the expected trajectory of outcome $y0$ would be the same for the treated in the absence of treatment as for the control group.

A second problem arose given the voluntary nature of PSAH enrolment. Communities and individuals who apply for the programme are likely to be different from those who do not apply (i.e., differences in motivation, entrepreneurship, etc. affect the decision to participate). These differences are likely to introduce significant bias to our estimates and attribution of impact to the programme. Therefore we need to correct for such bias before estimating the DID models (Ho et al., 2007). We performed genetic matching (Diamond and Sekhon, 2013) to balance our treated and control samples, using relevant variables that we believe determine treatment status and program outcomes (Caliendo and Kopeinig, 2005; Imbens and Wooldridge, 2009). Genetic matching uses a generalised Malahanobis distance matrix to iteratively maximise the covariate balance (Diamond and Sekhon, 2013). We used nearest neighbour matching with replacement and standard errors calculated using Abadie and Imbens (2006) formula for finite samples. While matching depends on the selection of relevant, observable variables, unobservable sources of bias may remain. We performed post-regression matching to eliminate any remaining bias and a Rosenbaum's sensitivity test (Rosenbaum, 1987), defined as:

$$\Gamma = \frac{\Pr(t = 1|t = 1)}{\Pr(t = 1|t = 0)} \tag{5}$$

where if $\Gamma = 1$ the probability that treated and controls receive the treatment is equal (i.e. a randomised trial). The test introduces bias by changing the value of Γ so that $\Gamma > 1$, and produces intervals of *p-values* for estimated treatment effect. At high Γ values, the range of *p-values* becomes too wide to be informative. The point at which this happens is a measure of sensitivity to remaining bias after matching (Sims et al., 2014). We present the maximum Γ value for which our statistically significant estimations remain so at the bottom of our tables.

Table 2 provides our matching variables for PSAH beneficiaries (treated) and non-beneficiaries (controls), before and after matching. The rows labelled as 'unmatched' show statistically significant differences between treatment and control groups for 9 out of our 12 covariates. Additionally, the normalised difference and the difference in quintile-quintile (eQQ) distributions are different from zero, confirming that there is a significant amount of bias in our sample. In other words, these results show that PSAH beneficiaries and non-beneficiaries are in fact different. On average, beneficiaries are younger, possess more assets, manage more land, and own more livestock than non-beneficiaries.

Table 2
Matching covariates before and after matching.

Variable	Sample[i]	Mean PSAH	Mean No PSAH[ii]	Diff in Means	Normalised Difference[iii]	Raw eQQ Diff[iv]
	Socio-Economic Covariates					
Land Owner Age	Unmatched	51.03	54.23	3.202*	−0.156	3.210
	Matched	51.03	52.28	−0.860*	−0.056	1.880
Male	Unmatched	0.87	0.89	0.018	−0.039	0.002
	Matched	0.88	0.88	0.000	0.000	0.000
Indigenous	Unmatched	0.9	0.94	−0.041*	−0.107	0.040
	Matched	0.91	0.91	0.000	0.000	0.000
Education	Unmatched	0.81	0.78	−0.027	0.047	0.030
	Matched	0.82	0.82	−0.040	0.000	0.000
Asset Index 2007	Unmatched	−0.53	−0.2	0.334*	−0.232	0.330
	Matched	−0.51	−0.49	−0.020	−0.007	0.040
Number of Assets 2007	Unmatched	2.51	3.02	0.505*	−0.233	0.500
	Matched	2.55	2.58	−0.030	−0.007	0.060
Agricultural Income 2007	Unmatched	0.24	0.25	0.016	−0.027	0.020
	Matched	0.23	0.23	0.000	0.000	0.000
Non-Agricultural Income 2007	Unmatched	0.14	0.15	0.012	−0.023	0.010
	Matched	0.13	0.13	0.000	0.000	0.000
	Biophysical and Productive Covariates					
Managed Land (ha) 2007	Unmatched	29.46	13.86	−15.609*	0.115	15.810
	Matched	21.86	16.69	5.170*	0.181	5.120
Agricultural Managed Land (ha) 2007	Unmatched	5.12	4.54	−0.583	0.035	0.700
	Matched	4.14	3.87	0.270*	0.041	0.540
Livestock 2007	Unmatched	0.71	0.75	0.041*	−0.066	0.040
	Matched	0.72	0.72	0.000	0.000	0.000
Processed Products 2007	Unmatched	0.35	0.49	0.144*	−0.209	0.140
	Matched	0.35	0.35	0.000	0.000	0.000

Source: Authors' elaboration.
[i] N = 2160; 610 beneficiaries PSAH.
[ii] Weighted means for matched controls.
[iii] *Normalised Difference* $= \frac{\bar{X}_T - \bar{X}_C}{\sqrt{S_T^2 + S_C^2}}$ (Samii et al., 2014).
[iv] Difference in means (for categorical variables) or medians (for continuous variables) in the empirical graph Q-Q of treated and control groups.
* Statistical significance at 5%.

The rows labelled as 'matched' present balance metrics for our variables after matching. If matching was successful, our measures of balance (difference in means, normalised difference and QQ diff) should tend to zero, indicating that the distribution of the covariate for treated and control groups has been empirically equalised. As shown in Table 2, we were able to substantially reduce the bias for all our covariates, and eliminate bias in most. To further reduce potential bias between treated and control groups, we conducted matching using 'callipers' to restrict the quality of controls for the treated group to within two standard deviations for every matching covariate.

4. Results

In this section, we present the results from our impact evaluation strategy described above. We first present the results from our environmental dependent variables, following with the results from our socio-economic outcomes (4.1) and in Section 4.2, we describe and present the results for ES perception.

4.1. Environmental and Socio-Economic outcomes

We performed our impact evaluation methodology for a series of environmental and socio-economic outcomes as described in Table 3. A naıve impact evaluation would simply look at the mean differences between PSAH beneficiaries and non-beneficiaries before and after programme participation. In Table 3 we see no differences in impact variables, beyond those related to household assets.

Table 4 presents the results of impact evaluation for environmental outcomes. The top two rows correspond to previously presented, naıve estimations. No pre-matching differences were found for a change in managed land, agricultural land, or changes in livestock. Results after genetic matching with calipers to remove bias indicated mild positive differences in the amount of managed land. This result is robust to further removal of bias by estimating the conditional mean using multivariate regression. The regression coefficient reveals that the difference in managed land attributable to the PSAH from 2007 to 2013 is positive, i.e. program participants manage 1.029 hectares more compared with what they would have managed had they not been enrolled into the program. This can be because programme payments relax capital constraints, which can generate incentives for participants to manage more land, seeking other profitable activities (Engel, 2016; Reutemann et al., 2016), especially in the context of communal land ownership. This result is however, very sensitive to the presence of hidden bias as indicated by a *Gamma* of 1.1 (i.e., presence of 10% in odds of participation due to hidden bias).

Socio-economic impact variables showed no significant impact of the PSAH programme on household income or assets, as presented in Table 5. Pre-matching differences found for asset variables cannot be attributed to the programme.

Results support recent socio-economic evaluations of PES and similar programmes (Alix-Garcia et al., 2015; Arriagada et al., 2015), finding mild or non-existent socio-economic impacts of the PSAH programme. In this context, Arriagada et al. (2015) call to go beyond "economic rationales and material outcomes" (p.13) to evaluate whether PES programmes have any impact on participants' perception of benefits obtained from the forest.

Table 3
Environmental and socio-economic impact variables.

Variable	Description	Mean PSAH	Mean Non-PSAH	t-stat	p-value
	Environmental impact variables				
Δ in managed land (ha)	Difference between ha of managed land in 2007 and 2013	1.523 (N = 696)	1.074 (N = 1728)	−0.921	0.357
Δ in agricultural land (ha)	Difference between ha of managed land for agriculture in 2007 and 2013	−0.086 (N = 697)	0.074 (N = 1725)	0.047	0.962
Δ in livestock	Difference in the proportion of households that owned livestock from 2007 to 2013	−0.028 (N = 704)	0.037 (N = 1744)	1.020	0.308
	Socio-economic impact variables				
Δ in asset index	Difference in household's asset index from 2007 to 2013	0.886 (N = 701)	0.487 (N = 1737)	−6.821	0.000
Δ in asset count	Difference in the number of household assets from 2007 to 2013	1.377 (N = 701)	0.770 (N = 1737)	−7.117	0.000
Δ in processed products	Difference in the proportion of households that processed goods from 2007 to 2013	0.010 (N = 704)	0.010 (N = 1744)	0.208	0.835
Δ in agricultural income	Proportion of households that earned more than the minimum wage from agricultural activities from 2007 to 2013	0.114 (N = 704)	0.128 (N = 1744)	0.968	0.333
Δ in non-agricultural income	Proportion of households that earned more than the minimum wage from non-agricultural activities from 2007 to 2013	0.098 (N = 704)	0.104 (N = 1744)	0.468	0.640

Table 4
Estimated PSAH impact on environmental variables.

	Δ in managed land	Δ in agricultural managed land	Δ in livestock
		Full Sample[a]	
Difference in means[b]	0.449	−0.012	−0.008
Normalised differences in means[c]	0.023	−0.007	−0.006
Difference in means[b]	0.942*	−0.097	−0.001
N of treated dropped by calipers	32	25	25
Marginal effect regression (post-matching)[e]	1.029**	−0.010	−0.002
Observations	610 (PSAH) 1550 (No-PSAH)	610 (PSAH) 1550 (No-PSAH)	610 (PSAH) 1550 (No-PSAH)
Rosenbaum Sensitivity Max Γ	1.1	–	–

Source: Authors' elaboration. *a*
[a] Treated = 696, Controls = 1728.
[b] *, **, *** t-test for statistical significance: 10%, 5% and 1%, respectively.
[c] *Normalised Difference* $= \frac{\bar{X}_T - \bar{X}_C}{\sqrt{S_T^2 + S_C^2}}$ (Imbens and Wooldridge, 2009).
[d] Caliper restriction matched to observations within two standard deviations for each matching covariate.
[e] Ordinary Least Square regression for the matched sample with all matching covariates as control variables.

4.2. Forest ecosystem services perception outcomes

Based on the results of this investigation, the PSAH programme may not generate a tangible economic benefit for its participants. However, PSAH participation may give participants greater knowledge that allows them to appreciate or better recognise benefits obtained from the forest. Table 6 describes the different activities related to forest management and forest stewardship that respondents claimed to have performed during the year prior to surveying.

Within PSAH and Non-PSAH groups, a higher percentage of PSAH participants engaged in forest management activities (except for plague control). We hypothesised that along with the trainings provided by CONAFOR, participation in these activities can increase participants' perception of ES.

According to the Millennium Ecosystem Assessment (MEA, 2005), ecosystem services can be classified as supporting, provisioning, regulating or cultural. Using an open-ended survey question: *"Para usted, ¿por qué es importante el bosque?"* ("Why is the forest important to you?"), we classify answers based on these ES categories. We only use provisioning, regulating, and cultural categorisations because items that are commonly listed as "supporting" ecosystem services such as "soil formation", "nutrient cycle", "water cycle", "photosynthesis", etc. (MEA, 2005; Wallace, 2007) were not mentioned explicitly as supporting services. For example, when mentioning "water", most respondents talked about obtaining water from the forest, rather than explicitly talking about the water cycle. There were very few cases where "supporting" services were explicitly mentioned, and therefore a dependent variable would have been too skewed. We made the decision to merge these responses in either provisioning or regulating services.

Before evaluating the impact of the PSAH programme on the number of ES mentioned by respondents, we compare these

Table 5
Estimated PSAH impact on socio-economic variables.

	Δ in asset index	Δ in asset count	Δ processed products	Δ agricultural income	Δ non-agricultural income
	Full Sample[a]				
Difference in means[b]	0.399***	0.607***	−0.001	−0.014	−0.006
Normalised mean difference in means[c]	0.206	0.219	−0.029	−0.117	−0.022
	Genetic Matching with Caliper Matching[d]				
Difference in means[b]	0.005	0.073	−0.003	−0.011	−0.007
N of treated dropped by calipers	25	25	25	25	25
Marginal effect regression (post-matching)	−0.001	0.060	−0.004	−0.010	−0.007
Observations	610 (PSAH) 1549 (No-PSAH)	610 (PSAH) 1549 (No-PSAH)	610 (PSAH) 1551 (No-PSAH)	610 (PSAH) 1551 (No-PSAH)	610 (PSAH) 1551 (No-PSAH)
Rosenbaum Sensitivity Max Γ	–	–	–	–	–

[a] Treated = 696, Controls = 1728.
[b] *, **, *** t-test for statistical significance: 10%, 5% and 1%, respectively.
[c] *Normalised Difference* $= \frac{\bar{X}_T - \bar{X}_C}{\sqrt{S_T^2 + S_C^2}}$ (Imbens and Wooldridge, 2009).
[d] Caliper restriction matched to observations within two standard deviations for each matching covariate.
[e] Ordinary Least Square regression for the matched sample with all matching covariates as control variables.

Table 6
Forest management activities by PSAH participation.

Activity	PSAH	Non-PSA
Fire brigade	51.4%	45.4%
Fire breaks	69.6%	66.1%
Plague control	21.6%	29.7%
Forest garden	22.7%	16.0%
Reforestation	48.0%	31.3%
Cleaning	56.9%	55.3%
Forest keeping	30.0%	27.5%
Soil conservation	20.8%	18.7%
Water collection	11.9%	1.2%
Observations	593	1480

Source: Authors' elaboration.

answers to those from the free lists to confirm whether or not respondents identify a wide range of benefits derived from the forest.

Questions were nearly identically on both questionnaires, but free lists were only applied to a random sub-sample of surveyed households. On the household questionnaire, respondents were allowed to provide open answers, while the free list methodology requires respondents to create lists of items related to the question. Fig. 2 plots each ES classification and the proportion of responses for (a) free lists and (b) the main survey. Despite methodological and sample variations, responses for all ES classifications were provided. In the main survey, over half of responses related to provisioning ES, around 32% to regulating ES and over 15% to cultural ES. For the free lists, almost 36% of responses were classified as provisioning ES, almost 50% as regulating ES and around 16% as cultural ES.

We applied the same strategy as for environmental and socio-economic outcomes and performed genetic matching using the same set of variables as predictors of PSAH participation. No retrospective questions regarding forest benefits were included in the survey, but several studies indicate a considerable variation across

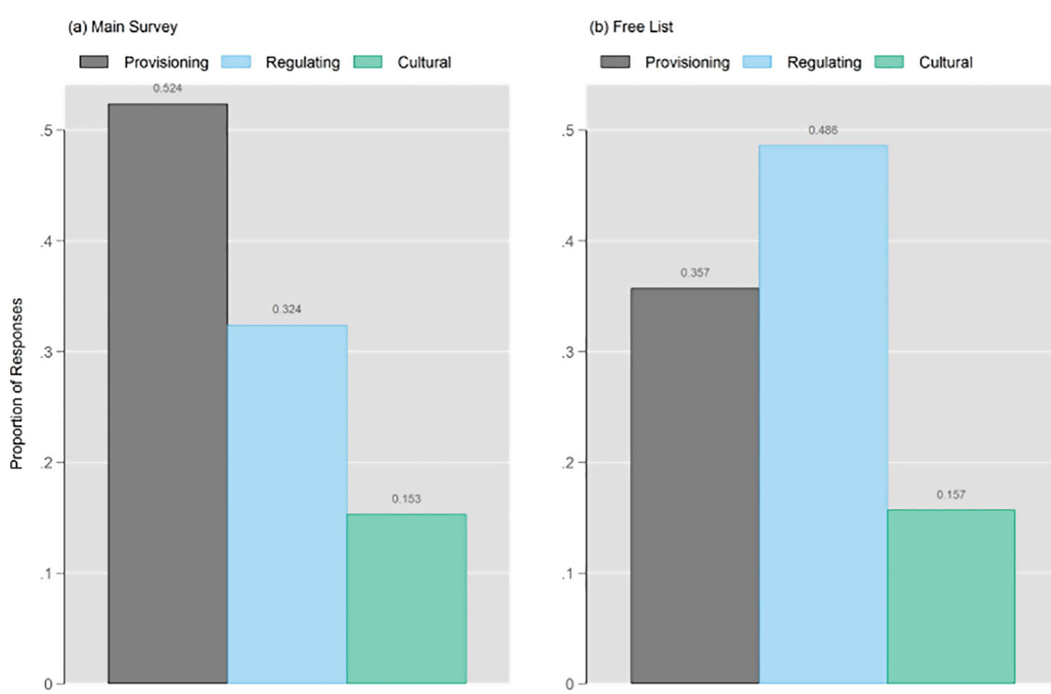

Fig. 2. Percentage of provisioning, regulating, and cultural ecosystem services answers for household survey and free lists. *Source:* Authors' elaboration with data from main questionnaire and free lists.

Table 7
Ecosystem services impact variables.

Variable	Description	Mean PSAH[a]	Mean Non-PSAH	Diff in Means[b]	Normalised Difference[c]
Ecosystem Services	Total Number of ES mentioned by respondent	2.211	1.714	−0.497***	0.258
Provisioning Services	Number of Provisioning Services mentioned by respondent	1.061	0.952	−0.109*	0 0.071
Regulating Services	Number of Regulating Services mentioned by respondent	0.731	0.527	−0.204***	0.216
Cultural Services	Number of Cultural Services mentioned by respondent	0.420	0.235	−0.184***	0.191

[a] Treated = 696, Controls = 1728.
[b] *, **, *** t-test for statistical significance: 10%, 5% and 1%, respectively.
[c] *Normalised Difference* $= \frac{\bar{X}_T - \bar{X}_C}{\sqrt{S_T^2 + S_C^2}}$ (Imbens and Wooldridge, 2009).

Table 8
Average marginal effects on ecosystem services impact variables using poisson regression models.

	Ecosystem Services		Provisioning Services		Regulating Services		Cultural Services	
	Full	Training	Full	Training	Full	Training	Full	Training
PSAH Impact	0.406***	0.587**	0.114*	0.255***	0.104***	0.136**	0.190***	0.256***
	(0.081)	(0.097)	(0.066)	(0.074)	(0.040)	(0.046)	(0.041)	(0.048)
Obs.	1190	862	1198	848	1102	858	1200	858
Treated	595	431	599	424	551	429	600	429
Controls	595	431	599	424	551	429	600	429
Rosenbaum Sensitivity Max Γ	1.5	1.8	1.0	1.2	1.1	1.3	1.6	2.0

Source: Authors' elaboration.
Matched sample after genetic matching (Rosenbaum, 1987).
AME: Average Marginal Effects on the number of ecosystem services mentioned. Controls included in all models.
t-test for statistical significance: *, **, ***, 10%, 5%, 1%, respectively.

socio-economic and cultural characteristics in the way people perceive and value ES (Abram et al., 2014; Hein et al., 2006; Zorondo-Rodríguez, 2012). We therefore assumed that, by performing matching using the same set of environmental and socio-economic variables, we were able to match ES perceptions at the baseline. Additionally, we estimated PSAH impact using post-matching regressions using the matched sample, considering covariates for matching as control variables, and as robustness check, the same variables measured in 2013, to address the possibility that ES perception is conditioned by respondents' performance in the PES programme. Full estimates and an assessment of robustness are presented in Table A9 in the Appendix A.

Table 7 presents our ES impact variables, their definitions, and descriptive statistics. We evaluated the impact of the PSAH programme on the total number of ES mentioned by respondents, and on each ES classification.

There are statistically significant differences for the average total ES mentioned by respondents, and for each of ES classification. While an average of one provisioning service was mentioned by both PSAH and non-PSAH groups, the averages for regulating and cultural ES mentions were well below one, especially for non-PSAH respondents.

Given the count nature of our dependent variables, our empirical strategy was to estimate Poisson models (Long and Freese, 2014) using the matched sample generated by genetic matching. Additionally, we included all covariates for matching within our econometric models as control variables. In a second model for each dependent variable, we added control variables for the following year. The results presented here are unchanged if we estimate the model using OLS or negative binomial estimation.

We indirectly tested whether forest management training is a moderator for PSAH impact on ES perceptions. Given that only PSAH participants could access these trainings, we performed our empirical strategy using a sample of only those PSAH participants who accessed these trainings and the sample of non-participants.

Table 8 presents the average marginal effects (AME) of the Poisson regression models on the matched sample. The columns labelled "Full" use the full sample of participants and non-participants, while the "Training" columns use the sub-sample described above. Our Poisson models show that the PSAH programme had a positive impact on the total number of perceived forest ES and on each of the ES classifications. AME were consistently higher for those models that used the 'training' sub-sample, suggesting that capacity-building activities can serve as a moderator for the impact of PES programmes on ES perceptions. The models using the 'training' sub-sample were also less sensitive to the presence of hidden bias, due to unobservable respondent characteristics. For the total number of ecosystem and cultural services, the *Gamma* values were 1.8 and 2.0, respectively, indicating we could change the odds of participation in our models up to 80% and 100% and our results would still be significant (20% for provisioning and 30% for regulating). This suggests that we were able to better match (and compare) participants and non-participants using the 'training' sub-sample.

AME for all models indicated that PSAH participation increased the number of items in each category by less than one. While these AME may seem low, we believe it is more informative to present the results in terms of the impact of the PSAH on the probability of ES perception of zero ES, one ES, or two or more ES for all classifications. Fig. 3 depicts the average marginal effect of the PSAH programme on such probabilities (for the 'training' sub-sample model). For all models, the PSAH reduced the probability of not mentioning any ES forest benefits. Specifically, the programme reduced the probability of not mentioning any cultural ES by almost 18%.

PSAH participation reduced the probability of mentioning only one ecosystem service. Participation also increased the probability of mentioning two or more provisioning services by around 9%, and of identifying one, or two or more regulating services by 2.4% and more than 5%, respectively. For cultural services, the increase in the likelihood of mentioning one, or two or more cultural services is 12% and 6%, respectively.

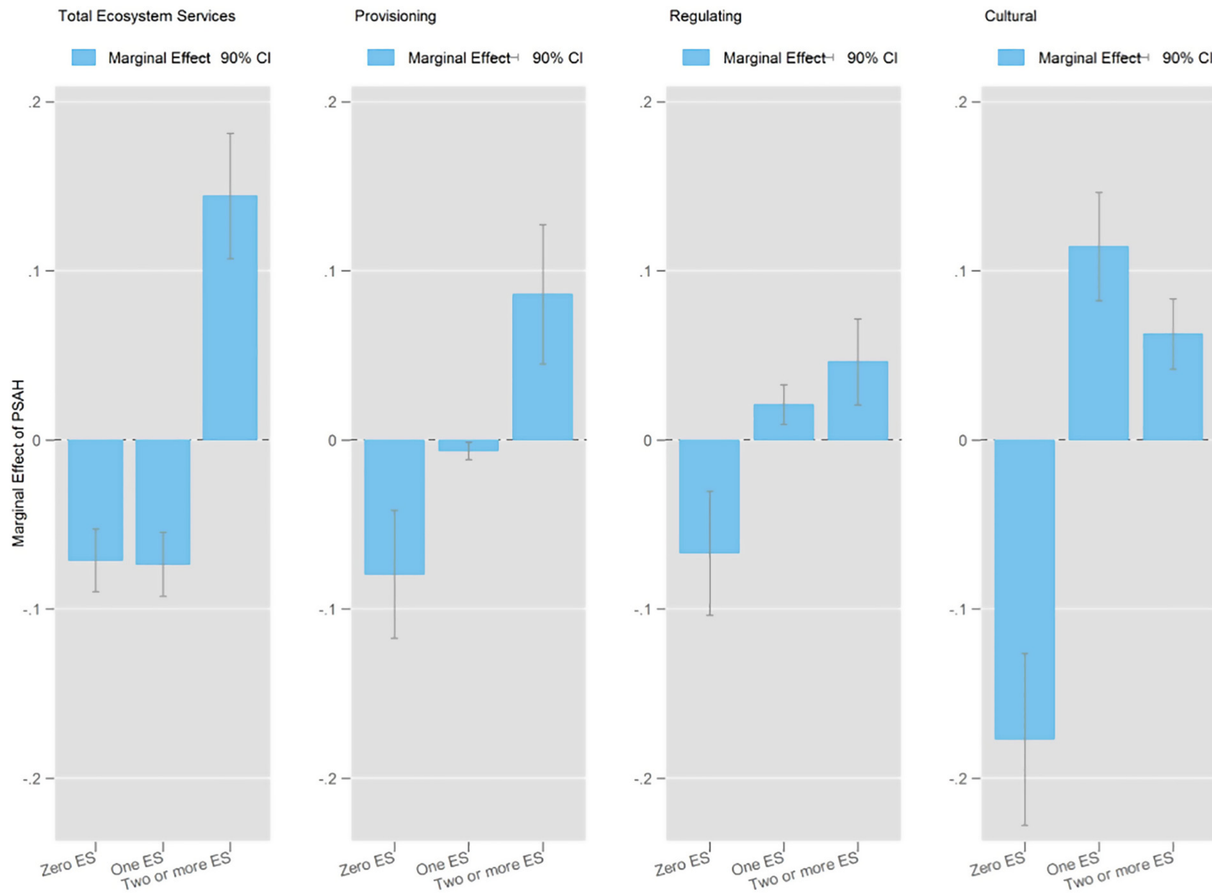

Fig. 3. Impact of PSAH on perception of ecosystem services. *Source:* Authors' elaboration with data from main questionnaire. Average Marginal Effects from 'Training' columns in Table 8. Original in colour. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

5. Summary and conclusion

This investigation sought to isolate the causal impact of the Mexican PSAH on environmental and socio-economic variables within indigenous communities, and to provide evidence of the impact of these programmes on participants' perceptions of ecosystem services.

Recent investigations have found a shortage of evidence regarding quantitative analyses that seek to assess causal effects of conservation programmes on well-being indicators (Börner et al., 2017; McKinnon et al., 2016; Samii et al., 2014). The evidence that does exist on the effectiveness of PES programmes often shows small positive or no impacts on well-being indicators attributable to participation in the programme. One possible explanation is that indeed participants in PES programmes do not see their well-being improved because of the programme; but this would raise the question of continuous participation in these initiatives. Another explanation is that improvements in well-being go beyond the metrics that these articles have normally used to assess the impact of PES-like programmes (Arriagada et al., 2015; Figueroa et al., 2016).

In this article, by using a dataset on beneficiaries and non-beneficiaries from the PSAH programme in Mexico, we have contributed to the impact evaluation literature of PES programmes. Using quantitative techniques designed to make causal attributions (i.e. DID and matching), we found mild impact on total managed land, but no impacts on any other environmental and socio-economic indicators that could be attributed to participation in the PSAH.

Additionally, we expand the range of well-being outcomes for which PES programmes might have an impact on, by analysing the number of benefits respondents claim to obtain from the forest (i.e. ES). We find that participants in the PSAH perceive they obtain more provisioning, regulating, cultural, and total ES that they would have perceived had they not been in the programme. We propose that investigating these outcomes is important in the context of Asah et al. (2014)'s view of ES perception as a mechanism for long term behavioural changes for conservation. In that sense, these results add more to the literature on the behavioural dimensions of ecosystem services and how this dimension may influence people's reaction when participating in programs of direct payments for conservation.

These findings motivate future research and appropriate data collection on the investigation of the mechanisms by which conservation programmes can generate permanent conservation efforts. In our case changes in the perception about provision of forest ES can be, by itself, a motivation to initiate and sustain behavioural changes that will sustain conservation. In the context of environmental education, these findings suggest that capacity building, training and forest management activities that are often part of the design of PES programmes can increase the perception participants have of forest ES. These findings also suggest that future PES programmes' design should include and potentiate activities that increase the knowledge participants (and non-participants) have of their natural environment.

Appendix A.

Table A9
Ecosystem services and robustness using 2007 + 2013 environmental and socio-economic variables.

Variable	Ecosystem Services		Provisioning		Regulating		Cultural	
	Matching Variables	2007 + 2013 Variables	Matching Variables	2007 + 2013 Variables	Matching Variables	2007 + 2013 Variables	Matching Variables	2007 + 2013 Variables
PSAH Impact	0.201***	0.208***	0.110*	0.145**	0.157***	0.141**	0.593***	0.543***
	(0.038)	(0.039)	(0.058)	(0.060)	(0.059)	(0.062)	(0.124)	(0.128)
Land Owner Age	−0.004***	−0.003**	−0.004*	−0.003	−0.007***	−0.006***	0.001	0.002
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)
Male	−0.100	−0.079	0.093	0.099	−0.225***	−0.228***	−0.209	−0.188
	(0.061)	(0.064)	(0.111)	(0.115)	(0.083)	(0.085)	(0.190)	(0.193)
Indigenous	−0.090	−0.131*	0.178	0.151	−0.226**	−0.235**	−0.318	−0.371*
	(0.067)	(0.070)	(0.115)	(0.118)	(0.098)	(0.098)	(0.201)	(0.206)
Education	0.120**	0.110**	0.214**	0.217**	−0.052	−0.082	0.100	0.078
	(0.054)	(0.055)	(0.093)	(0.095)	(0.082)	(0.083)	(0.168)	(0.171)
Asset index 2007	−0.157	0.244	−0.249	−0.098	−0.205	0.282	0.097	0.425
	(0.169)	(0.183)	(0.233)	(0.269)	(0.266)	(0.264)	(0.508)	(0.550)
Number of Assets 2007	0.107	−0.168	0.201	0.108	0.180	−0.154	−0.189	−0.432
	(0.114)	(0.125)	(0.154)	(0.181)	(0.180)	(0.178)	(0.348)	(0.376)
Non-Agricultural Income 2007	−0.043	0.021	−0.061	0.045	0.106	0.111	−0.503**	−0.467*
	(0.060)	(0.073)	(0.096)	(0.120)	(0.087)	(0.116)	(0.234)	(0.241)
Agricultural Income 2007	0.136***	0.077	0.301***	0.241***	−0.158*	−0.170	0.187	0.269
	(0.050)	(0.062)	(0.072)	(0.090)	(0.082)	(0.104)	(0.146)	(0.216)
Managed Land 2007	−0.002***	0.001	−0.004***	−0.002	0.002*	0.004	−0.006**	0.018**
	(0.001)	(0.002)	(0.001)	(0.004)	(0.001)	(0.003)	(0.003)	(0.008)
Agricultural Land 2007	−0.001	−0.004	−0.016**	−0.020*	0.001	−0.013**	0.019***	0.021***
	(0.003)	(0.005)	(0.008)	(0.010)	(0.004)	(0.006)	(0.005)	(0.004)
Livestock 2007	−0.158***	−0.126**	−0.235***	−0.098	0.094	0.057	−0.220	−0.512**
	(0.045)	(0.060)	(0.065)	(0.100)	(0.070)	(0.114)	(0.136)	(0.201)
Processed Products 2007	−0.114***	−0.149	−0.133**	−0.305*	−0.157**	−0.023	0.038	−0.418
	(0.044)	(0.110)	(0.062)	(0.172)	(0.070)	(0.173)	(0.134)	(0.348)
Asset Index 2013		−0.513***		0.124		−0.996***		−0.454
		(0.164)		(0.257)		(0.211)		(0.532)
Number of Assets 2013		0.385***		−0.047		0.683***		0.436
		(0.111)		(0.174)		(0.141)		(0.357)
Non-Agricultural Income 2013		−0.105*		−0.182*		0.042		−0.111
		(0.058)		(0.100)		(0.095)		(0.171)
Agricultural Income 2013		0.071		0.067		0.015		−0.169
		(0.056)		(0.086)		(0.096)		(0.197)
Managed Land 2013		−0.004**		−0.003		−0.002		−0.024***
		(0.002)		(0.004)		(0.003)		(0.008)
Agricultural Land 2013		0.003		0.004		0.018***		−0.004
		(0.006)		(0.012)		(0.007)		(0.012)
Livestock 2013		−0.054		−0.185*		0.041		0.340*
		(0.058)		(0.097)		(0.109)		(0.200)
Processed Products 2013		0.061		0.189		−0.119		0.543
		(0.114)		(0.178)		(0.175)		(0.353)
Constant	0.675*	0.233	−0.693	−0.252	−0.300	−1.515**	−0.469	−1.223
	(0.372)	(0.429)	(0.544)	(0.650)	(0.570)	(0.625)	(1.235)	(1.405)
Obs	1190	1147	1198	1161	1202	1162	1200	1166
BIC	−0.960	23.282	−33.511	−1.274	49.670	87.483	15.873	41.869

Matched sample after genetic matching (Diamond and Sekhon, 2013).
Source: Authors' elaboration.
t-test for statistical significance: *, **, ***, 10%, 5%, 1%, respectively.

Appendix B. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.ecoser.2017.12.007.

References

Abadie, A., Imbens, G.W., 2006. Large sample properties of matching estimators for average treatment effects. Econometrica 74, 235–267.
Abram, N.K., Meijaard, E., Ancrenaz, M., Runting, R.K., Wells, J.A., Gaveau, D., Pellier, A.-S., Mengersen, K., 2014. Spatially explicit perceptions of ecosystem services and land cover change in forested regions of Borneo. Ecosyst. Serv. 7, 116–127.
Agarwal, B., 2009. Gender and forest conservation: The impact of women's participation in community forest governance. Ecol. Econ. 68, 2785–2799.
Alcorn, J., Toledo, V., 1995. The role of tenurial shells in ecological sustainability: property rights and natural resource management in Mexico. In: Hanna, S., Monasinghe, M. (Eds.), Prop. Rights a Soc. Ecol. Context. The World Bank, Washington, DC.
Alix-Garcia, J., Wolff, H., 2014. Payment for ecosystem services from forests. Annu. Rev. Resour. Econ. 6, 4.1–4.20.
Alix-Garcia, J.M., Shapiro, E.N., Sims, K.R.E., 2012. Forest conservation and slippage: evidence from Mexico's national payments for ecosystem services program. Land Econ. 88, 613–638.
Alix-Garcia, J.M., Sims, K.R.E., Yañez-Pagans, P., 2015. Only one tree from each seed? Environmental effectiveness and poverty alleviation in Mexico's Payments for ecosystem services program. Am. Econ. J. Econ. Policy 7, 1–40.
Arriagada, R.A., Sills, E.O., Ferraro, P.J., Pattanayak, S.K., 2015. Do payments pay off? Evidence from participation in Costa Rica's PES program. PLoS One 10, 1–17.
Arriagada, R.A., Sills, E.O., Pattanayak, S.K., Ferraro, P.J., 2009. Combining qualitative and quantitative methods to evaluate participation in Costa Rica's program of payments for environmental services. J. Sustain. For. 28, 343–367.
Asah, S.T., Guerry, A.D., Blahna, D.J., Lawler, J.J., 2014. Perception, acquisition and use of ecosystem services: human behavior, and ecosystem management and policy implications. Ecosyst. Serv. 10, 180–186.
Berlin, E.A., Berlin, B., 1996. Medical Ethnobiology of the Highland Mayan of Chiapas, Mexico: The Gastrointestinal Diseases. Princeton University Press, Princeton, N.J..
Bernard, H.R., 2006. Research Methods in Anthropology: Qualitative and Quantitative Approaches. Altamira Press, New York.
Börner, J., Baylis, K., Corbera, E., Ezzine-de-Blas, D., Honey-Rosés, J., Persson, U.M., Wunder, S., 2017. The effectiveness of payments for environmental services. World Dev. 96, 359–374.
Boster, J., 1994. The successive pile sort 1 triad tests and free pile sorts. Cult. Anthropol. Methods J. 6, 2–4.
Broussard, S.R., Jones, S.B., Nielsen, L.A., Flanagan, C.A., 2001. Forest stewardship education: fostering positive attitudes in urban youth. J. For. 99, 37–42.
Bruijnzeel, L.A., 2004. Hydrological functions of tropical forests: Not seeing the soil for the trees?.
Caliendo, M., Kopeinig, S., 2005. Some practical guidance for the implementation of propensity score matching. SSRN eLib. 22, 31–72.
Caro-Borrero, A., Corbera, E., Neitzel, K.C., Almeida-Leñero, L., 2015. "We are the city lungs": payments for ecosystem services in the outskirts of Mexico City. Land Use Policy 43, 138–148.
Corbera, E., Soberanis, C.G., Brown, K., 2009. Institutional dimensions of payments for ecosystem services: an analysis of Mexico's carbon forestry programme. Ecol. Econ. 68, 743–761.
Costedoat, S., Corbera, E., Ezzine-de-Blas, D., Honey-Rosés, J., Baylis, K., Castillo-Santiago, M.A., 2015. How effective are biodiversity conservation payments in Mexico? PLoS One 10, 1–20.
Diamond, A., Sekhon, J., 2013. Genetic matching for estimating causal effects. Rev. Econ. Stat. 95, 932–945.
DOF, 2013. Tercera seccion. Secretaria de medio ambiente y recursos naturales, Terc. Secc. Secr. MEDIO Ambient. Y Recur. Nat., 111
Dolisca, F., McDaniel, J.M., Shannon, D.A., Jolly, C.M., 2009. A multilevel analysis of the determinants of forest conservation behavior among farmers in Haiti. Soc. Nat. Resour. 22, 433–447.
Engel, S., 2016. The devil in the detail: a practical guide on designing payments for environmental services. Int. Rev. Environ. Resour. Econ. 9, 131–177.
Engel, S., Pagiola, S., Wunder, S., 2008. Designing payments for environmental services in theory and practice: an overview of the issues. Ecol. Econ. 65, 663–674.
Ferraro, P.J., Simpson, R.D., 2002. The cost-effectiveness of conservation payments. Land Econ. 78, 339–353.
Figueroa, F., Caro-Borrero, Á., Revollo-Fernández, D., Merino, L., Almeida-Leñero, L., Paré, L., Espinosa, D., Mazari-Hiriart, M., 2016. "I like to conserve the forest, but I also like the cash": Socioeconomic factors influencing the motivation to be engaged in the Mexican Payment for environmental services programme. J. For. Econ. 22, 36–51.
Frick, J., Kaiser, F.G., Wilson, M., 2004. Environmental knowledge and conservation behavior: exploring prevalence and structure in a representative sample. Pers. Individ. Dif. 37, 1597–1613.
Gross-Camp, N.D., Martin, A., McGuire, S., Kebede, B., Munyarukaza, J., 2012. Payments for ecosystem services in an African protected area: exploring issues of legitimacy, fairness, equity and effectiveness. Oryx 46, 24–33.
Van Hecken, G., Bastiaensen, J., 2010. Payments for ecosystem services in Nicaragua: do market-based approaches work? Dev. Change 41, 421–444.
Hegde, R., Bull, G.Q., 2011. Performance of an agro-forestry based payments-for-environmental-services project in Mozambique: a household level analysis. Ecol. Econ. 71, 122–130.
Hein, L., van Koppen, K., de Groot, R.S., van Ierland, E.C., 2006. Spatial scales, stakeholders and the valuation of ecosystem services. Ecol. Econ. 57, 209–228.
Ho, D.E., Imai, K., King, G., Stuart, E.S.A., 2007. Matching as nonparametric preprocessing for reducing model dependence in parametric causal inference. Polit. Anal. 15, 199–236.
Imbens, G.W., Wooldridge, J.M., 2009. Recent developments in the econometrics of program evaluation. J. Econ. Lit. 47, 5–86.
Jack, B.K., Kousky, C., Sims, K.R.E., 2008. Designing payments for ecosystem services: Lessons from previous experience with incentive-based mechanisms. Proc. Natl. Acad. Sci. 105, 9465–9470.
Katz, D., 1960. The functional approach to the study of attitudes. Public Opin. Q. 24, 163–204.
Keller, S., Hemmert, W., Völk, F., 2016. Aspects of generating syntax-free word lists for quantifying speech intelligibility. J. Acoust. Soc. Am. 140, 3213.
Koster, J., Bruno, O., Burns, J.L., 2016. Wisdom of the Elders? Curr. Anthropol. 57, 113–121.
Liu, C., Lu, J., Yin, R., 2010. An estimation of the effects of China's priority forestry programs on farmers's income. Environ. Manage. 45, 526–540.
Long, J.S., Freese, J., 2014. Regression Models for Categorical Dependent Variables Using Stata. Stata Press, Texas.
Martin Persson, U., Alpízar, F., 2013. Conditional cash transfers and payments for environmental services-a conceptual framework for explaining and judging differences in outcomes. World Dev. 43, 124–137.
McKinnon, M.C., Cheng, S.H., Dupre, S., Edmond, J., Garside, R., Glew, L., Holland, M. B., Levine, E., Masuda, Y.J., Miller, D.C., Oliveira, I., Revenaz, J., Roe, D., Shamer, S., Wilkie, D., Wongbusarakum, S., Woodhouse, E., 2016. What are the effects of nature conservation on human well-being? A systematic map of empirical evidence from developing countries. Environ. Evid. 5, 8.
MEA, 2005. Ecosystems and Human Wellbeing: Synthesis, Washington, DC.
Muller, S., 2008. Indigenous payment for environmental service (PES) opportunities in the Northern Territory: negotiating with customs. Aust. Geogr. 39, 149–170.
Muñoz-Piña, C., Guevara, A., Torres, J.M., Braña, J., 2008. Paying for the hydrological services of Mexico's forests: analysis, negotiations and results. Ecol. Econ. 65, 725–736.
Muñoz-Piña, C., De Janvry, A., Sadoulet, E., 2003. Recrafting rights over common property resources in Mexico. Econ. Dev. Cult. Change 52, 129–158.
Muradian, R., Corbera, E., Pascual, U., Kosoy, N., May, P.H., 2010. Reconciling theory and practice: an alternative conceptual framework for understanding payments for environmental services. Ecol. Econ. 69, 1202–1208.
Pagiola, S., Agostini, P., Gobbi, J., de Haan, C., Ibrahim, M., Murgueitio, E., Ramírez, E., Rosales, M., Ruíz, J.P., 2005. Paying for biodiversity conservation services. Mt. Res. Dev. 25, 206–211.
Pagiola, S., Ramírez, E., Gobbi, J., de Haan, C., Ibrahim, M., Murgueitio, E., Ruíz, J.P., 2007. Paying for the environmental services of silvopastoral practices in Nicaragua. Ecol. Econ. 64, 374–385.
Pattanayak, S.K., Wunder, S., Ferraro, P.J., 2010. Show me the money: do payments supply environmental services in developing countries? Rev. Environ. Econ. Policy 4, 254–274.
Pham, T.T., Campbell, B.M., Garnett, S., Aslin, H., Hoang, M.H., 2010. Importance and impacts of intermediary boundary organizations in facilitating payment for environmental services in Vietnam. Environ. Conserv. 37, 64–72.
Porras, I., Alyward, B., Dengel, J., 2013. Monitoring payments for watershed services schemes in developing countries, p. 36.
Reutemann, T., Engel, S., Pareja, E., 2016. How (not) to pay — field experimental evidence on the design of REDD + payments. Ecol. Econ. 129, 220–229.
Rodríguez-Robayo, K.J., Ávila-Foucat, V.S., Maldonado, J.H., 2016. Indigenous communities' perception regarding payments for environmental services programme in Oaxaca Mexico. Ecosyst. Serv. 17, 163–171.
Rosenbaum, P., 1987. Sensitivity analysis for certain permutation inferences in matched observational studies. Biometrika 74, 13–26.
Ryan, G.W., Nolan, J.M., Yoder, P.S., 2000. Successive free listing: using multiple free lists to generate explanatory models. Field Methods 12, 83–107.
Samii, C., Lisiecki, M., Kulkarni, P., Chavis, L., 2014. Effects of payment for environmental services (PES) on deforestation and poverty in low- and middle-income countries. Campbell Syst. Rev. 11.
SEMARNAT, 2003. Reglas de Operación para el otorgamiento de pagos del Programa de Servicios Ambientales Hidrológicos, D. Of. La Fed., pp. 6–22.
Sims, K.R.E., Alix-Garcia, J.M., 2017. Parks versus PES: evaluating direct and incentive-based land conservation in Mexico. J. Environ. Econ. Manage. 86, 8–28.
Sims, K.R.E., Alix-Garcia, J.M., Shapiro-Garza, E., Fine, L.R., Radeloff, V.C., Aronson, G., Castillo, S., Ramirez-Reyes, C., Yañez-Pagans, P., 2014. Improving environmental and social targeting through adaptive management in Mexico's payments for hydrological services program. Conserv. Biol. 28, 1151–1159.

Wallace, K.J., 2007. Classification of ecosystem services: problems and solutions. Biol. Conserv. 139, 235–246.
S. Wunder, 2005. Payments for environmental services: some nuts and bolts, Jakarta.
Wunder, S., 2007. The efficiency of payments for environmental services in tropical conservation: essays. Conserv. Biol. 21, 48–58.
Wunder, S., 2015. Revisiting the concept of payments for environmental services. Ecol. Econ. 117, 234–243.
Zander, K.K., Dunnett, D.R., Brown, C., Campion, O., Garnett, S.T., 2013. Rewards for providing environmental services – where indigenous Australians' and western perspectives collide. Ecol. Econ. 87, 145–154.
Zanella, M.A., Schleyer, C., Speelman, S., 2014. Why do farmers join payments for ecosystem services (PES) schemes? An assessment of PES water scheme participation in Brazil. Ecol. Econ. 105, 166–176.
Zhang, W., Pagiola, S., 2011. Assessing the potential for synergies in the implementation of payments for environmental services programmes: an empirical analysis of Costa Rica. Environ. Conserv. 38, 406–416.
Zorondo-Rodríguez, F., 2012. Natural Capital and Human Well-Being: What are the Links? A Study Among Rural Inhabitants from Kodagu District (Karnataka State). Universitat Autònoma de Barcelona, India.