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WORKING PAPER

A TALE OF REDD+ PROJECTS.

HOW DO LOCATION AND CERTIFICATION IMPACT ADDITIONALITY?

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Since the emergence of the REDD+ mechanism, hundreds of projects have emerged around the globe. Much attention has been given to REDD+ projects in the literature, but the conditions under which they are likely to be efficient are still not well known.
In this article, we study how the location of REDD+ projects is chosen and how those location choices influence project additionality. Based on a sample of six REDD+ projects in Brazil, we propose an empirical analysis of the location choices and estimate additionality in the first years of implementation using impact evaluation techniques.
In order to explain the heterogeneity of the empirical results, we present a simple theoretical model and show that project location is strongly influenced by the type of project proponent, which appears to be a good proxy for its objectives, whether oriented toward environmental impacts, development impacts, or external funding.
Our results suggest that (1) the incentives behind REDD+ certification mechanisms can lead to low environmental efforts or an investment in areas that are not additional, (2) location biases are dependent on the REDD+ project manager's type, and (3) the existence of a location bias does not necessarily preclude additionality.

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1 Introduction

REDD+ is an international mechanism aimed at compensating developing countries for their participation in the global effort to mitigate climate change through the reduction of deforestation and forest degradation, as well as the conservation and enhancement of their forest carbon stocks.

At the local level, REDD+ has resulted in hundreds of REDD+ projects. Some of these projects are financed through the sale of carbon credits, which are assumed to remunerate their additionality. The additionality of forest conservation projects can be defined as the avoided deforestation attributable to the project (Engel et al., 2008; Wunder, 2015). It is based on a comparison between the actual deforestation in the area under conservation and a hypothetical counter factual situation without project implementation. As explained by Persson and Alpízar (2013), additionality is determined by the share of area enrolled that would not meet program requirements, e.g., forest conservation, without program implementation.

In this article, we explore the mechanisms that can lead to the additionality of REDD+ projects. Using both an empirical and a theoretical analysis, we build a theory of change (Baylis et al., 2016) based on the choice of a location, the type of certification scheme and the additionality of REDD+ projects.

First, we empirically study the characteristics of six REDD+ projects located in Brazil, using an original database, and estimate their additionality in the short-run using impact evaluation methodologies as recommended in the recent literature about forest conservation policy instruments (Miteva et al., 2012; Baylis et al., 2016; Le Velly and Dutilly, 2016). The six projects studied are heterogeneous regarding the type of project proponents and the choice of a certification scheme. We consider two types of actors: Non-Governmental Organizations (NGOs) and private-for-profit organizations; and two types of standards for certification: the Verified Carbon Standard (VCS), which focuses on the carbon dimension of the projects, and the Climate, Communities and Biodiversity (CCB) Alliance standard, which addresses the non-carbon impacts of the projects. Our results show that the choice of location and additionality are highly heterogeneous from one project to another and are likely to be influenced by the type of project proponent and the choice of a certification scheme. Moreover, we show that proponents who choose to target areas that are structurally threatened by deforestation may fail to achieve additionality, while the ones who favor less endangered forests may implement additional projects.

In order to explain our empirical results we develop a simple theoretical model to study the decisions of project proponents. Our theoretical results show that project proponents face a trade-off between targeting more threatened forests, as well as an efficient allocation of scarce resources. In some cases, given the uncertainty of the baseline that generates carbon credits through certification, it can be optimal for the project proponent to implement a project in a location that generates very low additionality in order to maximize funds from the carbon markets. Moreover, the theoretical model also shows that conjointly pursuing social and environmental objectives could lead to lower additionality.

In Section 2, the REDD+ mechanism and the different certification standards are presented. Sections 3 and 4 respectively, present our empirical analysis and the theoretical model. Section 5 concludes and proposes recommendations for the implementation of REDD+ projects.

2 Context

2.1 The REDD+ mechanism

Annual emissions from tropical deforestation and degradation are estimated at around 7-14 percent of global carbon dioxide (CO2) emissions (Harris et al., 2012; Grace et al., 2014; Le Quéré et al., 2015), making tropical forests a key issue for global climate change mitigation. Over the last two decades, tropical forests gradually became a central element of the United Nations Framework Convention on Climate Change (UNFCCC) strategy for climate change mitigation. Afforestation and reforestation projects were included in the Clean Development Mechanism (CDM) of the Kyoto Protocol signed in 1997 and a mechanism aimed at Reducing Emissions from Deforestation and forest Degradation, known as RED, was established during the 11th Conference of the Parties (COP) that took place in Montreal in 2005. The core idea of this mechanism was to offer financial rewards to developing countries in exchange for emissions reductions achieved through decreased deforestation. The mechanism was later expanded to include provisions addressing forest degradation, along with conservation, the sustainable management of forests, and the enhancement of forest carbon stocks, and renamed REDD+ accordingly. The Paris Agreement, which entered into force in November 2016, recognizes the role of forests as carbon sinks and emphasizes, in its Article 5, the necessity for implementing REDD+. Article 4 of the Paris Agreement requires that UNFCCC Parties prepare Nationally Determined Contributions (NDCs) that detail their national mitigation strategy to contribute to the global objective of keeping global temperature rise below 2.0-1.5°C above pre-industrial levels. A majority of tropical countries have included forestry, land use, and land-use change in their NDCs (Richards et al., 2015).

Although REDD+ was initially proposed as a national mechanism, pilot activities were encouraged during COP 13 in Bali (Pistorius, 2012). As of September 2016, over 300 REDD+ projects were being implemented across the tropics (Simonet et al., 2016). Among the various sources of funding used by REDD+ projects proponents, 69 percent of the projects plan to sell carbon credits (Simonet et al., 2015). In 2015, REDD+ projects (including tree-planting and improved forest management) generated 18 percent (or 15 megatons of CO2 equivalent) of the total volume of offsets transacted in the voluntary carbon markets (Hamrick and Goldstein, 2016).

Since its creation in 2005, the REDD+ mechanism has generated much academic debate. On the one hand, REDD+ has been presented as a promising tool, capable of channeling substantial funding to forest conservation, notably through carbon markets, and of delivering multiple benefits, by combining climate change mitigation, biodiversity conservation and poverty alleviation. On the other hand, REDD+ has raised considerable criticism, in particular as regards its environmental and social impacts. The environmental effectiveness of the mechanism has been questioned for several reasons. Among those critics, the additionality of REDD+ projects, which corresponds to the environmental benefits that would not have happened without a project, have especially been questioned, notably due to the difficulty in establishing accurate baseline scenarios of future deforestation (Seyller et al., 2016). In addition to this environmental issue, concern has been expressed by many academics and organizations defending human rights about the potential negative social impacts of REDD+ (Lund et al., 2017), which is feared to generate, among others, tenure conflicts, displacements of people for conservation reasons or 'green-grabbing', which is defined as the "the appropriation of land and resources for environmental ends" (Fairhead et al., 2012).

2.2 Certification standards

To prevent the potential negative environmental and social impacts of REDD+, the UNFCCC Cancun Agreement established seven safeguards (Decision 1, CP.16). In the voluntary carbon markets, although there is no legal authority which controls and certifies carbon credits, several certification schemes emerged as an answer to the fear expressed by buyers that REDD+ carbon credits could be associated with a lack of additionality or negative social impacts (Seyller et al., 2016). In 2014, half of REDD+ projects were certified by one of the standards of the voluntary market (Simonet et al., 2015). Data provided by Simonet et al. (2016) indicates that 40 percent of REDD+ projects certified or in the process of certification are using the Verified Carbon Standard (VCS), which is the most commonly used voluntary market standards (Hamrick and Goldstein, 2016). The VCS validates carbon monitoring methodologies proposed by project proponents and applies the same methodological principles as the CDM. Project proponents seeking VCS certification must submit a Project Design Document hat describes the methodology used to estimate the emissions reductions or carbon sequestration generated by the project.

To answer buyers' concerns regarding the potential negative impacts of REDD+ projects on biodiversity or local people, projects proponents often combine the VCS certification with a certification by the Climate, Community and Biodiversity (CCB) Alliance standard, which focuses on the non-carbon benefits of the projects. Goldstein (2015) reports than three-quarters of the VCS forestry credits transacted in 2014 were also certified by the CCB.

Under the umbrella of REDD+ projects, a vast heterogeneity of projects can be found, notably in terms of project type, location, proponents or funding sources (Simonet et al., 2015). Given this heterogeneity among projects, it seems crucial when questioning the additionality of REDD+ projects to wonder, not only if REDD+ projects generate additionality, but which types of projects in particular generate additionality.

Some authors already highlighted the link between the national REDD+ strategy and the type of REDD+ projects implemented in a country, and its position on the forest transition curve (Angelsen and Rudel, 2013; Simonet and Wolfersberger, 2013). Others showed that the location of REDD+ projects can be explained by the presence of protected areas (Lin et al., 2012), as well as the baseline CO2 emissions, the forest carbon stock, the number of threatened species, the quality of governance and the region, with a bias toward Latin America (Cerbu et al., 2011).

Other less explored sources of heterogeneity are the type of project proponent and the certification scheme adopted. Regarding project proponents, the large majority of REDD+ projects is implemented by the private sector, either by non-for-profit organizations such as NGOs that see REDD+ projects as a new source of financing for forest conservation projects, or by for-profit carbon companies that seek to start capital-generating projects focused on carbon. Public sector and research institutes represent less than 20 percent of the proponents (Simonet et al., 2015). The certification process is also very heterogeneous as some certification schemes address only carbon issues and others rather focus on the social and biodiversity impacts of the projects.

In the rest of the paper, we focus on projects of avoided deforestation, which represent around half of REDD+ projects worldwide (Simonet et al., 2015).

3 Empirical analysis

In order to study how the type of project proponent and the choice of a certificate scheme can influence the choice of location and the additionality of REDD projects, we study a sample of six REDD projects in Brazil.

3.1 Data and methods

3.1.1 Sample of REDD Projects in Brazil

Brazil is a key player in the field of deforestation, with deforestation generating 44 percent of the total greenhouse gases emissions (GHG) of the country (in 2012, according to data from the World Resource Institute) and because of the significant shift observed in its deforestation since 2004. Indeed, the annual deforestation rate in Brazil fell by 70 percent between 2005 and 2013 due to the implementation of command-and-control measures, the expansion of protected areas, and interventions in the soy and beef supply chains, such as the Soy Moratorium established in 2006 (Nepstad et al., 2014). In 2009, Brazil received about one billion of USD to implement REDD+ projects, mainly by Norway, through the Amazon Fund. This fund makes Brazil the main recipient of REDD+ funding (Silva-Chavez et al., 2015).

Simonet et al. (2016) built an international database of REDD+ projects around the world. This database is available on-line [1] and contains 454 projects located in 56 countries. As of August

[1] http://www.reddprojectsdatabase.org/

2018, the database included information about 59 projects in Brazil, of which 30 are ongoing projects of avoided deforestation (REDD). However, a vast majority of these projects were not certified. Given the scope of this article, we focus on projects that relied, or will soon rely, on funding coming from the voluntary carbon markets. Therefore, we choose to focus on projects that already obtained the VCS and/or the CCB certifications. Moreover, we choose to focus on conservation projects instead of reforestation ones for two reasons. First, it is easier to monitor deforestation than reforestation using satellite images. Second, reforestation projects are smaller, making georeferencing complicated if not impossible. Eventually, we exclude projects that are partially overlapping with protected areas in order not to bias the estimates of additionality.

Our sample is composed of 6 REDD projects that cover around 1.6 millions hectares of forests. We hypothesize that the projects that are promoted by private-for-profit organizations tend to rely more financially on the voluntary market. In line with the theoretical model presented in section 3, the income obtained from the projects is a strong objective for these actors compared to NGOs. Qualitative evidence collected during the construction of the ID-RECCO database showed us that NGOs rely only partially on the carbon market. As a matter of fact, most NGOs already existed and relied on other sources of funding before selling carbon credits, while many private-for-profit organizations emerged for the purpose of selling carbon credits. This hypothesis is supported by the fact that, according to the database, selling carbon credits appears as an objective of the project in around 50% of the REDD projects implemented by private for-profit organizations, against 36% for NGOs.

Our sample of projects is composed of three groups, detailed in Table 1. All the projects obtained VCS certification but only four of them obtained CCB certification. The two projects that did not obtain CCB certification are implemented by private for-profit proponents. Two projects are implemented by NGOs and they all obtained both CCB and VCS certifications. In the analysis, we hypothesize that the projects with both certifications have higher preferences for social benefits given that they obtained both certification.

3.1.2 Data

We georeferenced each project using the Project Design Documents (PDD) that the proponents of the projects must elaborate in order to obtain the certification. The PDDs include a map of

Table 1: List of projects

Certification	Actors	Variable	Number of projects
VCS only	Private for-profit	$VCS^{Pri} = 1$	2
CCB and VCS	Private for-profit	$CCB^{Pri} = 1$	2
CCB and VCS	NGO's	$CCB^{Ngos} = 1$	2

the projects in PDF format that can be projected using a GIS software but lacks of geographic coordinates. In order to correctly locate each project, we use shape files mapping waters, urban areas and roads, provided on-line by the *Instituto Brasileiro de Geografia e Estatistica* (IBGE) and Digital Chart of the World, and the shape file of protected areas provided by the International Union for Conservation of Nature (IUCN). We overlap each image extracted from the PDD with some of these geographic features to locate the six projects. Once the projects are located, we draw the polygons that correspond to each project. We use this methodology for the six REDD projects. We build polygons that measure on average 103% of the project areas declared by project proponents in the PDDs. This ratio is heterogeneous but for all six projects, the difference between computed and declared areas is lower than 15%. For this reason, we are confident that we successfully georeferenced the six REDD projects.

In order to build a database, we use a similar procedure as Le Velly et al. (2017), combining conservation policies, gridding and forest cover. We use a gridding of 5 km x 5 km so that each cell measures 2,500 hectares. We intersect this grid with the forest cover in 2005 at the beginning of our period analysis using PRODES data and create a new shape file of forested cells. Regarding forest cover and deforestation, we use data provided by PRODES[2]. PRODES is a national program that provides geographic data about deforestation and forest cover in the Legal Amazon between 2006 and 2014, based on LandSat images of 20 to 30 meter resolution. The georeferenced projects all started during this period of analysis which allows us to compute deforestation before and after implementation of the project. All non forested areas in 2005 are excluded from our sample. Eventually, we intersect this shape file with the REDD projects boundaries. Therefore, each forested cell is either entirely within or outside REDD projects. This procedure allows us to compute yearly deforestation between 2006 and 2014 within each cell. We drop cells of less than 1000 hectares as they mainly result from polygons overlapping and may bias our results.

[2] http://www.dpi.inpe.br/prodesdigital/prodes.php

3.1.3 *Analyzing the choice of a location*

In the first stage of our analysis, we study the choice of a location by project proponents according to the type of certification and the type of proponents. In Section 3.1.1, we defined three groups of projects. In order to study the difference in the choice of location for each type of REDD projects proponent, we restrict our sample to the cells included in one of the six REDD projects. We obtain a sample of 566 observations.

Given the small number of REDD projects, we cannot claim to identify the impact of the characteristics of a location on the probability of enrollment in one type of project or another. For this reason, we rely on qualitative evidence based on difference-in-mean tests. We study the characteristics of the locations using variables influencing the opportunity costs of deforestation.

Since there are three types of projects we compute three pairwise tests in order to compare the samples two by two. For each test, we analyze if the characteristics of the location chosen by one type of project proponent differ from the one chosen by the two other types of proponents separately.

$$H0 : \bar{X}_i - \bar{X}_j = 0$$
$$H1 : \bar{X}_i - \bar{X}_j \neq 0$$

X is a vector of six variables including geographic characteristics that are structural determinants of deforestation (Kaimowitz and Angelsen, 1998; Pfaff, 1999; Robalino and Pfaff, 2013) such as distances to the closest waters, roads and localities in hundreds of kilometers, as well as slope in percent rise. We also include two measures of deforestation before the implementation of the REDD projects. The first one is the average yearly deforestation rate between 2006 and the first year of implementation of the project within the boundary of the project. The second variable measures the average yearly deforestation rate for this same period before the implementation of the project but in the direct neighboring cells. For all measures of deforestation, we compute the average yearly deforestation rates ex-ante according to the following equation:

$$DefRate_i = 1 - (Cover_{i,t-1}/Cover_{i,2006})^{\frac{1}{t-1-2006}} \tag{1}$$

In Equation 1, t corresponds to the first year of the project and $Cover_{i,t}$ is the forest cover at time t within the cell i. Given that we do not consider reforestation in our analysis, this measure is always positive and increases with deforestation.

Details about the sources of the data can be found in Appendix B.

3.1.4 Estimating additionality

In the second stage of the analysis, we estimate the additionality of each of the six projects separately. Additionality cannot be estimated only by comparing enrolled and non-enrolled areas. As a matter of fact, there are factors, called confounding variables, influencing both deforestation and the enrollment in a REDD projects, making simple comparisons biased. To estimate the additionality, we rely on impact evaluation methodologies, and more specifically matching methods, in order to estimate the Average Treatment Effect on the Treated.. In line with this literature, we define the areas enrolled in the REDD projects as treated areas and build a counter factual using a control group of non-enrolled areas.

In order to build a relevant counter factual, we use difference-in-difference (DID) matching (Chabé-Ferret and Subervie, 2013; Chabé-Ferret, 2015). Contrary to simple matching, DID-Matching introduces a control on time-unvarying unobservable confounding factors. The objective of this procedure is to select a group of observations that are as similar as possible to the treated areas and only differ regarding the treatment. For each REDD project we consider as treated the cells that are located within the polygon of the project and build a control group of observations that are outside the boundary of a REDD project.

We use covariate matching based on the Mahalanobis distance with Abadie and Imbens (2011)'s correction. In order to check the robustness of our results, we display for each project the results of the matching procedure using the nearest, the three nearest and the five nearest neighbors. We use the weights generated by the matching procedure in order to compute the impact of the program on the difference in average yearly deforestation rates after the project implementation and before the project. Therefore, we wonder if deforestation rates decreased or increased more in areas within the REDD projects using the matched control group as a counter factual. Our outcome variable is defined as:

$$DID_i = (1 - (Cover_{i,2015}/Cover_{i,t})^{\frac{1}{2015-t}}) - (1 - (Cover_{i,t-1}/Cover_{i,2006})^{\frac{1}{t-1-2006}}) \qquad (2)$$

We define our control group as all the cells located within a distance of 15 to 100km around each project. In order to obtain a valid estimation of the impact, the Stable Unit of Treatment Value Assumption (SUTVA) must hold. This hypothesis requires that the outcome of an observation, here deforestation, is only influenced by its own status regarding the treatment. In our case, it means that the project does not impact deforestation in the control group. For this reason, we consider that the direct buffer of 15km around the projects (approximately the three cells closest to the project) is likely to be influenced by the project through leakage for instance (Alix-Garcia et al., 2012). If we do not exclude the neighboring cells, the SUTVA hypothesis would not hold and the estimation might be biased. However, in order to identify the impact of the projects, the choice of the control and treated groups must take into account unobservable confounding factors that affect both deforestation and the location of the REDD projects. By restricting our control group to the cells that are located no further than 100km from the REDD project, we hope to balance unobservable covariates such as agro-ecological conditions. We also exclude protected areas and/or other REDD projects from the control group since they also are under conservation policies.

We introduce six variables in the matching procedure: the six variables from X_i described above excluding deforestation rates ex-ante but including the size of the cell in hundreds of hectares. This procedure allows us to build a relevant control group for each of the six REDD projects.

One of the key assumptions of DID-matching is the conditional parallel trend. This assumption states that, once controlled for observable confounding factors through the matching procedure, there are no significant differences between the two groups in terms of deforestation rates before the implementation of the program. In order to test for the validity of our matching procedure, we run placebo tests using deforestation rates before the implementation of the program as an outcome variable for each estimation. If the conditional parallel trend assumption holds, there should be no statistically significant differences between treated and control group after weighting

Table 2: Characteristics of location per type of projects

		(1)	(2)	(3)
X	Statistic	For profit: VCS only vs. For profit : VCS and CCB	NGOs : VCS and CCB vs. For profit: VCS and CCB	NGOs : VCS and CCB vs. For profit: VCS only
Distance to waters	Difference	0.3588***	0.4073***	0.0485***
(100km)	S.E.	0.0858	0.04745	0.0782
Distance to road	Difference	0.1749***	0.2622***	0.0873
(100km)	S.E.	0.0597	0.0330	0.0545
Distance to the closest	Difference	0.4891***	-0.0186	-0.5077***
urban area (100km)	S.E.	0.0407	0.0225	0.0371
Slope (%)	Difference	0.3155**	0.2547***	-0.0608
	S.E.	0.1279	0.0707	0.1166
Av. yearly def. rates in	Difference	0.0001	0.0098***	0.0097***
neighbor cells ex-ante	S.E.	0.0024	0.0014	0.0023
Av. yearly def. rates	Difference	-0.0003	0.0111***	0.0114***
ex-ante	S.E.	0.0034	0.0019	0.0031

S.E.: Standard Errors, *** p<0.01, ** p<0.05, * p<0.1

3.2 Results

3.2.1 Choice of a location

Table 2 presents the results of the difference-in-mean test presented in Section 3.1.3.

NGOs tend to enroll areas in REDD projects where the pressure to deforest seems higher. As shown in Column (2) and (3) of Table 2, deforestation rates were higher around and within the areas enrolled in a project managed by an NGO compared to the two other types of projects. NGOs also tend to enroll areas that are closer from the urban areas compared to private for-profit organizations that only obtained VCS certification. However, these areas are more remote from the roads than the areas enrolled by private-for-profit organizations with a double certification.

Regarding certification choices, Column (1) of Table 2 allows us to compare the choices made by private-for-profit organizations that combine CCB and VCS certification and those that only choose VCS certification. According to the difference-in-means test, we do no find evidence of statistical difference between the two groups regarding the deforestation rates before the implementation of the project. However, projects with only VCS certifications are located further from the roads and the urban areas, which are both crucial determinants of deforestation. Proponents with a double objective seems to favor locations with high opportunity costs since their projects are closer to the main infrastructure in order to better target the populations and achieve social objectives.

Table 3: Addtionality of the projects using five nearest neighbor matching

	(1)	(2)	(3)	(4)	(5)	(6)
	CCB^{Pri}		CCB^{Pri}		VCS^{Pri}	
	Unmatched	Matched	Unmatched	Matched	Unmatched	Matched
Treated group (n=47)	0.0004	0.0004	**-0.0006**	-0.0006	0.0001	**0.0001**
Control group (n=1,742)	-0.0020	-0.0001	**-0.0068**	-0.0022	-0.0062	**0.0132**
Difference	0.0024	0.0005	**0.0062****	0.0016	0.0063	**-0.0131****
Standard-Error	0.0019	0.0004	**0.0027**	0.0012	0.0083	**0.0053**
p-value	0.208	0.177	**0.021**	00.168	0.452	**0.013**
Placebo Treated group	**0.0002**	0.0002	**0.0015**	0.0015	0.0000	0.0000
Placebo Control group	**0.0092**	0.0002	**0.0110**	0.0027	0.0143	-0.0062
Placebo Difference	**-0.0090*****	0.0000	**-0.0096*****	-0.0012	-0.0143	0.0062
Standard-Error	**0.0022**	0.0004	**0.0031**	0.0009	0.0089	0.0043
p-value	**0.000**	0.938	**0.002**	0.185	0.110	00.148
	(7)	(8)	(9)	(10)	(11)	(12)
	VCS^{Pri}		CCB^{NGOs}		CCB^{NGOs}	
	Unmatched	Matched	Unmatched	Matched	Unmatched	Matched
Treated group (n=47)	-0.0006	**-0.0006**	0.0002	0.0002	-0.0073	-0.0073
Control group (n=1,742)	-0.0015	**0.0090**	-0.0014	0.0000	-0.0068	-0.0094
Difference	0.0009	**-0.0096*****	0.0016	0.0002	-0.0004	0.0021
Standard-Error	0.0033	**0.0031**	0.0009	0.0006	0.0014	0.0022
p-value	0.787	**0.002**	0.065	0.658	0.747	0.338
Placebo Treated group	**0.0006**	0.0006	**0.0006**	0.0006	0.0154	0.0154
Placebo Control group	**0.0090**	0.0010	**0.0027**	0.0013	0.0129	0.0165
Placebo Difference	**-0.0084****	-0.0004	**0.0021****	-0.0007	0.0025	-0.0011
Standard-Error	**0.0040**	0.0029	**0.0009**	0.0005	0.0015	0.0021
p-value	**0.035**	0.900	**0.018**	0.116	0.107	0.579

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

According to this result, NGOs and private-for-profit organizations with higher social preferences seem to focus on more threatened forests than private-for-profit organizations with a carbon objective only. Therefore an important result is that the location bias frequently identified in the literature crucially depends on the project managers' type.

Further, one can expect that the first two groups of projects will be more additional since they focus on areas that are structurally more threatened. To answer this question, the second part of our analysis estimates additionality of these projects during the first years of implementation.

3.2.2 Additionality

Table 3 displays the estimates of the covariate matching procedure for each project. We display the results using the five nearest neighbor matching because the conditional parallel trend is verified for all projects using this type of matching. Results using the nearest neighbor and the five nearest neighbor matchings confirm our findings but the conditional parallel trends do not hold for two estimations. Those results can be found in the Appendix in Table 6 and Table 7. For all projects, we display the results before and after matching. The results of the placebo tests for conditional parallel trends are at the bottom of each estimation in Tables 3, 6 and 7.

For all Tables, Columns (1) to (4) present the results for the projects promoted by private for-profit organizations that obtained both VCS and CCB certification, Columns (5) to (8) display the results for the projects promoted by private for-profit organizations that obtained only VCS certification and eventually Columns (9) to (12) for the projects promoted by NGOs. As a comparison, the yearly deforestation rate in the Brazilian Amazon over the period 2010-2015 is around 0.1%, according the FAO's Global Forest Resource Assessment (MacDicken et al., 2015).

Contrary to the predictions based on the choice of a location analyzed in Section 3.2.1, the only types of project that achieved additionality on the short-run are the ones implemented by private-for profit organizations that only obtained VCS certification. For both projects, deforestation rates are almost null within the area of the project but would have increased without the projects according to our counter factual analysis.

On the contrary, in areas with higher deforestation rates, NGOs fail to achieve additionality. According to our estimations, deforestation rates either remained stable compared to previous period or, if they decreased, they did not decrease more within the areas where the project is implemented. We find similar results for the private-for-profit organization that obtained both VCS and CCB certifications. Note that, using nearest neighbor matching, we even find an increase in deforestation rates for one project as can be seen in Table 6. This increase in deforestation could be due to a relax of the credit constraint as suggested by Jayachandran (2013). However, this result is not robust using three nearest and five nearest neighbor matching.

These results imply that even if location bias may exist when choosing the location of a REDD+ project, as shown in section 2, the existence of a location bias does not necessarily preclude additionality. More attention will be paid to this surprising result in the theoretical section.

In order to test that the matching procedure succeeded in balancing confounding factors between the treated and control group, we use balancing tests for each estimation. Results are available upon requests. Despite some remaining imbalances, the bias has been largely reduced for all estimations which confirms the validity of our results. Moreover, as a robustness tests, we increase the size of the buffer around each project that is excluded from the control group. The results, which are available upon request, confirm our findings but, in some cases, we are not able to validate the conditional parallel trend assumption with a larger buffer. It is probably due to the fact that, with a lower number of control observations, the procedure fails to find appropriate matches.

3.3 Analysis of the results

According to our findings, the only projects that achieved additionality are the ones that only obtained an environmental certification. This suggests a trade-off between social and environmental objectives. Moreover, the projects managed by an NGO failed to avoid deforestation even though NGOs target more threatened forests. On the contrary, the only projects that achieved additionality on the short-run is led by a private-for-profit organizations even though the forests within the boundary of the projects seemed less threatened.
This last result is quite counter-intuitive. In order to understand the mechanisms that lead to additionality, we propose a simple theoretical model that combines the choice of a location, the type of proponent and the choice of a certification scheme. This model allows us to understand why, in some cases, it might be more optimal in order to achieve additionality to focus on less endangered forests.

4 Modeling additionality and location selection

The project proponent is presented first. Then the reaction of the community to the project is presented. Finally, we show how the project proponent's objectives may influence the project location and additionality.

4.1 Project proponent

A project proponent (Pp) aims to set an avoided deforestation project, with a set of various objectives: (1) a weight α is given to the outcome in terms of avoided deforestation (which is our indicator of additionality); (2) a weight β is given to the livelihood quality of the community where the project is implemented; (3) a weight $(1-\alpha-\beta)$ is given to financial aspects, approximated by the amount of money received from selling REDD+ credit on voluntary carbon markets.

For that purpose, three choices have to be made: (1) first, a certification scheme m; (2) a project location i; (3) an effort allocation e. The project proponent first selects one location among the N possible ones, as well as a certification scheme. He then chooses his effort allocation between environment (avoided deforestation) and development (improving livelihoods).

The overall value of the project located in i, with certification m and effort allocation e is thus:

$$v_{im}(e) = \alpha U_E(AD_i(e)) + \beta U_L(\Delta_i(e)) + (1-\alpha-\beta) U_F((p_{cm}(\gamma_{cm}\overline{d_i} - d_i^*(e)) + p_{um}(u_i^*(e) - \gamma_{um}\overline{u_i}))) \quad (3)$$

We consider that utility from environmental improvement (U_E), utility from livelihood improvement (U_L) and utility from project funding (U_F) are all increasing and concave.[3]

$AD_i(e)$ is the actual level of avoided deforestation (supposedly known by the Pp). $\Delta_i(e)$ is the project impacts in terms of livelihood improvement. $p_{cm}(\gamma_{cm}\overline{d_i} - d_i^*(e))$ is the amount of money received from selling REDD+ credits on voluntary markets under certification m. p_{cm} is the price of carbon credits, while γ_{cm} is the level of stringency relating avoided deforestation to credits. A low (< 1) γ_{cm} represents strong requirements and/or low uncertainty in baseline estimation, while a large (> 1) γ_{cm} represents low levels of stringency and/or high uncertainty regarding the baseline. $p_{um}(u_i^*(e) - \gamma_{um}\overline{u_i})$ represents the payment related to livelihoods improvement under certification m. p_{um} is the price premium that may be paid to the project proponent if such co-benefit is taken into account by the certification scheme[4]. γ_{um} is the stringency level of livelihood improvement measurements. If $\gamma_{um} < 1$, the initial level of livelihoods is underestimated, which tends to overestimate livelihoods improvements. Thus the label is considered loose in terms of livelihoods measurements. In contrast, it is considered stringent if $\gamma_{um} > 1$.

Overall, the certification scheme m is composed of 4 elements: a carbon price p_{cm}, a level of environmental stringency γ_{cm}, a price premium to livelihood improvement p_{um} and a level of livelihoods stringency γ_{um}.

[3] Log functions will be used for the simulations.

[4] If the certification scheme only considers the avoided deforestation output, with no importance given to livelihoods as a co-benefit, we simply have $p_{um} = 0$.

4.2 The community

4.2.1 Business-as-usual cases

We consider a set of $N \in [1, ..., n]$ potential REDD+ projects locations. Each location i is represented by a benefit b_i for each unit of deforestation d_i. v is the cost of deforestation, including non-market benefits from forest conservation. We assume convex costs, with a quadratic specification. The representative agent in location i thus maximizes livelihoods:

$$\max_{d_i} u_i = b_i d_i - \frac{v}{2} d_i^2 \tag{4}$$

Under no intervention, the optimal level of deforestation is thus: $\overline{d_i} = \frac{b_i}{v}$. The level of livelihoods is: $\overline{u_i} = \frac{b_i^2}{2v}$. Those levels are considered as the business-as-usual scenarios.

4.2.2 Community's reaction to the REDD+ project

The Pp allocates his effort between reducing deforestation (e) and improving livelihood in the community ($1 - e$). We consider that effort allocated to environmental objectives increases the benefit from forest conservation for the community, and that effort allocated to livelihoods improvement increases the net benefit from the community's activities. Note here that we focus on a case in which effort for reducing deforestation and effort for improving livelihood are not complementary, meaning that we focus on environment-development trade offs situations. In the opposite case where development and environmental objectives can be targeted jointly with no adverse effects, the problem is trivial.

Moreover, depending on the selected project, effort may be more effective for environmental purpose than for development purpose, or vice versa. Thus effort efficiency is $\delta_i e$. For $\delta_i > 1$ (resp. < 1), effort is more (less) productive for environmental purpose than development ones. Further more, effort efficiency is likely to depend on the marginal benefit from deforestation: $\delta_i(b_i)$. Indeed, opportunity costs from avoided deforestation are larger when the marginal benefit of deforestation is larger, which decreases the effort efficiency for avoided deforestation. On the contrary, larger marginal benefits may represent larger development potential, and thus larger effort efficiency in terms of livelihood improvement. Thus we can consider that $\delta_i'(b_i) < 0$. [5]

[5] For the simulations, we consider that $\delta_i(b_i) = 1/b_i^a$.

The representative agent's utility thus becomes:

$$\max_{d_i} u_i = (2 - \delta_i e)(b_i d_i - \frac{v}{2}((1 + \delta_i e) d_i)^2) \tag{5}$$

The community's reaction to the REDD+ project is thus:

$$d_i^*(e) = \frac{b_i}{v} \frac{1}{(1 + \delta_i e)^2} \tag{6}$$

$$u_i^*(e) = \frac{b_i^2}{2v} \frac{(2 - \delta_i e)}{(1 + \delta_i e)^2} \tag{7}$$

The community reacts to the effort allocation in the following way:

$$d'_{ie} = \frac{\partial d_i^*(e)}{\partial e} = \frac{b_i}{v} \frac{-2\delta_i}{(1 + \delta_i e)^3} < 0 \tag{8}$$

$$u'_{ie} = \frac{\partial u_i^*(e)}{\partial e} = \frac{b_i^2}{2v} \frac{\delta_i(\delta_i e - 5)}{(1 + \delta_i e)^3} < 0 \iff \delta_i < 5/e \tag{9}$$

Avoided deforestation from the project is:

$$AD_i(e) = \overline{d_i} - d_i^*(e) = \frac{b_i}{v} \frac{\delta_i e(2 + \delta_i e)}{(1 + \delta_i e)^2} \tag{10}$$

Avoided deforestation is increasing in e:

$$AD'_{ie} = \frac{\partial AD_i^*(e)}{\partial e} = \frac{b_i}{v} \frac{2\delta_i(1 - \delta_i e)}{(1 + \delta_i e)^2} > 0 \iff \delta_i < 1/e \tag{11}$$

Livelihoods improvement from the project is:

$$\Delta_i(e) = u_i^*(e) - \overline{u_i} = \frac{b_i^2}{2v} \frac{(1 - \delta_i^2 e^2 - 3\delta_i e)}{(1 + \delta_i e)^2} \tag{12}$$

$$\Delta'_{ie} = \frac{b_i^2}{2v} \frac{\delta_i(\delta_i e - 5)}{(1 + \delta_i e)^3} < 0 \iff \delta_i < 5/e \tag{13}$$

For the remaining of the paper, we will focus on the case of low enough environmental effort efficiency: $\delta_i < 1$.

4.3 Results: location and additionality in a REDD+ project

We proceed backward: first, we consider how the Pp allocates his effort between the avoided deforestation and livelihood objectives; second, the choices of location and third, certification schemes are considered.

4.3.1 Effort allocation

The objective of the Pp is thus to allocate his effort in order to maximize its utility from the project, taking location i and certification m as given:

$$\max_e v_{im}(e) = \alpha U_E(AD_i(e)) + \beta U_L(\Delta_i(e)) + (1-\alpha-\beta) U_F((p_{cm}(\gamma_{cm}\overline{d_i} - d_i^*(e)) + p_{um}(u_i^*(e) - \gamma_{um}\overline{u_i}))) \tag{14}$$

The first-order condition implicitly gives the effort allocation e^* of the Pp:

$$v'_{um}(e) = \alpha U'_E(AD'_{ie}) + \beta U'_L(\Delta'_{ie}) + (1-\alpha-\beta) U'_F(-p_{cm} d'_{ie} + p_{um} u'_{ie}) = 0 \tag{15}$$

The optimal allocation effort e^* is chosen so that the marginal environmental benefit of increasing effort on forest preservation equals the marginal economic benefit of increasing effort on livelihood improvement.

What drives effort allocation?

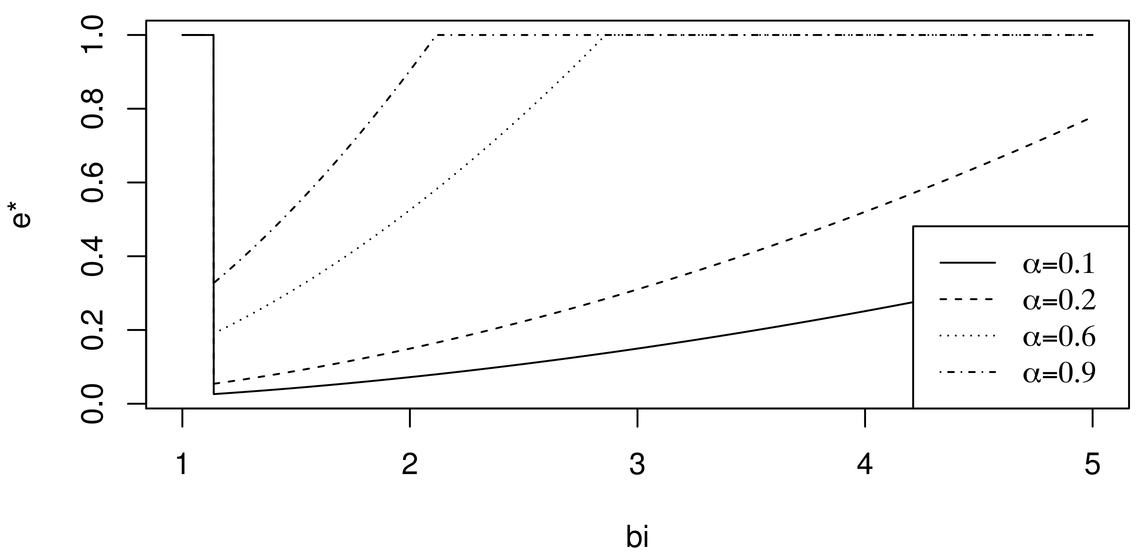
In order to analyze what drives effort allocation for the project proponent, we will consider several cases. First, we consider what happens when the project proponent is not interested in funding from carbon markets : the *NoMo* case. Project proponents are all interested in obtaining funding since they all asked for certification. However, we study this extreme to analyze the decisions made by the proponents less interested by funding. Second, we will focus on a project proponent only interested in funding from carbon markets: the *OnMo* case. Finally, we will consider the interaction between funding and the other two objectives: *BoMo* case.

NoMo Case: $(\alpha + \beta = 1)$.

When the project proponent does not consider external funding in its objective function, the effort allocation e^* is increasing in α and decreasing in β. Moreover, the optimal effort allocation is increasing in b_i: the marginal effort efficiency is increasing in b_i for both environmental and development purposes ($\frac{\partial AD'_{ie}}{\partial b_i} > 0$ and $\frac{\partial \Delta'_{ie}}{\partial b_i} < 0$). Finally, the optimal effort is decreasing in δ_i (as $\frac{\partial AD'_{ie}}{\partial \delta_i} < 0$ and $\frac{\partial \Delta'_{ie}}{\partial \delta_i} > 0$).

Result 1 : *When the project proponent does not focus on external funding from carbon markets, his environmental effort allocation e^* increases in environmental preferences α, decreases in livelihood preferences β, increases in the community marginal benefit b_i and increases in environmental effort efficiency δ_i. If the environmental effort efficiency is decreasing in the marginal benefit from deforestation, then effort may be either increasing or decreasing in b_i.*

Figure 1: Effort allocation for diverse values of b_i, α, *NoMo case*



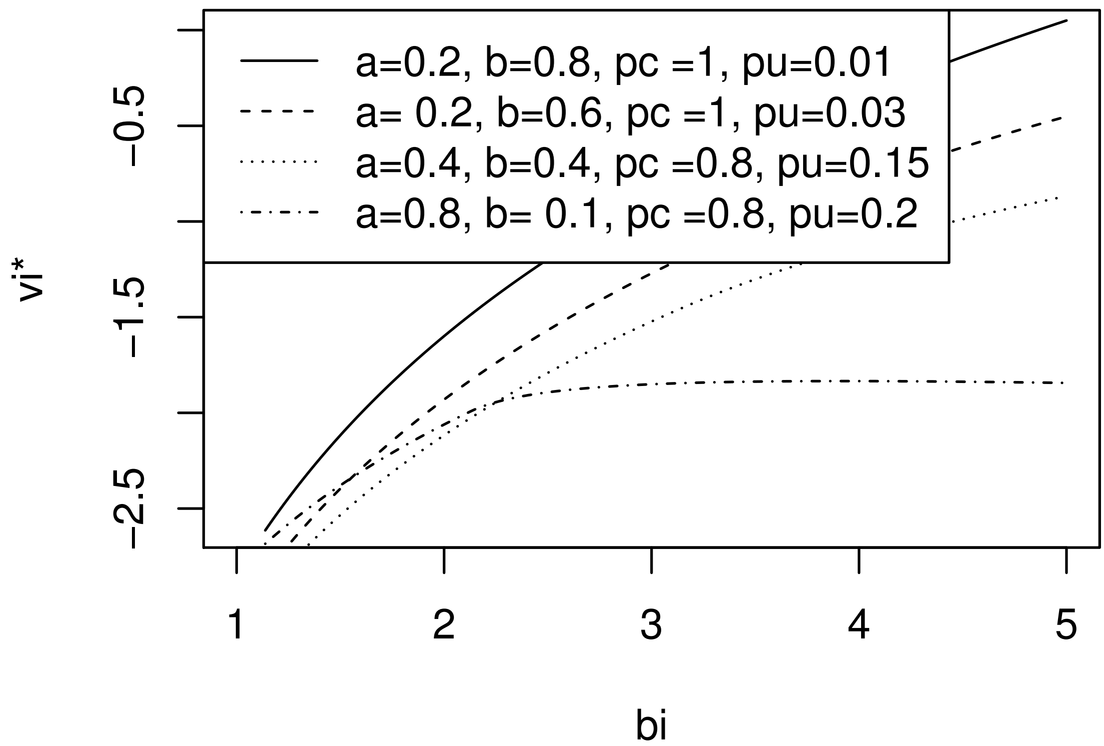
OnMo Case: $(\alpha + \beta = 0)$.

If the project proponent only cares about funding from carbon markets, his effort will be entirely focused on environmental purposes or development purposes. We have the following corner solution:

$$\begin{cases} e^* = 0 \iff p_{um} u'_{ie} > p_{cm} d'_{ie} \\ e^* = 1 \iff p_{um} u'_{ie} < p_{cm} d'_{ie} \end{cases}$$

Result 2 : *When the project proponent only focuses on external certification funding, his environmental effort allocation e^* will be maximal if the price given to avoided deforestation p_c is high enough, if the price given to livelihood improvement p_u is low enough, if the environmental effort efficiency δ_i is high enough, if the marginal benefit from avoided deforestation b_i is high enough. It will be null in the contrary.*

Figure 2: Project value for various levels of b_i, p_c, p_u, *OnMo case*



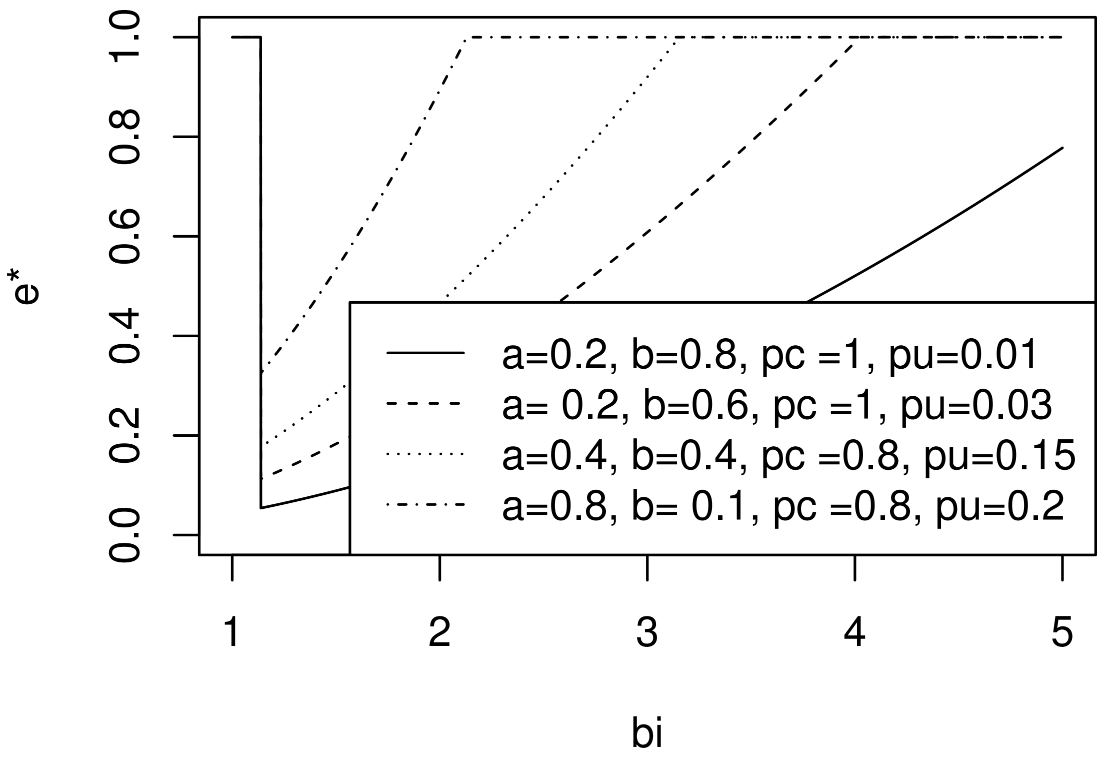
BoMo Case: $(0 < \alpha + \beta < 1)$.

When the project proponent cares both about projects impacts and certification funding, this tends to put an extra-weight on avoided deforestation or livelihoods. This extra-weight depends on the condition:

$$\begin{cases} \frac{\partial e^*}{\partial \alpha} < 0 \text{ and } \frac{\partial e^*}{\partial \beta} > 0 \iff p_{um} u'_{ie} > p_{cm} d'_{ie} \\ \frac{\partial e^*}{\partial \alpha} < 0 \text{ and } \frac{\partial e^*}{\partial \beta} < 0 \iff p_{um} u'_{ie} < p_{cm} d'_{ie} \end{cases}$$

Result 3: *When the project proponent considers both impacts from the project and certification funding, increasing the importance given to avoided deforestation (resp. livelihoods) increases (decreases) environmental effort if the price given to avoided deforestation p_c is high enough, if the price given to livelihood improvement p_u is low enough, if the environmental effort efficiency δ_i is high enough, if the marginal benefit b_i is high enough. It will be decreasing (increasing) in the contrary.*

Figure 3: Effort allocation for diverse values of b_i, α, β, p_c, p_u, *BoMo case*



4.3.2 Choosing project location

At first, the Pp has to select the right location for implementing the REDD+ project. Locations are represented by the couples levels of marginal benefit from deforestation and potential project efficiency: $L(b_i, \delta_i)$. It is important to note here that the project impacts not only depend on the effort repartition described in the previous period, but also on the initial conditions in the project location.

Overall, as shown before, the optimal effort level depends on the two variables that define location: $e^*(b_i, \delta_i(b_i))$. Thus the choice of the project location is linked to the selection of the right b_i.

The project location is chosen so that:

$$\begin{aligned} \max_{b_i} v_i(e^*(b_i, \delta_i(b_i))) &= \alpha U_E(AD_i(e^*(b_i, \delta_i(b_i)))) + \beta U_L(\Delta_i(e^*(b_i, \delta_i(b_i)))) \\ &+ (1-\alpha-\beta)U_F(p_c(\gamma_c \overline{d_i} - d_i^*(e^*(b_i, \delta_i(b_i)))) + p_u(u_i^*(e^*(b_i, \delta_i(b_i))) - \gamma_u \overline{u_i}))) \end{aligned} \quad (16)$$

Location i is chosen if the following condition is satisfied:

$$v'_{um}(b_i) = (e^{*'}_{b_i} + e^{*'}_{\delta_i}\delta'_i(b_i))v'_{um}(e) + (1-\alpha-\beta)(p_c\gamma_c\overline{d_i}'_{b_i} - p_u\gamma_u\overline{u_i}'_{b_i}) = 0 \quad (17)$$

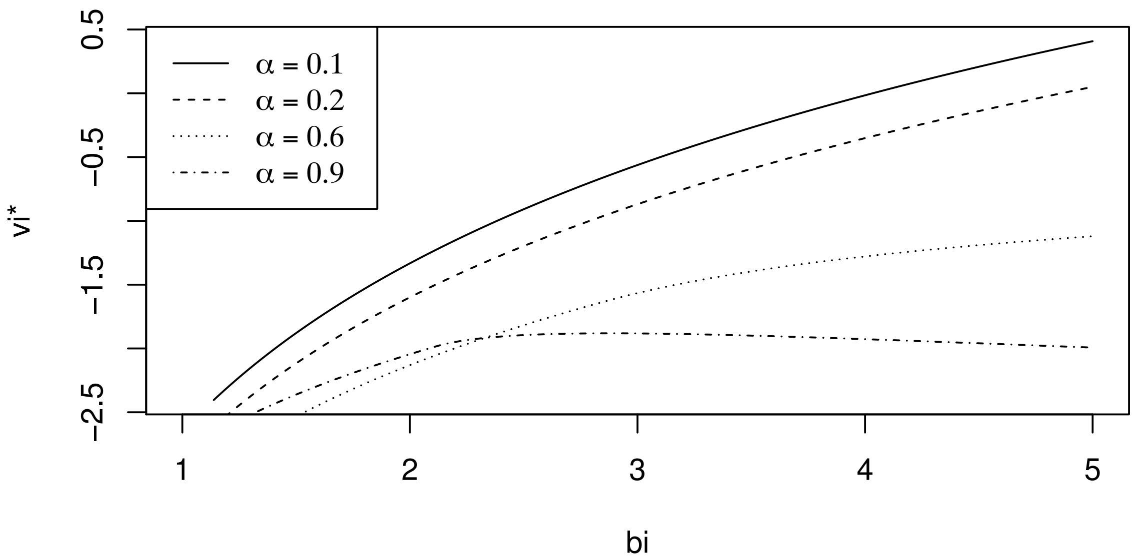
Therefore, when choosing the project location, the project proponent considers how location will affect his effort allocation, through two channels: the marginal benefit from deforestation and the effort efficiency. Larger marginal benefit b_i tends to increase the potential livelihood benefit from the project, but it also decreases the effort efficiency in terms of avoided deforestation. Finally, larger b_i tend to increase financial aspects from credits.

If we consider first the simple case where the environmental effort efficiency does not depend on the marginal benefit from deforestation, it is trivial to see that both avoided deforestation and livelihood improvement increase with b_i. Thus, in this case, the project proponent will choose the location with the highest marginal benefit from deforestation, whatever his preferences in terms of environmental and livelihoods benefits.

Yet, due to higher opportunity costs of avoided deforestation, the marginal benefit from deforestation is likely to have a large impact on environmental effort efficiency. In this case, larger environmental preferences may push the project proponent to select a location with lower marginal benefit from deforestation.

Result 4: *If the marginal benefit has a low impact on the environmental effort efficiency (δ_i close to 1, whatever b_i), then the project proponent will tend to choose a location with large marginal benefit whatever his preferences in terms of avoided deforestation, livelihoods, or certification funding. If the marginal benefit has a large effect on the environmental effort efficiency ($\frac{\partial \delta_i}{\partial b_i} < 0$ and large enough), the project proponent will choose a lower b_i if α increases, and a larger b_i if β increases.*

Figure 4: Project value for diverse values of b_i, α, *NoMo case*



4.3.3 Choosing the certification scheme

Finally, the Pp has to select the certification scheme m that best fits with his objectives, within the M possible certification schemes. A certification scheme is a combination of credit prices, requirement levels and certification cost k: $C(p_c, \gamma_c, p_u, \gamma_u, k)$. The chosen certification scheme will be the one maximizing:

$$\max_{m \in [0,\ldots,M]} v_{im}(e^*) = (p_c(\gamma_c \overline{d_i} - d_i^*(e^*)) + p_u(u_i^*(e^*) - \gamma_u \overline{u_i})) - k \quad (18)$$

Location i is chosen if the following condition is satisfied:

$$v_{im}(e^*) > v_{is}(e^*), \forall\ s \neq m \tag{19}$$

Result 5: *Project proponents will tend to choose the certification scheme associated to the highest possible price, and the lowest possible additionality requirement.*

4.4 Analysis of the result

According to the results of our theoretical model, the objectives of the project proponents influence his choice of a location, defined by a marginal benefit b_i and an environmental effort efficiency $\delta_i(b_i)$, his environmental effort e and the certification scheme. We also show that interactions between b_i and $\delta_i(b_i)$ influence the environmental effort.

We can hypothesize that b_i strongly and negatively influences the environmental effort efficiency $\delta_i(b_i)$. In this case, we can show that the Pp will provide lower environmental effort (Result 1 and 2). This is especially the case when the Pp is only motivated by funding from carbon markets ($\alpha = 0$ and $\beta = 0$) and if the carbon price is too low: this case converges towards a corner solution where his environmental effort e_i is null. Note that, if the level of environmental stringency of the carbon standard is low (γ_{cm}>1) i.e. if the baseline of deforestation is overestimated, the Pp can still get funding from carbon markets even if his environmental effort is null.

In relation with our empirical results, this explains why it might be optimal for the private-for-profit organizations to focus on areas where opportunity costs are low and where there is little deforestation. As a matter of fact, it is more profitable for them to focus on areas where the efficiency of the effort will be higher. On the contrary, the other types of proponents try to target areas with higher opportunity costs but the efficiency of the effort is lower in those areas which explains why they are not additional.

Moreover, from Result 5, we understand that the choice of certification is related to the weight given to environmental (α) and social preferences (β) in the objective function of the Pp. Therefore, we can hypothesize that the Pp that choose a double certification have higher social preferences than that Pp that only obtained VCS certification. In this case, Result 4 suggests that Pp with higher β will favor locations with higher b_i even though the environmental efficiency will be low which, according to Result 1, lead to a low additionality. This result can also explain why the only two additional projects on the short-run are the ones that do not combine two certifications.

5 Conclusion

In this article, we both empirically and theoretically study the interactions between the type of project proponent, the choice of a location and the choice of a certification scheme within the context of REDD+ projects. According to our results, location and additionality from the projects are closely related to the project proponent preferences. Our estimations show that the projects that only obtained VCS certification had an additional impact on deforestation, despite the fact that they target forests that are less threatened. On the contrary, we cannot exclude the possibility that the projects that combined both CCB and VCS certification were not additional, even though they are located in areas with higher opportunity costs. Our work therefore underlines the fact that location biases, often identified in the literature, are not independent of the REDD+ project manager's type. Furthermore, the existence of a location bias does not necessarily imply a lack of additionality. In contrast, choosing a location with high opportunity costs may lead to low (if any) levels of additionality.

This result can be explained by our theoretical model. As a matter of fact, projects are likely to have stronger additionality when the project proponents have larger preferences for environmental quality, and smaller preferences for funding from voluntary markets. Moreover, a higher preference for funding can lead to targeting less threatened forests. Consequently, the trade-off between project opportunity costs and the efficiency of the environmental effort is crucial. Because higher opportunity costs decrease environmental efficiency, it might be optimal in order to maximize funding from carbon markets to implement the project in non threatened forests.

Given the conclusions of our theoretical model, we acknowledge that our approach suffers from our lack of data regarding the social impact of REDD projects. As a matter of fact, the theoretical model considers both social and environmental benefits. The empirical analysis confirms the results regarding deforestation but, unfortunately, we are unable to confirm the results of the model regarding social benefits. Moreover, we were only able to georeference six REDD projects so our results rely on a small sample of projects. In order to increase the external validity of our results, it would be interesting to expand it to other projects.

Our analysis provides innovative theoretical and empirical evidence regarding the mechanisms that lead to additionality. We show how the incentives behind REDD+ can lead to lower environmental effort. Following recent calls by Baylis et al. (2016), among others, the question is not if REDD+ projects are effective instruments for forest conservation but, instead, how and under which conditions they deliver the expected results. We believe that this focus on the mechanisms is a crucial issue that needs to be tackled by academics in order to improve our understanding of conservation policies.

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Appendices

A Value of the parameters for the simulations

Table 4: default

Variable	Value
b_i	$\in [1;5]$
v	5
δ_i	$\frac{1}{b_i^a}$
a	1.8
p_c	1, 0.8
p_u	0.1, 0.3, 1.5, 2
γ_c	1
γ_u	1

B Data sources

Table 5: Data sources

Variable	Source
Distance to waters (100km)	Digital Chart of the World
Distance to road (100km)	Digital Chart of the World
Distance to the closest urban area (100km)	IBGE
Slope (Percentage rise)	SRTM
Total deforestation in neighbouring cells before the implementation (100ha)	PRODES
Total deforestation before the impelmentation (100ha)	PRODES
REDD+ projects	ID-RECCO

C Robustness Tests

Table 6: Addtionality of the projects using first nearest neighbour matching

	(1)	(2)	(3)	(4)	(5)	(6)
	CCB^{Pri}		CCB^{Pri}		VCS^{Pri}	
	Unmatched	Matched	Unmatched	Matched	Unmatched	Matched
Treated group (n=47)	0.0004	**0.0004**	**-0.0006**	-0.0006	0.0001	**0.0001**
Control group (n=1,742)	-0.0020	**-0.0006**	**-0.0068**	-0.0019	-0.0062	**0.0117**
Difference	0.0024	**0.0010***	**0.0062****	0.0013	0.0063	**-0.0116*****
Standard-Error	0.0019	**0.0004**	**0.0027**	0.0016	0.0083	**0.0036**
p-value	0.208	**0.081**	**0.021**	0.424	0.452	**0.001**
Placebo Treated group	**0.0002**	0.0002	**0.0015**	0.0015	0.0000	**0.0000**
Placebo Control group	**0.0092**	0.0006	**0.0110**	0.0022	0.0143	**-0.0061**
Placebo Difference	**-0.0090*****	-0.0004	**-0.0096*****	-0.0007	-0.0143	**0.0061***
Standard-Error	**0.0022**	0.0006	**0.0031**	0.0014	0.0089	**0.0033**
p-value	**0.000**	0.469	**0.002**	0.612	0.110	**0.068**
	(7)	(8)	(9)	(10)	(11)	(12)
	VCS^{Pri}		CCB^{NGOs}		CCB^{NGOs}	
	Unmatched	Matched	Unmatched	Matched	Unmatched	Matched
Treated group (n=47)	-0.0006	-0.0006	0.0002	0.0002	-0.0073	-0.0073
Control group (n=1,742)	-0.0015	0.0050	-0.0014	0.0007	-0.0068	-0.0073
Difference	0.0009	-0.0056	0.0016	-0.0005	-0.0004	0.0000
Standard-Error	0.0033	0.0038	0.0009	0.0008	0.0014	0.0027
p-value	0.787	0.144	0.065	0.522	0.747	0.985
Placebo Treated group	**0.0006**	**0.0006**	**0.0006**	0.0006	0.0154	0.0154
Placebo Control group	**0.0090**	**-0.0153**	**0.0027**	0.0004	0.0129	0.0136
Placebo Difference	**-0.0084****	**0.0159*****	**0.0021****	0.0002	0.0025	0.0018
Standard-Error	**0.0040**	**0.0048**	**0.0009**	0.0006	0.0015	0.0027
p-value	**0.035**	**0.001**	**0.018**	0.695	0.107	0.511

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

Table 7: Addtionality of the projects using three nearest neighbour matching

	(1)	(2)	(3)	(4)	(5)	(6)
	CCB^{Pri}		CCB^{Pri}		VCS^{Pri}	
	Unmatched	Matched	Unmatched	Matched	Unmatched	Matched
Treated group (n=47)	0.0004	0.0004	**-0.0006**	-0.0006	0.0001	**0.0001**
Control group (n=1,742)	-0.0020	0.0002	**-0.0068**	-0.0022	-0.0062	**0.0128**
Difference	0.0024	0.0006	**0.0062****	0.0016	0.0063	**-0.0127****
Standard-Error	0.0019	0.0004	**0.0027**	0.0015	0.0083	**0.0063**
p-value	0.208	0.135	**0.021**	00.267	0.452	**0.044**
Placebo Treated group	**0.0002**	0.0002	**0.0015**	0.0015	0.0000	0.0000
Placebo Control group	**0.0092**	0.0003	**0.0110**	0.0027	0.0143	-0.0055
Placebo Difference	**-0.0090*****	-0.0001	**-0.0096*****	-0.0012	-0.0143	0.0055
Standard-Error	**0.0022**	0.0004	**0.0031**	0.0013	0.0089	0.0047
p-value	**0.000**	0.784	**0.002**	0.349	0.110	0.239
	(7)	(8)	(9)	(10)	(11)	(12)
	VCS^{Pri}		CCB^{NGOs}		CCB^{NGOs}	
	Unmatched	Matched	Unmatched	Matched	Unmatched	Matched
Treated group (n=47)	-0.0006	**-0.0006**	0.0002	0.0002	-0.0073	-0.0073
Control group (n=1,742)	-0.0015	**0.0057**	-0.0014	-0.0007	-0.0068	-0.0092
Difference	0.0009	**-0.0063****	0.0016	0.0009	-0.0004	0.0020
Standard-Error	0.0033	**0.0029**	0.0009	0.0006	0.0014	0.0025
p-value	0.787	**0.031**	0.065	0.103	0.747	0.428
Placebo Treated group	**0.0006**	0.0006	**0.0006**	**0.0006**	0.0154	0.0154
Placebo Control group	**0.0090**	0.0020	**0.0027**	**0.0024**	0.0129	0.0164
Placebo Difference	**-0.0084****	-0.0014	**0.0021****	**-0.0018*****	0.0025	-0.0011
Standard-Error	**0.0040**	0.0029	**0.0009**	**0.0005**	0.0015	0.0024
p-value	**0.035**	0.631	**0.018**	**0.001**	0.107	0.648

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

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