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Gwenole Le Velly, Céline Dutilly Diane, Driss Ezzine de Blas, Chloë Fernandez. PES as Compensation? Redistribution of Payments for Forest Conservation in Mexican Common Forests. 2015. halshs-01226800

HAL Id: halshs-01226800

<https://shs.hal.science/halshs-01226800v1>

Preprint submitted on 10 Nov 2015

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Études et Documents n° 28

November 2015

To cite this document:

Le Velly G., Dutilly C., Ezzine de Blas D., Fernandez C. (2015) " PES as Compensation ? Redistribution of Payments for Forest Conservation in Mexican Common Forests", *Études et Documents*, n° 28, CERDI. http://cerdi.org/production/show/id/1758/type_production_id/1

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This work was supported by the LABEX IDGM+ (ANR-10-LABX-14-01) within the program “Investissements d’Avenir” operated by the French National Research Agency (ANR).

Études et Documents are available online at: <http://www.cerdi.org/ed>

Director of Publication: Vianney Dequiedt
Editor: Catherine Araujo Bonjean
Publisher: Mariannick Cornec
ISSN: 2114 - 7957

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Abstract

This article empirically explores the distribution of a Payments for Environmental Services (PES) scheme within Mexican forest communities. The PSA-H is a Mexican federal PES that has been remunerating communities for forest conservation since 2003. During the last decade, Mexico's National Forestry Commission [CONAFOR] has developed a complex targeting system in order to enroll forests owned by communities with certain socio-economic and ecological characteristics. In the present study we analyze the socio-economic characteristics and land use changes of recipients of the PSA-H to understand how the targeting objectives have been expressed in the field. We conducted a combined survey of 47 *ejidos* and 163 households in the south of the state of Yucatan – the Cono Sur region. We first investigate, at the *ejido*-level, what determines the unequal distribution of payments. Second, we analyze the amount of payment received depending on the characteristics of households. Our analysis shows that the way the PSA-H is being distributed by *ejidatarios* bypasses the initial compensation objective. As a matter of fact, the distribution of the payments reflects past land use trajectories.

Key words

PES ; Mexico ; Communities ; Forest conservation ; Economic compensation ; Distribution of payments.

JEL codes

Q28, Q23, D63

Acknowledgment

This research is part of the PESMIX project, funded by the French Research Agency (Convention 2010- STRA-0008). The authors thank Roberto Sangines and Lucely Contreras and would like to acknowledge Catherine Araujo-Bonjean, Serge Garcia, Alain Karsenty, Eric Kéré, Thomas Legrand, Jean-Michel Salles, Alexandre Sauquet and Arild Vatn for their very helpful comments. The authors would also like to thank all participants at the POLICYMIX conference in Leipzig (February 2014), the Journées de Microéconomie Appliquée in Clermont-Ferrand (June 2014) and the PESMIX workshop in Montpellier (June 2014).

1. Introduction

Payments for environmental services (PES) are innovative forest conservation instruments that have developed extensively during the last decade (Engel et al. 2008). But a fierce debate remains about their objectives. According to Wunder's definitions (Wunder 2005, 2015), PES are a direct application of Coase theorem and, to be environmentally effective, PES must demonstrate additionality and focus on credible threats of deforestation (Wunder, 2007). Therefore, they should focus on threatened forests and compensate landowners for the foregone income.

This vision of PES has been criticized by many authors because it ignores the institutional process behind the emergence of PES. In reality, PES are shaped by local institutions (Muradian et al., 2010; Muradian et al., 2013) and existing regulations (Brimont et Karsenty, 2015) and often do not look like a pure Coasean agreement (Vatn, 2010; 2015). PES as a compensation are exceptions to a polluters-pays principle and can be seen as illegitimate and unfair if it only remunerates landowners that are willing to deforest. Making the scheme acceptable and effective on the long-run often requires better considering equity and legitimacy in the attribution of payments (Adger et al., 2003; Corbera et al., 2007; Pascual et al, 2014) and PES following a compensation logic are unlikely to emerge.

The PSA-H is a PES scheme to protect watershed services run by the Mexican federal government (Muñoz-Piña et al., 2008; Alix-Garcia et al., 2012). In order to conserve the forest cover, the PSA-H offers five year contracts with yearly payments, which are proportional to the area of forest under conservation. The Mexican forest commission, CONAFOR, has developed a complex targeting system in order to focus its intervention (Rolon et al., 2011; Muñoz Piña et al., 2011) on threatened forest in order to maximize additionality.

In Mexico, 80% of the forest cover is owned as commons by communities called *ejido*¹. (Bray et al., 2003; Kaimowitz, 2005) and a great share of the scheme does not allocate payments to individual landowners but rather to the assembly of each *ejido*. This assembly then decides how to use the payments and how to redistribute them. The final allocation depends crucially on the community sharing rules.

¹ We use in this paper the term *ejido* in the sense of *nucleo agrario* i.e. that encompass the agrarian communities

In this article, we analyze the distribution of the payments within the *ejidos* in order to understand how the objectives of the PSA-H are understood and whether the internal distribution complies or conflicts with the logic of economic compensation. In particular, we study how land-use heterogeneity impacts PSA-H redistribution. Within *ejidos*, the *ejidatarios*² perform different economic activities that can rely more or less on the availability of forestland to be put into agricultural production. Does the land-use practices affect inequality in payments redistribution? Who are the final beneficiaries? Studying the interaction between land-use practices and redistribution of the PSA-H within the *ejidos* allows us to understand how the program's objectives may have been appropriated by the *ejidos*. We explore this issue in a sub-region of Mexico's Yucatan state. Within the *ejido* different types of land users whose production activities rely more or less on clearing of the forest cover coexist. We show that inequality in payment allocation tends to be linked to the agro-economic profile of the *ejidatarios* with cattle ranchers being less prone to receive payments compared to subsistence and sedentary agriculture farmers. Therefore, past trajectories and the current dependence on clearing are the main determinants of the amount of payments received.

The next section presents the PSA-H and its targeting system and discusses payment repartition within the *ejidos*. Section 3 presents the Cono Sur of Yucatan and the methodology employed. Finally Section 4 presents the results of our empirical analysis regarding payment redistribution in the Cono Sur sampled *ejidos*.

2. The PSA-H in Mexico : targeting and distribution modalities.

The PSA-H is a federal scheme of payments for hydrological environmental services whose objective is to create a financial incentive to conserve the forest in over-exploited aquifers (Muñoz-Piña et al., 2008). Can it be considered as a compensation mechanism? This section discusses this interrogation from the conception of the PSA-H to its implementation at various scales and in

² Within the *ejido*, the membership is defined in regards to three statuses: *ejidatarios*, *posesionarios* and *avecindados*. Only *ejidatarios* have a voting right at the assembly. *Ejidatarios* and *posesionarios* have rights to parcelised land and a share of commons contrary to the *avecindados*. In our sample, most *ejidos* have been recently formed and there are very few *posesionarios* and no *avecindados*. For this reason, our sample is composed at 99% of *ejidatarios* and we use the term *ejidatarios* is used for all surveyed households.

particular within the *ejidos*³.

2.1. Targeting of the PSA-H

As highlighted by Shapiro-Garza (2013) and McAfee and Shapiro (2010), interactions with civil society and other stakeholders, such as NPA commissions, forced CONAFOR to consider multiple objectives. These interactions tended to hybridize the programme into a multiple objectives scheme targeting not only toward threatened forests but also marginal areas. Studying allocation rules of the program, one can distinguish three types of criteria: administrative, marginality and environmental priority. Sims et al. (2013) showed that, through adaptive management of the selection criteria, the PSA-H succeeded in combining both objectives. We here focus on environmental priority. We will show in the forthcoming section that, despite the hybridization, CONAFOR conceived the PSA-H as a compensation instrument to protect threatened forests.

According to CONAFOR's rules, the primary objective of the PSA-H and the PSA-CABSA is to "offer payments for environmental services generated by forest ecosystems"⁴ (CONAFOR, 2009). Rural development only appears as one of many objectives of Proarbol "through valorisation, conservation and sustainable exploitation of forest resources"⁵.

Every year, CONAFOR defines eligibility zones based on land-use change maps, advice and propositions from regional offices and a deforestation risk index. The eligibility zones are defined as "areas or forest ecosystems where the degradation process endangers biodiversity and environmental services"⁵ (CONAFOR, 2009). The deforestation risk index is computed by the *Instituto Nacional de Ecología y Cambio Climático* (Muñoz-Piña et al., 2008). It predicts, at the pixel-level, the risk of deforestation based on past deforestation trends, agro-ecological characteristics and socio-economic variables⁶. Figure 1 shows the evolution of eligibility zones between 2004 and 2012 which have been widely enlarged since 2003 and now cover about a quarter of the Mexican territory⁷.

Only eligible *ejidos* can apply for the scheme. Every year, CONAFOR receives new applications for the scheme and ranks these applications according to predefined ranking criteria. Because of

³ The beneficiaries of the PSA-H can be private landowners as well as communities, the first ones represented one third of the contracts signed in 2005 (Munoz-Pina et al., 2008, table1)

⁴ Translation by the authors

⁵ Translation by the authors

⁶ See Muñoz-Piña et al., (2008) for more details regarding the econometric analysis

⁷ Authors' calculations based on data provided by CONAFOR

budget constraints, only the highest ranked *ejidos* are accepted into the programme (Rolon et al., 2011). The deforestation risk index is also part of the ranking criteria together with other environmental indicators such as soil degradation, over-exploitation of aquifers or water availability, among others (CONAFOR, 2009). Beneficiaries commit to avoid land-use change for five years in the area of forest enrolled, and receive, in return yearly payments proportional to the area of forest enrolled.

Eventually, the amount of payments allocated per hectare of forest enrolled varies according to the deforestation risk index. Originally, the payments were set at the average income that could be obtained from one hectare of maize in order to reflect the opportunity costs of one hectare of forest (Muñoz-Piña et al., 2008). The payments were later diversified per type of forest and deforestation risk to capture OC heterogeneity. The amounts of payments are presented in Table 1.

The above elements tend to show that CONAFOR conceived the PSA-H as a compensation mechanism as it targets threatened forest and as the amount of payments are intended to reflect income loss attributable to conservation. As highlighted above, interactions with civil societies and other groups of interest forced CONAFOR to consider other conceptions of PES and integrate new objectives. This hybridization may be responsible for the low additionality observed in the early cohorts of beneficiaries (Muñoz-Piña et al., 2008; Muñoz Piña et al., 2011; Alix-Garcia et al., 2012). Nevertheless, Sims et al. (2013) highlight that, through adaptive management of the targeting criteria, the designers succeeded over time at combining both objectives.

Figure 1: Evolution of eligible areas (Source : Authors)



Table 1: Area of payments

	Forest type	Deforestation risk	Payment
Area 1	Bosque Mesofilo	Very high	1.100 Pesos per Ha (84 USD)
Area 2	Bosque Mesofilo	Low to high	700 Pesos per Ha (53 USD)
Area 3	Bosque de coníferas, selva subcaducifolia and bosque de encino	Very low to very high	550 Pesos per Ha (42 USD)
Area 4	Selva alta perennifolias	Very low to very high	382 Pesos per Ha (29 USD)

Note: Conversion in USD made using 2010 exchange rate (1USD = 13 Mexican pesos)

Source: CONAFOR, 2009

2.2. Appropriation of the PSA-H by the ejidos

In Mexico, 80% of the forests are owned by *ejidos* (Bray et al., 2003; Kaimowitz, 2005). This unique figure is the result of one century of agrarian reforms spanning from the Mexican revolution in the early 20th century to the second agrarian reforms, called PROCEDE, that took place during the 1990's (De Janvry et al., 2001; Muñoz-Piña et al., 2003). Within the *ejidos*, each *ejidatario* owns a private parcel, with complete or incomplete property rights and a share of the commons. In 1992, PROCEDE gave *ejidos* the opportunity to redefine their commons and obtain formal property rights. Although PROCEDE led to a vast privatization of lands, however most of the forest is formally owned as commons managed by the assembly.

As emphasized by Corbera et al. (2009), since the forest is owned as commons, PES does not directly remunerate households or individual landowners but rather *ejidos*. Once enrolled, the *ejido* can decide to redistribute the payments among its members, to invest in public goods (roads, school, new income generating activities etc...), or remunerate labor related to activities promoted by the program such as patrolling into the forest or building firebreak. This last use of PSA-H payments has been found in other Mexican States but, in our sample in Yucatan, excepting minor collective investment, all the payments were redistributed among the *ejidatarios*.

In Chiapas, multiple authors showed that participation and distribution of the payments within the community was not egalitarian and tended to reflect existing power relationships within the

community (Garcia et al., 2010; Hendrickson and Corbera, 2015). Our studies complete these results with an emphasis on the type of land-use and the logic of the distribution rules.

In order to understand how the ejidatarios share the payments, we need to clarify the internal negotiation process taking place. As explained above, the governance of the *ejido* relies mainly on the decisions made at the assembly of *ejidatarios* which are composed of families with different community-related historic backgrounds. Reaching an agreement at the assembly to enroll in the PSA-H does not necessarily mean that all *ejidatarios* choose to enroll in the programme. The assembly can agree to enroll part of the forest and decide that only the *ejidatarios* willing to participate are eligible to receive payments. On the contrary, non participants can ask to exclude another part of the common forests from the programme. If the per hectare amount of payment is constant within the same agro-ecological zone (Table1), the potential amount received per ejidatario will therefore depend on this negotiation process and vary from an *ejido* to another.

In the *Cono Sur* region of Yucatan, we observed three meaningful examples of the distribution rules which vary over time and between *ejidos* but are often a combination of these three examples. A first distribution rule consists in dividing all the payments equally among the ejidatarios. Here, remuneration is not directly linked to the dependence on forest clearing, some ejidatarios use the commons more than others. Nevertheless, since all of them have land-use rights and voting rights at the assembly, they receive equal payments. Another rule is to divide the payments, not equally among each member, but rather inversely proportional to the share of common forests they have cleared. Each ejidatario owns an equal share of commons and therefore an equal share of the common forest. This forest cover can be converted to agricultural fields or pasture for personal use with the permission of the assembly. The more the ejidatario has converted of his share of forest, the less PES remuneration he receives. A last example of a distribution rule involves sharing payments but only among a certain group of ejidatarios willing to participate. The ejidatarios that do not wish to join the programme are either those who were absent during the assemblies or those who want to keep their share of forest out of the programme. The latter, often cattle-ranchers, do not join either because they consider that payments are not high enough or because they feel that environmental programs threaten their activities.

The objective of CONAFOR was to target threatened forests and compensate the agents that deforest. However, this logic is not found in any these three allocation rules. In the next sections, we will further analyze the distribution of the payments within the *ejidos* in order to understand whether the internal distribution complies or conflicts with compensation logic.

3. Methods

3.1. Study area and survey methodology

The Cono-Sur is located at the south of Yucatan State between the states of Campeche and Quintana Roo and concentrates most of the PSA-H contracts of the State (Fig.2). The area has known several periods of large deforestation, especially during the late 1970's and 1980's. During this period, public policies such as PRONADE (a national clearance programme) offered subsidies to clear land and establish mechanised agriculture. Whilst deforestation slowed down in the 1990's with the end of PRONADE and, more generally, with the reduction of state supports to agriculture, it remains an important matter of concern. Cattle-ranching, and to a lesser extent traditional slash-and-burn agriculture, are the main sources of deforestation in the area.

Ejidors from the southern part of our study zone lack basic infrastructure such as roads, running water and electricity and have been partly deserted by the population. This has led to the formation of labor-*ejidos* where *ejidatarios* maintain economic activities but live in the nearest city. In our sample, about 45% of the households do not live in their *ejido*. The average size of an *ejido* in our sample is about 2,500 ha and the average number of *ejidatarios* is 75.

Figure 2: The Cono Sur of Yucatan



Our sample is composed of 47 *ejidos* receiving the PSA-H out of the 77 eligible *ejidos* in 2012. They constitute a quasi-exhaustive sample of all of the *Cono Sur*. At the *ejido* level, we conducted participatory surveys with the authorities and with *ejidatarios* willing to participate. The surveys explored land-use, household economic activities, governance, and infrastructure and PSA-H payment distribution, among other criteria.

The repartition of the 47 *ejidos* regarding the first year of reception of the PSA-H is presented in Table 2. Note that *ejidos* can cumulate PSA-H contracts by enrolling new forest areas and apply to enroll again the same area at the end of the five year contract. Yearly payments allocated to the *ejidos* vary from 3,500 to more than 93,000 Mexican pesos (300 USD to more than 7,000 USD). There are on average 44 *ejidatarios* in each *ejido* for a superficies of 2,350 ha. Common forests cover on average 64% of the *ejidos* and measures 1,600 ha.

Table 2: Number of *ejido* contracting PSA-H per year of first reception

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012
Nb <i>ejido</i>	1	6	0	20	2	7	4	6	1

At the household level, the sample size could not exceed 200 households and for logistical reasons it was impossible to conduct household surveys in all the *ejidos*. We randomly selected 25 beneficiary *ejidos* and checked the representativity of this sample regarding demography, PSA-H payments and economic activities. Surveying 200 households corresponded to 20% of the total number of *ejidatarios*, with a maximum limit of 15 households and a minimum limit of 5 households per *ejido*⁸. Once we excluded outliers and the households from non beneficiary *ejidos* that were not relevant for this study, our sample was composed of 163 households. The household survey allowed deeper investigation of land user profiles and reception of the PSA-H.

Among those 163 households, 151 declared that they had received payments from the PSA-H. The average households' size is 4.8 members. The household's head is on average 54 years old and 22% of them do not know writing and reading.

⁸ The number of *ejidatarios* varies widely and the results regarding the distribution of the PSA-H within the *ejidos* would have been biased by the decisions made by larger *ejidos*

Total payments received per ejidatario between 2005 and 2013 range from 3,000 to 180,000 Mexican pesos (230 to 13,850 USD). Most of this heterogeneity is explained by the fact that some *ejidos* have only received the programme for one year whilst others participated during the entire period of analysis. Nevertheless, if on average the *ejidatarios* received around 10,000 Mexican pesos (770 USD) per year of reception, this amount varies between 600 and 34,000 per *ejidatarios* (46 to 2,615 USD).

3.2 Land uses and distribution rules: hypothesis and descriptive statistics

3.2.1. Three land use practices

There are three main land use practices in the area, often combined by the *ejidatarios*:

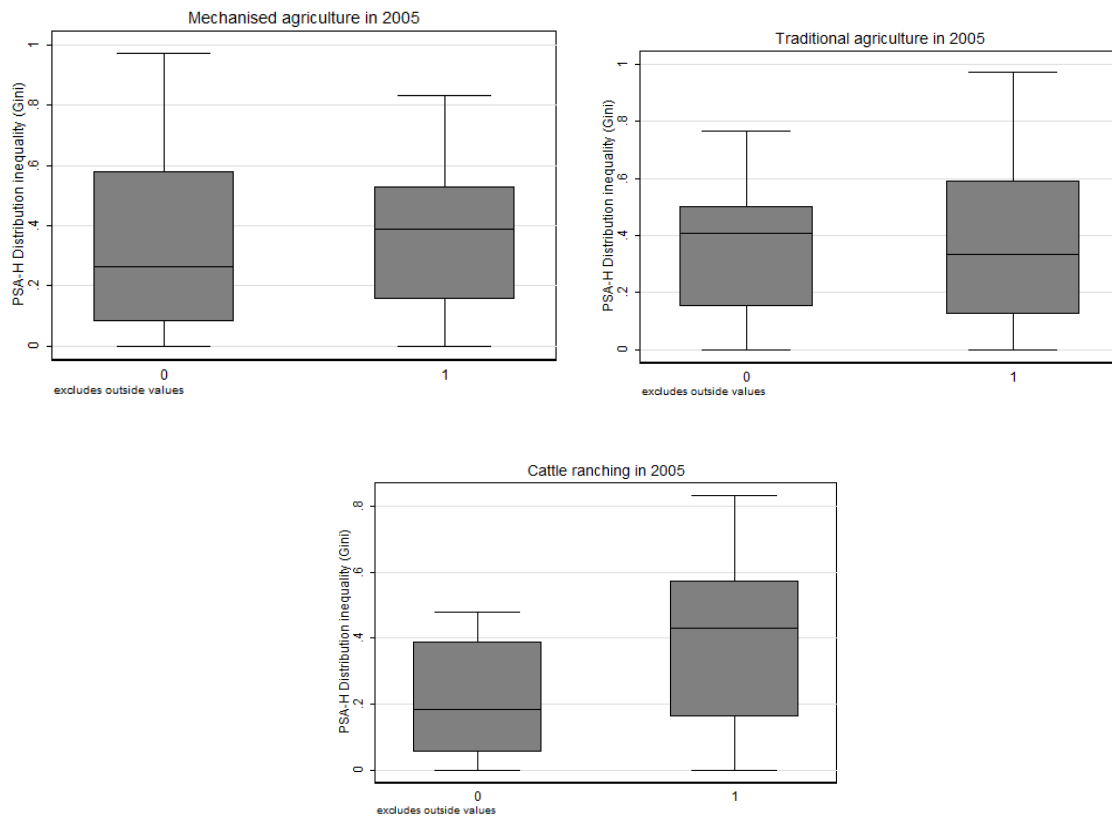
- Traditional slash-and-burn agriculture: Shifting cultivation of maize inter-cropped with beans is the traditional form of agriculture called *milpa*. In our sample, traditional producers cultivate 2 hectares on average. Producers shift parcels every two or three years and fallow periods last for 10 to 15 years. Yields that can be obtained from this activity remain low and vary according to the climatic conditions and the use of inputs (from 0.6 t/ha/year to 1 t/ha/year). Being poorly profitable, traditional agriculture tends to be abandoned or is maintained in combination with other activities such as cattle and off-farm activities. In our sample, 50 *ejidatarios* implemented milpa in 2005 and 47 in 2013.
- Mechanised agriculture: This form of intensive non-rotative agriculture developed in Cono Sur in the late 1970's with the implementation of PRONADE. The area under cultivation in our sample varies from 1 to 22 hectares. The yields that can be obtained are three to four times superior to those obtained by slash-and-burn if combined with an irrigation system. . In our sample, 81 *ejidatarios* engaged in this type of activity in 2005 and 85 in 2013.
- Cattle-ranching: The *Cono Sur* is also a traditional cattle-ranching area. In our sample, 30% of *ejidatarios* have at least one head of cattle but some of them only breed a few heads at home for savings or short-term profit. More than 20% of our sample have individual pastures or use common pasture and forest for grazing. In our sample, 29 *ejidatarios* engaged in cattle-ranching activities in 2005 and 41 in 2013.

These land uses yield heterogeneous returns and depends more or less on forest clearing. Although mechanized agriculture is the most profitable form of agriculture, cultivating new land requires high investment in land-leveling. Most producers cannot afford this investment and they are not directly dependent on the forest cover, at least in the short-run. Moreover, they mainly cultivate on individual parcels. On the opposite, traditional producers cultivate very small areas with moderate, it cannot be considered in our region as the main source of deforestation since this activity is decreasing since several decades (personal communication with Luis Arias and Luis Dzib). Moreover, as highlighted by Borrego and Skutsch (2014), if fallow period are long enough, this type of agriculture is likely to be sustainable. In Jalisco, the authors also showed that the highest return on clearing activities were obtained by cattle ranchers and that, land cleared for pasture is larger than for traditional agriculture. Cattle-ranchers also are the main agents that deforested in the past in *Cono Sur*. Therefore, in line with the objective of the PSA-H to target the agents that deforest, CONAFOR may be willing to target cattle-ranchers in order not to remunerate windfall effects and avoid deforestation. However the redistribution within the *ejido* may result in a completely different allocation.

3.2.2. Land uses and PES distribution: Descriptive statistics

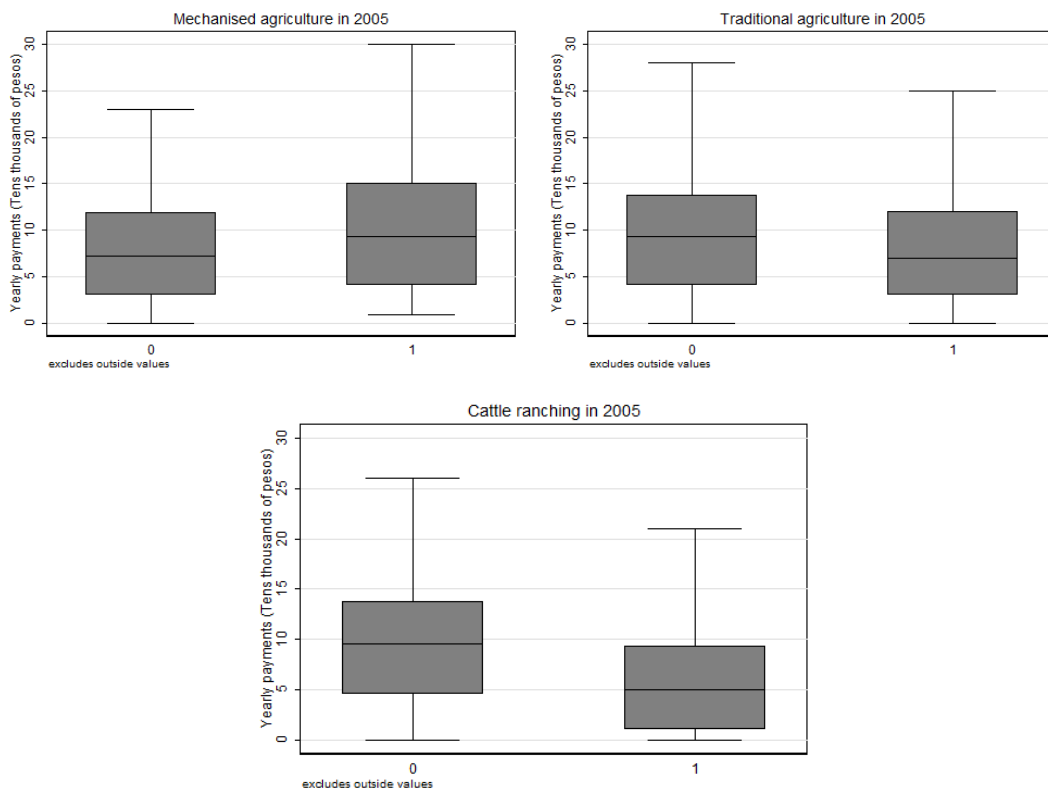
Figure 3 presents the distribution of the Gini coefficient of inequality for the distribution of payments in the 47 *ejidos* according to the presence of the three main land use practices in the *ejido*. Calculations of the Gini are based on the total amount of payments received by each *ejidatario* in the 47 *ejidos* that received payments between the beginning of the PSA-H and 2012. We note that the presence of cattle-ranching in the *ejido* tends to be associated with more unequal distribution. This pattern seems less marked with mechanized and traditional agriculture.

Figure 3: PSA-H distribution inequality and type of activities (ejidal level)



At the household-level, Figure 4 presents the yearly amount of payments received by the 163 ejidatario surveyed according to the three types of land use: mechanized agriculture, cattle-ranching and traditional slash-and-burn. The land use can be impacted by the PSA-H so we use activities in 2005, before PSA-H reception, to avoid endogeneity. Moreover, we use the average reception per year because the total amount is highly influenced by the year of entry of the *ejido*, making irrelevant the comparison between households of different *ejidos*. According to Figure 4, the *ejidatarios* who practiced mechanised agriculture tended to receive more payments, whilst *ejidatarios* who practiced cattle-ranching received less. This is probably due to the fact that mechanized producers were able to conserve larger areas of forests over the years contrary to cattle ranchers.

Figure 4: PSA-H yearly payments and type of activities (household level)



Note that the amount of payments received by the *ejidatarios* depends on the amount received by their *ejido*. In order to analyze the distribution of the payments, it is crucial to compare the amount of payments received by one *ejidatario*, not with the amount received by the entire sample, but by the other *ejidatarios* living in the same *ejido*. In the econometric analysis presented in the following section, we use a panel structure to capture between-*ejido* heterogeneity and focus on within-*ejido* heterogeneity.

3.3. Model

This section proposes an empirical analysis of the repartition of payments within the *ejido*. The first section of this econometric analysis investigates the determinants of inequality in payment distribution at the *ejido*-level. The second section explores the determinants of the yearly amount of payments received by one *ejidatario* compared to its peer.

3.3.1. Distribution inequality among beneficiary ejidos

We explore the determinants of inequality of payment distribution within the *ejidos*. We estimate an OLS model with the Gini index of payment distribution between 2003 and 2012 as our explained variable. Our hypothesis is that inequality in distribution is directly linked to land-use heterogeneity within the *ejido*. Given that the Gini index range from 0 to 1, we use an arc-sinus functional form (Chen, 1990) and estimates the following model:

$$\arcsin(\sqrt{Gini_j}) = \alpha + \beta L_j + \gamma X_j + \varepsilon_j \quad (1)$$

In equation 1, L_j corresponds to the different land use in *ejido j* as presented in Section 4.2.1. We use the 2005 level of each variable in order to avoid endogeneity. In a first step, we consider dummy variables if mechanised agriculture (*mec05_ejid*), traditional agriculture (*trad05_ejid*) and cattle-ranching (*ranch05_ejid*) are implemented in the *ejido*. In a second step, we introduce the percentage of ejidatarios implementing each activity (*per_mec05*, *per_trad05* and *per_ranch05*). X_j includes control variables likely to influence inequality such as number of ejidatarios, average participation to the assembly, area of forests in hectare and percentage of total common lands in the *ejido*. We also include a dummy variable for labour-*ejido* defined as the *ejido* with less than 20 inhabitants.

3.3.2. Within ejido heterogeneity: payments at the household level

Our hypothesis is that PES distribution tends more to reflect past trajectories than to compensate foregone benefits. We test this hypothesis using a panel. The panel is structured with two dimensions: *ejido* and households. The panel estimation allows us to capture between-*ejido* heterogeneity and focus on within-*ejido* heterogeneity, i.e. the difference of payments received by one ejidatario compared with other ejidatarios from the same *ejido*. We test the impact of the type of land use implemented by the ejidatario before PSA-H implementation on the amount of PSA-H received.

We estimate the following models with fixed effects (2):

$$psahyear_{ij} = \alpha + \beta L_{ij} + \gamma X_{ij} + \eta D_j + \varepsilon_{ij} \quad (2)$$

In equations 2, $psahyear_{ij}$ corresponds to the average yearly amount of payments received by ejidatario i in *ejido j* during one year of reception. Some ejidatarios joined the programme several

years after the others programme either due to absence from the *ejido* or a reluctance to participate at the program's onset. For this reason, we chose to use average yearly payments rather than total payments.

As in estimation (1), we use the level of the variables in 2005 in order to avoid endogeneity. Three of these variables are linked to land-use: (*mec05_hh_{ij}*), (*trad05_hh_{ij}*) and (*ranch05_hh_{ij}*) respectively for mechanised agriculture, traditional slash-and-burn and cattle ranching. We consider as cattle ranchers only households using either pasture or common land for grazing. We also include one dummy variable to control for permanent off-farm activity. X_{ij} include control variables such as the size of the household and a measure of the assets computed using principal component analysis. Eventually, we include a dummy variable equals to one if the ejidatario is a member of the *ejido* authorities, a producer organization and the average percentage of assemblies in which he participated.

4. Results

4.1. At the *ejido* level

Table 3 presents the results for the estimation of equation 1 on the sample of the 47 beneficiary *ejidos*. Column (1) presents the results of the estimation with only the control variables. Column (2) adds dummy variables for each activity and column (3) percentage of *ejidatarios* implementing each activity. Comparing the R-squared of column (1) with columns (2) and (3), we note that considering the type of land-use in the estimation adds to the explanatory power of the model.

As suggested by the box-plots presented in Figure 3, the presence of cattle ranching seems to increase distribution inequality. According to the results of column (3), the more cattle ranchers there are in the *ejido*, the more unequal is the distribution. Our results also suggest the opposite results for mechanised agriculture. The more *ejidatarios* with mechanised plots, the less unequal is the distribution. Our results also suggest that the distribution has been more equal in the *ejidos* with higher participation rate at the assembly.

This result suggests that inequality in payment distribution is linked to the agricultural profile of the *ejido*. As a matter of fact, whilst *ejidos* relying on mechanised agriculture tend to have more equal

rules of allocation, the *ejidos* involved in cattle ranching have more heterogeneity in individual payments. Nevertheless, these results do not tell us who benefits more from the programme. In the next section, we study the amount received by each *ejidatario* according to their land use.

4.2. At the household level

Table 4 presents the results of the econometric analysis regarding distribution of the payments using the sample of the 163 recipient households. Columns (1) present the results of the estimation of the model presented in equations 2. The coefficient estimates for our three main variables of interest, *mec05_hh*, *trad05_hh* and *ranch05_hh*, are all significant. The main beneficiaries were the *ejidatarios* who engaged in mechanized activities and traditional agriculture. Producers with cattle-ranching activities received less payment than others.

Our results are robust in many settings. Column (2) excludes from the sample the *ejidatarios* that decided to remain outside of the programme. Columns (3) and (4) displays the results using the total amount of payments received rather than average yearly payments respectively with the whole sample and excluding the ones that decided to remain outside of the programme. Our variables of interest remain significant in all specifications, which confirm the robustness of our results.

5. Discussion and conclusion

This article explores the distribution at the community and household levels of the PSA-H, a Mexican PES created in year 2003. CONAFOR tried to design the PSA-H as a compensation instrument by targeting threatened forest. However, since most of the Mexican forests are commons, PES payments are allocated to communities called *ejidos*, and the assembly of each *ejido* divides payments among the *ejidatarios* according to their own rules and perception of fairness. Based on *ejido* and household surveys in a sub-region of Yucatan State, we explore the interaction between the land-use practices and internal payment redistribution. In our study area, cattle ranchers are the agents that deforested more common forests in the past, they are the main agents to target in order to achieve additionality.

Table 3: Inequality in payments distribution at *ejido-level*

VARIABLES	(1) gini	(2) gini	(3) gini
mec05_ejid		-0.1939* (0.1071)	
trad05_ejid		0.0104 (0.0978)	
ranch05_ejid		0.2681** (0.1010)	
per_mec05			-0.2441 (0.1716)
per_trad05			-0.0934 (0.1521)
per_ranch05			0.4995** (0.1868)
Ejidatarios	-0.0013 (0.0011)	-0.0022* (0.0012)	-0.0012 (0.0011)
Forest 2005 (Ha)	0.0001 (0.0001)	0.0001* (0.0001)	0.0001 (0.0001)
Assembly participation	-0.5919** (0.2567)	-0.5394* (0.2686)	-0.6193** (0.2553)
% Commons	-0.2874** (0.1186)	-0.3623*** (0.1247)	-0.3113** (0.1284)
Labour-ejido	-0.1049 (0.0967)	-0.0915 (0.1102)	-0.1229 (0.1057)
Constant	1.1671*** (0.2066)	1.0701*** (0.2207)	1.1833*** (0.2195)
Observations	47	47	47
R-squared	0.2454	0.2970	0.3119

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4: Distribution of the payments within *ejidos*

VARIABLES	(1) psahyr	(2) psahyr	(3) psahtot	(4) psahtot
mec05_hh	3.5699** (1.4728)	2.9309** (1.2990)	14.3650* (8.0749)	12.4988 (8.3852)
trad05_hh	2.8864** (1.0915)	3.0168** (1.2050)	15.0109** (6.5327)	16.1110** (7.3033)
ranch05_hh	-1.6087** (0.6782)	-1.7637** (0.7243)	-6.7567* (3.8242)	-7.4813* (3.8947)
Off-farm in 2005	1.0509 (1.0027)	0.4371 (0.9260)	7.3072 (4.6444)	5.2664 (4.8150)
Household size in 2005	-0.0300 (0.1903)	0.1195 (0.1614)	-0.1383 (1.0875)	0.6230 (1.0567)
Asset index in 2005	1.4733 (3.0285)	2.0509 (2.0526)	9.6924 (15.6316)	17.0019 (12.4851)
Assembly participation	1.6631 (1.8753)	-0.9907 (1.2386)	7.2754 (6.6840)	-5.4178 (5.6671)
Ejido's authorities	1.6577 (1.1905)	0.5970 (0.8219)	5.4999 (5.8846)	-0.3387 (4.6936)
Producer organization	-0.0804 (0.7211)	0.1860 (0.6813)	2.6979 (5.0268)	4.4169 (5.1885)
Constant	5.5486*** (1.6327)	7.6583*** (1.6221)	26.3508** (9.6076)	34.5779*** (10.7311)
Observations	163	151	163	151
R-squared	0.1872	0.1705	0.1378	0.1379
Number of fixed effects	23	23	23	23

We estimate the impact of land use type on both the Gini coefficient of distribution at the *ejido*-level and the yearly payment amount received by each *ejidatario* at the household-level. Our econometric results suggest that the more prevalent cattle ranching is in the *ejido*, the more unequal the distribution tends to be. Moreover, within the same *ejido*, the *ejidatarios* that conserved the forest in the past receive higher payments whilst the cattle-ranchers, receive less remuneration than their peer-*ejidatarios*. Most payments are allocated to the agents that obtain a lower part of their income by exploiting the common forests. Cattle ranchers receive less payment either because they decided to remain outside of the program or because they already cleared their share of commons. The final allocation of the PSA-H reflects mainly past trajectories and the agents that deforested in the past tend to receive fewer payments.

This study highlights the difficulty to involve the land users willing to deforest in the process, especially within common lands. In our study, cattle ranchers may have remained outside simply because they cleared most of their share of commons or because they considered that payments were too low. It is also very likely that they currently regard environmental programs as a threat more than as an opportunity.

PES schemes as compensation mechanisms are exceptions to the polluter-pays principle (Pirard et al. 2010). The idea that payments should be directed to the agents that deforest is far from being appropriated by forest owners or all intermediaries involved from the federal-level to the *ejidos*. The *ejidos* may have reinterpreted the program's objectives according to their own conception of fairness and consider that the program is primarily targeted toward the agents that already conserve the forest as a reward for greener behavior (Pascual et al., 2010). This would explain why cattle-ranchers are excluded from the process.

Once confronted with reality, PES can result in unexpected outcome and our study confirms the difficulty to design a national PES scheme targeted toward the agents that deforest. When dealing with commons, it seems ethically impossible to compensate income loss within a community without rewarding those already conserving the forest. It may not be a problem if, on the long-run, PES impulses a change of behavior by the agents that deforest. Nevertheless, more effort is needed to include the forest users in a process that they currently regard as a threat to their activity.

References

- Adger, W. N., Brown, K., Fairbrass, J., Jordan, A., Paavola, J., Rosendo, S., and Seyfang, G. (2003). Governance for sustainability: towards a thick analysis of environmental decision making. *Environment and Planning*, 35(6):1095–1110.
- Alix-Garcia, J. M., Shapiro, E. N., and Sims, K. R. (2012). Forest conservation and slippage: Evidence from Mexico's national payments for ecosystem services program. *Land Economics*, 88(4):613–638.
- Borrego, A. and Skutsch, M. (2014). Estimating the opportunity costs of activities that cause degradation in tropical dry forest: Implications for REDD+. *Ecological Economics*, 101:1–9.
- Bray, D. B., Merino-Pérez, L., Negreros-Castillo, P., Segura-Warnholtz, G., Torres-Rojo, J. M., and Vester, H. F. M. (2003). Mexico's community-managed forests as a global model for sustainable landscapes. *Conservation Biology*, 17(3):672–677.
- Brimont, L., & Karsenty, A. (2015). Between incentives and coercion: the thwarted implementation of PES schemes in Madagascar's dense forests. *Ecosystem Services*. In press
- Chen, H. (1990). The accuracy of approximate intervals for a binomial parameter. *Journal of the American Statistical Association*, 85(410), 514–518.
- CONAFOR (2009). Reglas de operacion del programa proarbol 2010. Technical report, Diario oficial 31 de Diciembre de 2009.
- Corbera, E., Brown, K., and Adger, W. N. (2007). The equity and legitimacy of markets for ecosystem services. *Development and change*, 38(4):587–613.
- Corbera, E., González Soberanis, C., and Brown, K. (2009). Institutional dimensions of payments for ecosystem services: An analysis of Mexico's carbon forestry programme. *Ecological Economics*, 68(3):743 – 761.
- De Janvry, A., Dutilly, C., Muñoz-Piña, C., and Sadoulet, E. (2001). Liberal reforms and community responses in Mexico. In Aoki, M. and Hayami, Y., editors, *Communities and Markets in Economic Development*. Oxford University Press.
- Engel, S., Pagiola, S., and Wunder, S. (2008). Designing payments for environmental services in theory and practice: An overview of the issues. *Ecological economics*, 65(4):663–674.
- García-Amado, L. R., Ruiz Pérez, M., Reyes Escutia, F., Barrasa García, S., and Contreras Mejía, E. (2011). Efficiency of payments for environmental services: Equity and additionality in a case study from a biosphere reserve in Chiapas, Mexico. *Ecological Economics*, 70(12):2361 – 2368.
- Hendrickson, C. Y. and Corbera, E. (2015). Participation dynamics and institutional change in the Scolel Té carbon forestry project, Chiapas, Mexico. *Geoforum*, 59:63–72.
- Kaimowitz, T. (2005). Mexico: Market options and barriers for timber and sawnwood from Michoacan, Oaxaca, Guerrero, Campeche and Quintana Roo. a summary. Technical report, Forest Trends.
- McAfee, K. and Shapiro, E. N. (2010). Payments for ecosystem services in Mexico: Nature, neoliberalism, social movements, and the state. *Annals of the Association of American Geographers*, 100(3):579–599.

- Muñoz-Piña, C., Guevara, A., Torres, J. M., and Braña, J. (2008). Paying for the hydrological services of Mexico's forests: Analysis, negotiations and results. *Ecological Economics*, 65(4):725–736.
- Muñoz Piña, C., Rivera, M., Cisneros, A., García, H., et al. (2011). Payment for environmental services in Mexico: Targeting challenges. *Revista Española de Estudios Agrosociales y Pesqueros*.
- Muñoz-Piña, C., Janvry, A. d., and Sadoulet, E. (2003). Recrafting rights over common property resources in Mexico. *Economic Development and Cultural Change*, 52(1):pp. 129–158.
- Muradian, R., Arsel, M., Pellegrini, L., Adaman, F., Aguilar, B., Agarwal, B., Corbera, E., Ezzine de Blas, D., Farley, J., Froger, G., et al. (2013). Payments for ecosystem services and the fatal attraction of win-win solutions. *Conservation Letters*, 6(4):274–279.
- Muradian, R., Corbera, E., Pascual, U., Kosoy, N., and May, P. H. (2010). Reconciling theory and practice: An alternative conceptual framework for understanding payments for environmental services. *Ecological Economics*, 69(6):1202–1208.
- Pascual, U., Muradian, R., Rodríguez, L. C., and Duraiappah, A. (2010). Exploring the links between equity and efficiency in payments for environmental services: A conceptual approach. *Ecological Economics*, 69(6):1237–1244.
- Pascual, U., Phelps, J., Garmendia, E., Brown, K., Corbera, E., Martin, A., Gomez-Baggethun, E., and Muradian, R. (2014). Social equity matters in payments for ecosystem services. *BioScience*, page biu146.
- Pirard, R., Billé, R., and Sembrés, T. (2010). Questioning the theory of payments for ecosystem services in light of emerging experience and plausible developments. Technical report, IDDRI Analyses n° 4/10.
- Rolon, E., Salas, I., and Islas, I. (2011). The Mexican pes programme: targeting for higher efficiency in environmental protection and poverty alleviation. In B. Rapidel, F. D., LeCoq, J. F., and Beer, J., editors, *Ecosystem Services from Agriculture and Agroforestry: Measurement and Payment*. Routledge.
- Shapiro-Garza, E. (2013). Contesting the market-based nature of Mexico's national payments for ecosystem services programs: Four sites of articulation and hybridization. *Geoforum*.
- Sims, K. R., Alix-Garcia, J. M., Shapiro-Garza, E., FINE, L., Radeloff, V. C., Aronson, G., Castillo, S., Ramirez-Reyes, C., and Yanez-Pagans, P. (2013). Adaptive management in Mexico's payments for hydrological services program improves targeting for environmental and social goals. Technical report, Working paper, Amherst College.
- Vatn, A. (2010). An institutional analysis of payments for environmental services. *Ecological Economics*, 69(6):1245–1252.
- Vatn, A. (2014). Markets in environmental governance: from theory to practice. *Ecological Economics*, 105:97–105.
- Wunder, S. (2005). *Payments for environmental services: some nuts and bolts*, volume 42. CIFOR Jakarta.
- Wunder, S. (2007). The efficiency of payments for environmental services in tropical conservation. *Conservation biology*, 21(1):48–58.

Wunder, S. (2015). Revisiting the concept of payments for environmental services. *Ecological Economics*. In press.

Appendix

Table 5. Variables description at *ejido*-level

Variable	Description
mec05_ejid	Presence of mechanised agriculture in the <i>ejido</i> in 2005 (Dummy variable)
trad05_ejid	Presence of traditional agriculture in the <i>ejido</i> in 2005 (Dummy variable)
ranch05_ejid	Presence of cattle-ranching in the <i>ejido</i> in 2005 (Dummy variable)
per_trad05	Percentage of <i>ejidatarios</i> with traditional agriculture in the <i>ejido</i> in 2005
per_mec05	Percentage of <i>ejidatarios</i> with mechanised agriculture in the <i>ejido</i> in 2005
per_ranch05	Percentage of <i>ejidatarios</i> with cattle ranching in the <i>ejido</i> in 2005
Ejidatarios	Number of <i>ejidatarios</i>
Forest 2005	Total superficies of forests in the <i>ejido</i> in 2005
Assembly participation	Average participation rate at the assembly
% Commons	Percentage of common land within the <i>ejido</i>
Labour- <i>ejido</i>	Labour- <i>ejido</i> (dummy variable)

Table 6. Variables description at household-level

Variable	Description
mec05_hh	<i>Ejidatarios</i> with mechanised agriculture in 2005 (Dummy variable)
trad05_hh	<i>Ejidatarios</i> with traditional agriculture in 2005 (Dummy variable)
ranch05_hh	<i>Ejidatarios</i> with cattle ranching in 2005 (Dummy variable)
Off-farm in 2005	<i>Ejidatarios</i> with permanent off-farm activities in 2005 (Dummy variable)
Asset index in 2005	Size of the household in 2005
Asset index in 2005	Assets of the household in 2005
<i>Ejido</i> 's authorities	Involvement in the <i>ejidos</i> ' authorities (Dummy variable)
Producer organization	Involvement in a producer organization (Dummy variable)