Land Use Policy 72 (2018) 510–522

Contents lists available at ScienceDirect

Land Use Policy

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

Wealth and the distribution of benefits from tropical forests: Implications for REDD+

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ARTICLE INFO

Keywords:
Forests
Elite capture
REDD+
Inequality
Conservation
Payments for ecosystem services

ABSTRACT

Interventions to strengthen forest conservation in tropical biomes face multiple challenges. Insecure land tenure and unequal benefit sharing within forest user groups are two of the most important. Using original household-level survey data from 130 villages in six countries, we assess how current wealth inequality relates to tenure security and benefit flows from forest use. We find that villages with higher wealth inequality report lower tenure security and more unequal flows from forest income and externally sourced income. Furthermore, we find that wealthier individuals within villages capture a disproportionately larger share of the total amount of forest benefits available to each village, while external income often benefits poorer individuals more. These findings suggest that unless future forest conservation interventions actively work to mitigate inequalities linked to existing forest benefit flows, there is a risk that these interventions—including those associated with REDD+ activities—reproduce or even aggravate pre-existing socioeconomic inequalities within user groups, potentially undermining both their conservation and economic objectives.

1. Introduction

Research on local forest governance suggests that in the absence of institutional arrangements that regulate the distribution of forest benefits, community-based forestry activities are susceptible to elite capture. Elite capture is a process that enables the richer members of user groups to receive a disproportionately large share from a stream of benefits, and this process can exacerbate economic inequalities within these groups (Iversen et al., 2006; Persha and Andersson, 2014; Torpey-Saboe et al., 2015). The sustainability of community-based forestry depends on reducing economic inequalities among forest users, and particularly helping economically disadvantaged users to improve their wellbeing (Brown et al., 2008).

The objectives of REDD+, the international initiative to Reduce Emissions from Deforestation and forest Degradation and foster conservation, sustainable management of forests, and enhancement of forest carbon stocks (hereafter REDD+), include safeguarding local livelihoods, alleviating poverty, and improving tenure security for rural people in developing countries (Sunderlin, 2014). Here, we examine the distribution of household wealth and income in villages located in and around sites selected for REDD+ interventions. Our sample reflects a wide range of forest use and users across the tropics. We provide empirical evidence on the conditions necessary for local forest governance to promote equal benefit sharing and the extent to which the benefits disproportionately reward the rich and powerful.

We use baseline data from an ongoing study of subnational REDD+ initiatives to examine the joint distribution of household wealth, tenure security, forest income, and income from external sources such as government programs. Important policy issues are at stake. If the current distribution of forest benefits predicts the future distribution of forest benefits, broadly conceived, then policy makers can use this knowledge to intervene to promote more equal benefit flows (Larson et al., 2015b).

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https://doi.org/10.1016/j.landusepol.2018.01.012
Received 15 February 2017; Received in revised form 8 January 2018; Accepted 8 January 2018
Available online 19 January 2018

The first step is to understand the association of wealth inequality and benefit distribution patterns in a large number of forest-dependent villages. Does forest use contribute to more or less socioeconomic inequality within user groups? How can future community-based forestry interventions be designed so that benefits are shared equitably, and help those users who are in greatest need?

To address these questions, we analyze data collected through interviews with 3929 households in 130 villages at 17 subnational REDD + sites in six countries: Brazil (n = 37 villages), Cameroon (n = 13), Indonesia (n = 41), Peru (n = 16), Tanzania (n = 15), and Vietnam (n = 8), as described in Sills et al. (2014).[1] The Center for International Forestry Research collected the data for their Global Comparative Study (GCS) on REDD+ (www.cifor.org/gcs). In each village, researchers collected information through multiple approaches, including a survey of 30 randomly selected households. The households and villages represent the wide variety of situations and contexts in which community-based forest conservation initiatives intervene to try to conserve tropical forests.

Overall, we find that existing wealth inequalities within villages, both in terms of land and non-land assets, are associated with skewed distributions of (a) perceived tenure security, (b) benefits from forests, and (c) benefits from external sources. Within villages, households with higher levels of economic endowments (wealth) are often those that garner higher forest income streams. In contrast, we see some evidence that existing external sources of income can defray some inequalities. Our findings imply that future REDD+ funds could either exacerbate or subdue existing inequalities depending on whether compensation follows existing distributions of forest benefits or the existing externally sourced income. If REDD+ programs are serious about reducing poverty and wealth inequality, our results indicate they should conscientiously create mechanisms to avoid the perpetuation of existing forest–benefit flows, and ensure that funds flow also to the households whose members' wellbeing stand to benefit the most from such support.[2]

2. Benefit sharing and elite capture

The concept of elite capture connotes domination and control of decision-making arenas, monopolization of shared benefits and resources, and a combination of both (Lund and Saito-Jensen, 2013). In the literature on local governance, elite capture is generally portrayed as a pernicious problem for community-based initiatives and programs (Platteau, 2004; Persha and Andersson, 2014), yet some scholars caution that certain forms of elite capture may also benefit the wider community (Dasgupta and Beard, 2007; Fritzen, 2007).

In some rural settings, the village authorities—typically led by the head of the village—may be the only bridge of communication between the village and external interventions (Andersson, 2013). The leadership position of the local village authorities gives these individuals tremendous influence and power (Larson et al., 2015a). The power of access and information allows the local leadership and elites to exert a great deal of influence over the local decision-making process (Beard and Phakphian, 2012). This power is often perpetuated through landholdings, family networks, wealth, knowledge of political protocols, political and religious affiliations, personal history, and personality (Lund and Saito-Jensen, 2013; Dasgupta and Beard, 2007; Platteau, 2004). As such, interventions to produce community-based natural resource management may succeed in changing the formal and visible institutional forms but not necessarily the subtler power relations or deeper socio-political differentiations within local groups (Wilshusen, 2009; Wong, 2010; Sneddon and Fox, 2007).

Payment for Environmental Services (PES) programs are similarly prone to elite capture. Corbera et al. (2007) finds that political inequalities are so widespread and deeply engrained in most Mesoamerican societies that PES schemes in this context are likely to reinforce the existing power structures and deepen existing inequalities in both decision making and in gaining access to resources. In Vietnam's national PES program, neither community members nor civil society is represented on any of the local PES program committees, and local corruption and nepotism are common. Pham et al. (2014) find that trust between communities and local leaders in Vietnam is a key factor affecting compliance to PES contracts and local perceptions of equity. Elite capture and corruption does not only occur at the local level—it is also identified as one of the major constraints to the implementation of equitable REDD+ benefit sharing mechanisms at all levels of governance, particularly where land tenure systems and institutions are weak and participation in decision-making processes constrained (Assembe-Mvondo, 2015; Pham et al., 2014; Alston et al., 2013).

Much of the existing evidence suggests that elite capture is common in community-based forest governance, and that a careful characterization and evaluation of the forms and outcomes of elite capture is needed to understand the underlying drivers of skewed distributions of power and resources (Lund and Saito-Jenson, 2013). There is also some evidence that when external interventions actively promote democratic accountability of village leaders, these interventions can reduce the likelihood of elite capture (Persha and Andersson, 2014).

What does this mean for REDD+ interventions? REDD+ represents both risks and opportunities for dealing with problems of elite capture. On the one hand, if REDD+ implementers ignore the skewed distribution patterns that potentially exist in selected intervention sites, the introduced incentives that may form part of the interventions risk exacerbating elite capture. On the other hand, REDD+ interventions could also help address elite capture if implementers not only recognize that such inequalities exist but also proactively design institutions to ensure a more equitable distribution of REDD+ benefits.

At many REDD+ sites, the aim has been to introduce conditional, performance-based "carrots" to forest users if they have fulfilled REDD + requirements of "verifiable emission reductions". To date, however, this approach to REDD+ has barely gotten underway (Sills et al., 2014; Turnhout et al., 2017; Angelsen, 2017). In principle, REDD+ implementers recognize that protecting and increasing local incomes (whether non-forest or sustainable forest incomes) is an instrumental means to achieving forest protection goals. Moreover, implementers recognize that income protection and enhancement must be widely dispersed across the local population for maximum forest-protection effect, implying (at least implicitly) a degree of determination to attain equitable outcomes. However, on-the-ground realities introduce a wide range of obstacles to achieving this goal. Given the limited sample of REDD+ initiatives with actual conditional incentives in place, lessons for how these can work has to be derived from experiences gained in other sectors and from other types of benefits and income streams. Studies on benefit sharing in PES schemes (Loft et al., 2017), community development projects, and participatory forest initiatives can all provide useful insights into how existing inequalities in wealth create vulnerability to elite capture and thus affect the governance outcomes, including forest income distribution.

3. Theory and hypotheses

We propose that policy interventions that offer conditional incentives to motivate local users to conserve natural resources run the risk of deepening economic inequalities within such user communities. The basis for this argument is that previous studies have found that many rural communities are very heterogeneous when it comes to the households' material assets (Agrawal and Gibson, 1999) and that this wealth inequality may affect the household members' ability to generate income from forests (Adhikari, 2005; Fisher, 2004; Rayamajhi

[1] Roughly, half the households are inside REDD+ initiative boundaries.

[2] See Alston and Andersson (2011) for an overview of the potential perverse incentive effects from REDD+ programs.

et al., 2012; Angelsen et al., 2012). Existing patterns of wealth distribution may shape the extent to which households gain access not only to current benefit streams from forests but also from future payments for forest-conservation services, unless such payments are part of programs that explicitly include redistributive mechanisms.

Some households will own land, livestock, farming equipment, and other valuable assets while other households in the same settlement will not have any of these assets in their possession. These existing patterns of inequality have been shaped by long-standing social structures and political processes through which some village residents enjoy an advantage over others when it comes to benefiting from any given benefit stream, whether such streams come from an external policy intervention, a newly developed market opportunity, or the harvesting of natural resources. There is an underlying logic of rent distribution at work here that tends to benefit those that are already relatively wealthy and powerful (Bardhan, 2002; Andersson and Agrawal, 2011).[3] According to this logic, the risk policy programs face is that interventions that seek to provide economic benefits to a socioeconomically heterogeneous group of people may end up benefiting primarily those who are already better off economically, unless these interventions pro-actively seek to prevent such inequalities by designing the intervention in ways that favor the poorer segments of the groups targeted.

Individuals who control more assets and are wealthier than most have greater political influence over collective decisions in the village, and sometimes this influence extends into higher jurisdictions. This asymmetry of power allows the political and economic elites in the locality to steer external interventions and their associated benefit streams in ways that disproportionately benefit their personal interests (Matson et al., 2016; Larson and Ribot, 2007; Torpey-Saboe et al., 2015). Hence, the policy intervention that may have had an intention of improving the welfare of all can end up deepening the existing socioeconomic inequalities within the village: the relatively wealthy get richer and the poor stay poor.

Applying these arguments to forestry activities, we argue that places characterized by high wealth inequality among residents are places that are likely to have relatively unequal distributions of benefit flows from forestry activities (Angelsen et al., 2012). In such villages, richer households can use their wealth to leverage more income from forests by using more advanced technology and hiring labor to increase their economic productivity. Rich households can buy chainsaws and trucks, employ laborers, access markets on more favorable terms and in this way get relatively good returns on their investment. They can also use their political power to gain access to the most valuable forest resources in the most desirable locations. In many cases, we believe a combination of these economic and political advantages are in play to give the richer elites a disproportionate share of valuable forest resources. Over time this process, through feedback loops, can widen the inequality gap, making the richer members of forest user groups even richer without improving the wellbeing of the poor.

In villages with more wealth inequality, we also expect higher variability of user perceptions of tenure insecurity as well as less overall perceived tenure security. The reasoning behind this hypothesis is similar to previous rationales, in that wealthier households are in a position to leverage their privileged economic status within the group and transform it into political clout, swaying the village decision-making process in ways that protect their property rights. One of the means of protecting one's property rights is to make sure they are monitored and enforced, either by the government or by private agents. Being relatively wealthy is likely to improve the likelihood of getting this done either through contracting or exerting political influence. The poorer segments of the village, however, are more vulnerable to encroachments and other violations of their property rights, as they may not have the means to ensure effective protection. We also acknowledge, however, that there are programs in REDD+ countries that are working to change this through targeted interventions to improve tenure security in economically disadvantaged communities, and that these efforts may alter the relationship between wealth disparities and tenure security.[4]

The hypothesized relationships are supported by qualitative observations during the data collection in the field. For example, in two sampled villages in Peru where wealth inequality is high, there is also high variance in forest income. Also, among all of the Brazilian villages sampled, the one with the highest inequality of wealth is located in a REDD+ site where land tenure insecurity is considered a major challenge to the initiative's success. In this site there is also a very high variability in local people's perceptions of tenure security (Cromberg et al., 2014). The opposite relationship is noted at a separate REDD+ site in Peru where native villages have secure land tenure with strong, legally recognized boundaries (Rodriguez-Ward and Paredes del Aguila, 2014) and wealth inequality is low.

Based on the literature review and these qualitative, first-hand observations from the field sites, we expect that villages with relatively high existing inequality of wealth (economic endowments) are likely to have: (a) less overall perceived tenure security and higher variability of user perceptions of tenure security; (b) relatively unequal distributions of benefit flows from forest products as well as external sources of income; and (c) when this occurs, it is the richer households that are likely to be the ones reaping most of the benefits.

4. Empirical approach

Our analysis seeks to explain existing patterns of tenure security and benefit sharing within villages, where benefits are measured as two different sources of income: forest income and external income. These income sources approximate the two types of benefits offered by REDD+: continued forest production and externally-funded incentives to reduce forest carbon emissions. We use the full baseline dataset from the GCS, including both REDD+ and non-REDD+ villages. All data were collected between 2010 and 2012, before the implementation of any REDD+ interventions.[5]

4.1. Dependent variables

We consider three dependent variables. First, we explore tenure security. Respondents identified each piece of land, whether still forested or cleared and used for agricultural purposes, to which they have rights, and identified whether they perceived secure (1) or insecure (0) tenure of that land.[6] In most cases, the individual did not hold formal title and the rights were de facto rights without legal recognition. In fact, as shown in Table 1, nearly 92% of all land across the sample is owned by the State. Nevertheless, over 97% of the land is under de facto control of individuals. On the basis of this pattern in our

[3] North et al. (2009) maintain that rent streams to elites may limit outbreak of violence so that breaking up the extant power structure may end up in conflict and dissipate rents, e.g. costly civil wars are an extreme example.

[4] Alston et al. (1999) show that formal titles to land for small landholders in the Amazon increases land values directly by increasing the extent of the market, and indirectly through access to credit markets and more site-specific investments.

[5] CIFOR selected these 17 initiatives in the six countries largely because they had already defined their intervention areas but had not yet begun implementation when GCS fieldwork began in 2010, allowing collection of baseline data from households and villages both inside and outside the intervention areas. The study included samples of REDD+ and control villages that were similar or "balanced" in terms of characteristics such as population, forest area, accessibility, and sources of deforestation pressure (Sills et al., 2017).

[6] Our measure of tenure security stems from survey questions that asked respondents to estimate their confidence that their household will continue to be able to use, at least for the next 25 years, the land assets they currently have. Forested land is limited to land where 1) a plantation, 2) early secondary forest, 3) mature secondary forest, or 4) mature forests is found. Any deforested land would fall under agriculture, though we do not have data on land history.

Table 1
Ownership and Control by Area.

Control	De Jure Owner			
	Community	Individual	State	Total
Community				
Row Percent	58.74	0.01	41.25	100.00
Column Percent	65.97	0.01	1.29	2.87
Individual				
Row Percent	0.90	5.93	93.18	100.00
Column Percent	34.03	99.98	98.70	97.12
State				
Row Percent	–	8.17	91.83	100.00
Column Percent	–	0.01	0.01	0.01
Total				
Row Percent	2.56	5.76	91.69	100.00
Column Percent	100.00	100.00	100.00	100.00

Note: Data from the GCS Household Survey.

sample, one may infer that tenure security is not based on formal title alone, but rather on individuals' expectations to be able to maintain de facto control over the land and its resources. To create a household measure, we average over all their land, weighted by the area of each plot of land reported. This could be interpreted as the fraction of the land to which the household feels it has secure property rights.

We then consider two proxies for benefit flows. First, we calculate existing income from the forest over the last 12 months, aggregating all types of forest income. Broadly, income is derived from either gathering food/wildlife or timber, with the former accounting for 63% of forest income.[7] Given the extent of de jure State ownership, it should not be surprising that most (over 80%) of this income comes from forests owned by the State.[8] Second, we aggregate income flows from external organizations, including payment for environmental services, support from NGOs, dividends from communal projects, and support from the government. We refer to the second source of income as "external income" and offer it as an additional outcome variable for which distribution within the village may also be indicative of how future REDD + benefits may be distributed, once international carbon finances begin to flow. Village-level aggregations of these variables and the independent variables described below, including their averages and standard deviations, are also used as data to analyze the distributions at the village level.

4.2. Independent variables

Our primary independent variables are based on stocks of assets, maintaining a distinction between land assets and non-land assets. Land is measured by area, while non-land assets are monetized in US dollars and include business assets, animal assets, as well as miscellaneous assets (e.g. transportation, household electrical, furniture, kitchen equipment, farm equipment, and other tools). We also consider the relationship of ethnicity—another avenue through which individuals may derive political power—with the three dependent variables. Each household indicates whether it is part of the dominant ethnic group. If so, we take it to mean that it potentially has access to this political power. When aggregated to the village level, this measure proxies for the extent of cultural homogeneity. We utilize the fraction of forested land, age and education attainment of the household head as well as the number of members of each household as additional controls that may influence our dependent and independent variables of interest.

4.3. Descriptive statistics

Table 2A presents a summary of the data, including the description of the variables, household summary statistics, and descriptive statistics for the village-level aggregations. In Fig. 1 we present histograms for the household-level dependent variables to provide additional insights into the data. Households in our sample tend to feel they have either secure or insecure tenure across all their lands, with only a few (10%) reporting some combination. To provide more context to the issue of tenure security, we show in Fig. 2 how it varies depending on ownership and land use. Two patterns emerge. First, communally owned land is the most secure (0.95), followed by individually owned land (0.84), while State land (the majority) is the least secure (0.75).[9] Secondly, users of individual and State-owned land feel slightly more secure on agricultural land than on forested land.[10]

Returning to Fig. 1, forest income (shown after taking the log) is distributed more normally, but nearly a third of households report no income from forests.[11] Only 50% of households receive external income. The bottom column of Fig. 1 shows the distributions for the independent variables of interest: almost all households (> 98%) report some assets, and the global data appears to fit a normal distribution. Wealth measured by land ownership remains somewhat skewed, even after taking the log, with many villagers owning small plots (20% reported one hectare or less).

Though the global distributions are informative, the data, gathered from diverse areas, exhibit considerable heterogeneity across countries (and villages). In Table 2B we provide the country-specific means. While tenure security is similar, forest and external incomes are highly variable. Forest income is notably higher in Brazil and Peru, respectively one and two magnitudes larger than in the other countries of our sample. In regards to external income, Brazil households receive considerably more than households elsewhere, while households in Tanzania receive far less. Similarly, in terms of wealth, the households in our two South American countries generally have more, as measured by either assets or land, than households in the other countries. We also note that the fraction of land still in forest is above 50% for all countries except Tanzania and Indonesia, where it is much lower.

Even within countries, households across villages exhibit significant variation. As an example, in Fig. 3 we provide box plots for forest income, assets, and total land of the 16 villages surveyed in Peru. Not only is there a wide distribution across village means, but also the distributions within the villages are highly variable. Furthermore, there appears to be some correlation of the villages' distributions across variables. Ultimately, these village-level distributions and the households' relative position within these distributions are what concern us: we seek to develop a better understanding of how the distribution of wealth within a village relates to the distribution of income flows within that village. And, while households in one village may generally have more wealth and income, we aim to understand whether the relatively wealthier within the village receive relatively more or less income regardless of their wealth relative to the entire sample.

4.4. Analytical methods

To achieve these ends, we use regression analysis both at the village and household level to analyze the connection among assets, tenure security, and flows of income. We use a hierarchical, multilevel

[7] Figure A1 in the Supplementary material provides the relative share of these two categories across the 6 countries. Notably Peru is dominated by the food category while Tanzania and Vietnam actually derive more income from timber-related extraction (though the latter two derive the least forest income of all the countries).

[8] Figure A2 in the Appendix breaks down the share of forest income by de jure ownership for each of the 6 countries. Tanzania is the most diverse, including forest income from all types of ownership, but still over 60% comes from State-owned land.

[9] These differences are statistically distinguishable at the 99th percentile confidence interval.

[10] For communally owned land, forested land is slightly more secure, but the distinction is not statistically significant.

[11] In order to include households reporting no land, assets, or forest or external income, we add 1 to the variables prior to taking the log.

Table 2A
Summary Statistics.

		Household Level (N = 3929)				Village Aggregation (N = 130)	
Variable	Description	Mean	Std. Dev.	Min	Max	Average Median	Average Std. Dev.
Tenure Security	Average tenure security of household land (weighted by acreage), Secure = 1	0.80	0.38	0	1	0.80	0.31
Forest Income	USD income from forest activity in the prior 12 months	1,965.41	6,025.18	0	80,138.10	1,201.56	2,328.34
External Income	USD 12-month income from government, NGOs, local politicians, community enterprises, and PES	610.34	1,770.10	0	35,523.96	259.81	948.64
Assets	USD total household assets excluding land	8,848.50	27,265.72	0	490,938.30	4,994.87	13,154.51
Land	Hectares of land under control of the household	84.63	248.33	0	3,942.50	69.89	54.91
Ethnicity	Indicator whether household identifies with the majority ethnic group within the village	0.79	0.41	0	1	0.79	0.23
Land in Forest	Fraction of land under household control in forest rather than agriculture	0.41	0.38	0	1		
Age	Age in years of the head of the household	46.54	13.86	7	98		
Size	Number of people in the household	4.91	2.49	1	26		
Education	Number of years of education attained by household head	5.43	3.88	0	21		

Note: Variables are constructed from CIFOR's GCS Household Surveys. Local currency converted to USD based on June 15, 2010 spot exchange rate. This table reports global summary statistics for the variables utilized in our analysis. The final two columns reports average village-level aggregations (within village median and standard deviation) utilized for village-level analysis.

regression framework to account for correlations and heterogeneity across countries and villages.[12] First we analyze the relationship of the village-level distributions using the following specification at the village level:

$$Village_{vc} = \beta_{0c} + \beta_1 medianassets_{vc} + \beta_2 st.\ dev.\ assets_{vc} + \beta_3 medianland_{vc} + \beta_4 st.\ dev.\ land_{vc} + \beta_5 ethnicity_{vc} + \beta_6 st.\ dev.\ ethnicty_{vc} + \varepsilon_{vc} \quad (1)$$

We use the specification to test our hypotheses stated above. Accordingly, $Village_{vc}$ takes on the various outcomes of interest: a) the villages' overall level of perceived tenure security and the villages' empirical standard deviation of households' perceptions of tenure security; b) the villages' average and standard deviation of household forest income; and c) the villages' average and standard deviation of external funds. Because villages are nested within countries, we let $\beta_{0c} = \gamma_{00} + U_{0c}$, allowing for random intercepts at the country level.

To better understand the village-level distributions, we investigate similar questions at the household level in order to analyze the relative winners and losers when it comes to forest income within villages. Specifically, we use the following specifications in a regression framework:

$$Household_{hvc} = \beta_{0vc} + \beta_1 assets_{hvc} + \beta_2 land_{hvc} + \beta_3 Ethnicity_{hvc} + \beta_4 fractionforest_{hvc} + \beta_5 age_{hvc} + \beta_6 size_{hvc} + \beta_7 education_{hvc} + \varepsilon_{hvc} \quad (2)$$

$Household_{hvc}$ is either: household perceived tenure security; forest income over the last 12 months; or compensation from external sources. We estimate the equation using hierarchical multilevel regressions to recognize that households are nested within villages that are in turn nested in countries. To account for variation across villages and countries and to focus on within-village variation we allow for random intercepts at both levels, i.e. $\beta_{0vc} = \gamma_{00c} + U_{0vc}$, where $\gamma_{00c} = \tau_{000} + \psi_{00c}$.

This allows us to assess whether those with relatively greater assets have relatively higher or lower levels of tenure security, forest income, or external income. For the household models we transform the measures of income and wealth by taking natural logs to reduce the influence of the observations far out in the right tail of the distributions, though results are qualitatively similar without the transformation (available in the Supplemental material). This mixed-linear model is appropriate despite the censoring of the dependent variables seen in Fig. 1, because the global distributions are not indicative of variation within villages, and when the variables are centered on the village mean, distributions appear more normal (shown in the Supplemental materials, Figure A3). Nevertheless, as a precaution, we do run alternative models and find that the results are robust to our modeling choice.[13]

The main independent variables of interest are the measures of wealth (assets and land) and ethnicity. In our regression analyses, we also control for measures of human and natural capital that have been shown to influence tenure security and the distribution of benefits from forests (Fisher, 2004; de Sassi et al., 2014; Andersson and Agrawal, 2011). Specifically, we include measures that are pre-determined or otherwise exogenous to tenure and forest income. These include the fraction of land controlled by the household that has forest cover; the age and educational attainment of the household head; and the size of the household as represented by the count of members.[14] Further, the regressions are run on the entire sample, but also by individual country to consider heterogeneous effects across various national institutional, economic, and ecological settings.

5. Results

The quantitative results provide evidence in support of each of the three hypotheses. The three main findings may be summarized as: (1) Villages with high levels of wealth inequality are more likely to experience higher variability of tenure security within the village and less tenure security overall for the village as a whole; (2) Villages with high levels of wealth inequality experience more unequal distributions of income from both forestry and external sources, and (3) Richer

[12] As shown by Bolker et al. (2009) hierarchical multilevel regression is particularly useful for analyses, like ours, where there are multiple sources of variation: intra-village, inter-village, and cross-country variation.

[13] For all three outcomes, we also run OLS regressions with village-level fixed effects, using only within village variation to identify statistical relationships. We also run models informed by the global distributions. For tenure, we apply a fixed effects logit model to recognize the primarily binary nature of the variable. For forest and external income we run Tobit models with village-level fixed effects to address the censored nature of the data. We note that bias from the incidental parameters problem in the Tobit models are generally small and the concern is related to disturbances with variance estimator (Greene, 2004). However, because our panel is not "short" ("i" is the 130 villages while "T" is around 30 households for each village) the problem is minimized.

[14] We also have household data on agricultural income, wage labor income, and market distance but decided not to include these variables in our regressions. The reason for not including the two income variables is the potential endogeneity issue this would cause; e.g. that forest income may explain wage income as much as wage income explains forest income. The reason we forego market distance is that this variable has very little variation within the villages of our sample, which is the main source of variation we are interested in.

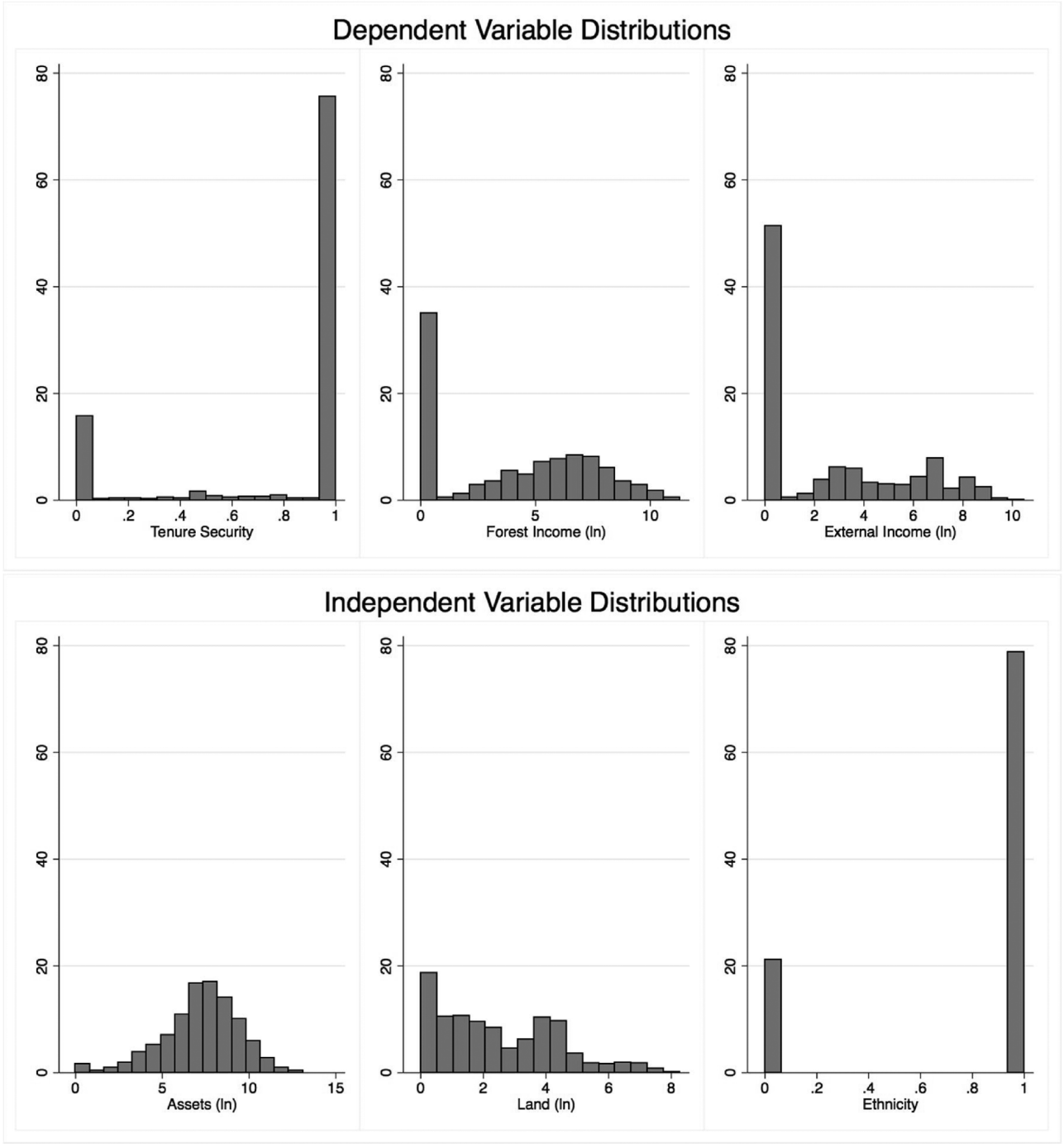

Fig. 1. Histogram with percentage of observations in bins.

households receive a greater share of their village's total forest income (but not of external income streams). Below, we present the evidence behind each of these findings.

(1) Villages with high levels of wealth inequality are more likely to experience higher variability of tenure security within the village and less tenure security overall.

In Table 3 we report the regression results for the four outcomes of interest at the village level. With regard to tenure security, villages with larger standard deviations of non-land assets report lower levels of security on average (column 1) and have greater variability in tenure security across the households (column 2), as predicted. The magnitude of the effect of wealth inequality on these two outcomes is significant when considering the scale of variation in inequality between villages: increasing the inequality of non-land assets by one standard deviation accounts for 22% of the standard deviation of tenure security distribution and 25% of the standard deviation of village-average tenure security levels. The coefficient estimates for the standard deviation of land assets exhibit the same pattern, decreasing overall security and increasing variation in tenure security, but these estimates are not statistically significant.

A closer look at the coefficients in column 1 shows that villages where households generally have more land also tend to report lower levels of tenure security. An additional hectare per person reduces the amount of land reported secure by 0.05%. Meanwhile, though not statistically significant at typical levels, wealth as measured by non-land assets has an estimated positive relationship with tenure security

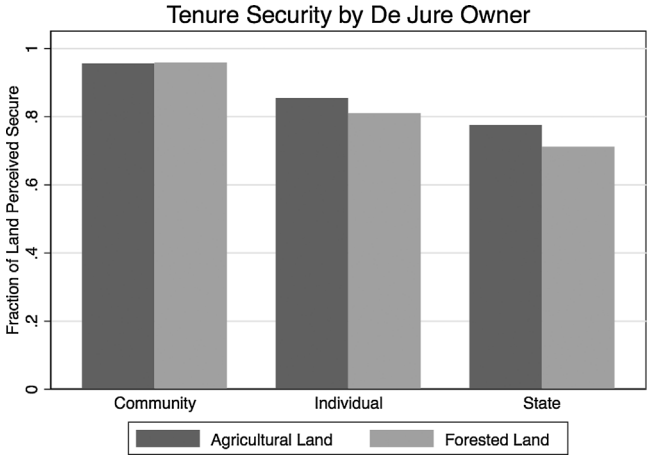

Fig. 2. Average reported tenure security by owner and land type.

at the village level. In contrast to high levels of non-land assets (which may increase tenure security through political access), more land assets increase the cost of enforcing claims, offering an explanation to the decrease in perceived tenure security for those with larger land-holdings.[15] Finally, the ethnic composition of a village also helps to explain tenure security levels; villages with higher standard deviations of the ethnic identity of households are associated with lower levels of tenure security. Given the construction of this variable, the result is evidence of a non-linear relationship of tenure security and ethnic heterogeneity. That is, the *rate* of decline in tenure security increases as the proportion of households from the dominant ethnic identity declines.[16] Because this measure impacts the mean and not the standard deviation of the tenure security, the evidence is suggestive that the lower tenure security is experienced by all members in the village, not just those in the minority.

(2) Villages with high levels of wealth inequality experience more unequal distributions of income from both forestry and external sources.

In columns (3) through (6) of Table 3 we show the statistical relationship between village wealth distributions and income distributions that may mirror REDD+ benefits. Generally, larger distributions of wealth are predictive of larger distributions of income flows. Reported in column (3), villages where households generally have more land also derive more income from forests, an additional 13.50 USD per person for each hectare per person. This average is even higher (5.65 USD) where the standard deviation of landholdings is larger (by an additional hectare). Additionally, in column (4) we find that villages with larger variation in land assets also have larger variation in forest income: a one standard deviation increase in the land inequality measure accounts for 34% of the standard deviation of forest income inequality. At the village level, non-land assets and their distribution do not further explain the distribution of forest income, though the point estimate is positive. Looking at external income, it appears that on average 2.25 USD per person more support flows to villages for every 100 USD per person less of wealth and that additional support flows to villages where the variation of non-land wealth is greater. Meanwhile, a similar pattern to that of variation in forest income appears for the variation in external sources of income: the higher the wealth inequality the higher the variation of external income, though in this instance only the estimate for non-land assets is statistically significant. Overall, high variability in wealth is associated with high inequalities of income from both forests and external sources of income.

(3) Richer households receive a greater share of their village's total forest income.

In Table 4 we report the household-level analysis for tenure security. In column (1) we find, contrary to our expectations, no overarching relationship between wealth and tenure security. There is, however, some heterogeneity across countries. In terms of non-land assets, there is weak support of our hypothesis in the form of positive and statistically significant point estimates for Indonesia and Vietnam. In Vietnam, for example, a one percent increase in the value of non-land assets is associated with a 2.8 percentage point increase in the likelihood of reporting secure tenure. Even more surprising is that the relationship is the reverse in Brazil, where a 1% increase in wealth correlates to a 2.19 percentage point reduction in the odds of reporting complete tenure security. Given our expectations that richer individuals could better protect their property, the negative relationship in Brazil is addressed in the discussion section below. One should note that reported tenure security is overall relatively high given the lack of formal title: nearly 3000 of the surveyed households report feeling completely secure (=1). Nevertheless, 600 (17%) report insecurity (=0) on all their lands. The mean is around 0.80 as an area-weighted aggregation of individual household security.

In terms of land wealth, while villages that generally have more land per household feel more insecure in their tenure (result from the village-level analysis), there is not much evidence that this holds true within villages. Only in Peru do we find a statistically significant relationship, and it is negative; a percent increase of land-holdings is associated with lower odds (3.15 percentage points) of land tenure reported as completely secure. Though we expect wealth to increase security, we actually find the opposite. This may be because having more land can increase enforcement costs, and these costs may exceed the benefits rich households derive from holding more political power.

In support of our village-level results, we find that ethnic identity of the household explains very little variation of tenure security. These results are consistent with the notion that more homogenous villages have greater tenure security, but benefits from increases in security are shared among both majority and minority ethnic groups. Notably, Cameroon villages mark the exception where being part of the ethnic majority does increase the likelihood of reporting secure tenure.

Given the importance of forested land to the goals of REDD+, we also test the relationship between tenure security and forested land. Overall, we find that forested lands are 6.35 percentage points less likely to be reported as having secure tenure: the larger the fraction of land in forest, the lower tenure security is overall. It is not readily identifiable through our analysis whether the insecure tenure drives deforestation or the other way around (deforestation leading to greater tenure security), though possibly both effects are at work. Individual country results expose regional patterns: the Sub-Saharan African countries in our sample (Tanzania and Cameroon) exhibit a positive relationship between security and forest, while the South American and Southeast Asian countries exhibit a negative relationship.

As far as the distribution of forest income goes, evidence from our household-level regression analysis, reported in Table 5, is consistent with our hypotheses of elite-capture: greater stocks of wealth are positively associated with greater amounts of forest income. The point-estimates on the wealth measures can be interpreted as elasticities. For example, a 1% increase in non-land wealth is associated with 0.042% additional forest income. The relationship with non-land assets is strongest and most pronounced in Peru, where a doubling of assets is associated with 26.2% higher forest income flow, likely given the very high household reliance on forest income at these sites. The relationship is also statistically significant in Tanzania (and Brazil and Indonesia in linear-linear specifications available in the Supplemental material, Table A3).

Land assets seem to be a particularly important source of wealth and co-variant of forest income: a household with twice as much land as

[15] Though not presented here, including population density as a measure of competition yields no explanatory power and leaves the remaining coefficients stable.

[16] This is because the standard deviation of a binary variable is inversely related to the mean. So as the proportion of households in the dominant ethnic group decreases, the standard deviation of the variable increases.

Table 2B
Household Mean by Country.

	Brazil	Peru	Cameroon	Tanzania	Indonesia	Vietnam
Tenure Security	0.76	0.82	0.87	0.87	0.77	0.86
Forest Income	1,136.82	11,098.48	664.96	65.35	529.27	162.01
External Income	1,815.47	116.47	139.66	4.14	190.33	167.32
Assets	22,621.83	8,881.37	2,191.09	1,241.07	2,672.23	2,717.66
Land	92.33	437.05	13.58	2.23	6.21	3.62
Ethnicity	0.99	0.44	0.58	0.69	0.85	0.93
Land in Forest	0.64	0.55	0.50	0.13	0.18	0.53
Age	47.41	48.78	45.62	46.59	44.74	48.52
Size	4.41	4.62	5.89	6.23	4.64	4.65
Education	3.02	8.01	7.36	4.13	5.98	7.06
Observations:	1106	491	493	433	1175	231

Note: Variables are constructed from CIFOR's GCS Household Surveys. Local currency converted to USD based on June 15, 2010 spot exchange rate.

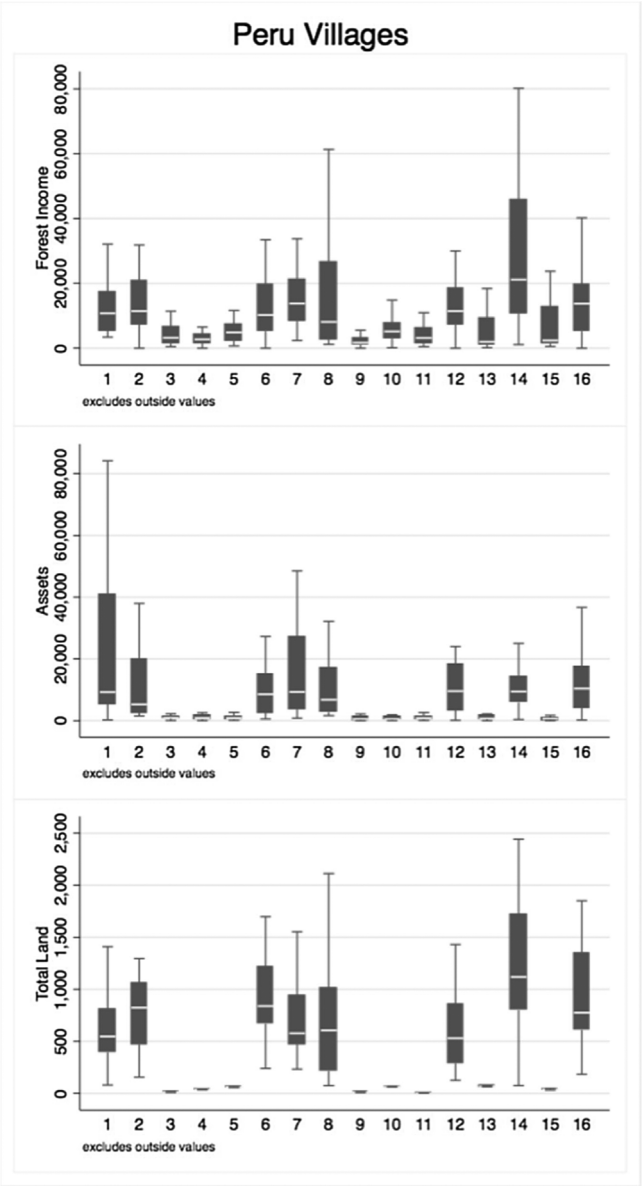

Fig. 3. Distribution across Peru villages for forest income and measures of wealth.

another generates 20% more forest income on average. Evidence of this positive relationship appears in Brazil, Peru, Indonesia, Vietnam, and Cameroon, though point estimates are statistically significant only for the first three. In contrast, households in Tanzania, where forest income tends to be the smallest, exhibit a strong negative relationship between land ownership and forest income.

Finally, in Table 6, we examine which households are the main beneficiaries of the external income flows; unlike what we observed for forestry-income, we find little evidence supportive of elite capture. In fact, in the pooled regression, those households with less land are predicted to receive more external benefits. Having half as much land is associated with 7.85% more external income. The relationship is particularly pronounced in Brazil and Vietnam. For instance, in Vietnam households with 1% less land receive 0.72% more external income. One should note, however, that the data on external income are quite incomplete—on average less than 15% of households reported any such income (compared to more than 70% for forestry income), and it is not evident that lumping together such a wide variety of "other" income sources into one category reflects any distinct distribution practice within a given village. These limitations may help to explain the general lack of significant results for this outcome variable.

6. Discussion

In the aggregate, household disparities in wealth seem to play an important role in shaping the distribution of forestry-related benefits within villages in our sample. A closer look at this relationship within the six countries reveals heterogeneous patterns. In this section, we present how the relationship between wealth and income distributions varies across countries, and we discuss possible reasons for such heterogeneous effects.

The overall results are driven to some extent by relationships observed in the South American countries of Brazil and, in particular, Peru, where wealth inequality seems to be particularly strongly correlated with distributions of both income and perceptions of tenure security. In Brazil and Peru, forest income also represents a much higher percentage of income than elsewhere, and this reality likely drives much of our results. For example, the livelihoods of villagers of the Peruvian site in Madre de Dios depend on income from the commercial sales of Brazil nut to a very high degree (Garrish et al., 2014). Average forest income is between 60 and 70% of total income in Peru, while it is less than 20% for the rest of the sites in our sample.

Our aggregate results, as well as the raw data in Fig. 2, indicate that perceived tenure security is higher for households with land covered in relatively less forest. The legislation for property rights in many of these countries helps explain these results. Historically, it has been easier to get a title to an area of public land if you have already deforested it—showing that you are "working the land" (Alston et al., 1999; Alston and Andersson, 2011). Accordingly, higher security on agricultural land may stem from anticipated recognition by the State, or on stronger local claims based on occupation, use and social networks, as found in Cronkleton and Larson (2015). Still, in multiple study villages in the Brazilian Amazon, perceived tenure security was low and in a few cases coupled with a perceived lack of ability to exclude unwanted users from

Table 3
Village-Level Distributions.

	(1) Tenure	(2)	(3) Forest Income	(4)	(5) External Income	(6)
VARIABLES	Mean	St. Deviation	Mean	St. Deviation	Mean	St. Deviation
Median Assets	3.48e-06	−1.17e-06	−0.0120	−0.00967	−0.0225**	−0.0165
	(2.53e-06)	(1.87e-06)	(0.0193)	(0.0339)	(0.00933)	(0.0138)
St. Dev. Assets	−1.93e-06**	1.50e-06**	0.000408	0.00939	0.00739**	0.0123***
	(8.78e-07)	(6.42e-07)	(0.00664)	(0.0117)	(0.00321)	(0.00476)
Median Total Land	−0.000495**	0.000248	13.59***	6.329**	−0.524	−0.0329
	(0.000222)	(0.000165)	(1.710)	(2.990)	(0.824)	(1.219)
St. Dev. Total Land	−9.27e-05	0.000236	5.654***	10.09***	0.784	2.162
	(0.000261)	(0.000191)	(1.972)	(3.460)	(0.952)	(1.414)
Mean Ethnicity	−0.0366	−0.0848	1068	2702**	−55.48	417.9
	(0.0950)	(0.0708)	(736.9)	(1287)	(354.7)	(524.3)
St. Dev. Ethnicity	−0.210*	0.0341	1353	2099	−367.7	−128.9
	(0.127)	(0.0939)	(973.4)	(1704)	(469.3)	(695.7)
Constant	0.947***	0.292***	−218.6	−1185	560.6	245.7
	(0.111)	(0.0898)	(1095)	(1662)	(474.2)	(653.8)
Observations	130	130	130	130	130	130
Number of Countries	6	6	6	6	6	6

Note: Hierarchical regression model results with village-level aggregations of household outcomes with random intercepts at the country level. Standard errors in parentheses.
*** p < 0.01.
** p < 0.05.
* p < 0.1.

Table 4
Household Tenure Security.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Assets (ln)	0.00282	−0.0219*	0.00417	0.00494	0.00837	0.0146**	0.0286*
	(0.00386)	(0.0121)	(0.0114)	(0.00805)	(0.00772)	(0.00705)	(0.0166)
Land (ln)	−0.000711	0.00474	−0.0315***	0.00842	0.0164	0.00254	0.000620
	(0.00713)	(0.0170)	(0.0122)	(0.0204)	(0.0222)	(0.0155)	(0.0299)
Ethnicity	0.0256	−0.00867	0.0589	0.0779***	−0.00210	−0.0103	0.0650
	(0.0181)	(0.113)	(0.0589)	(0.0297)	(0.0333)	(0.0325)	(0.0600)
Land in Forest (Fraction)	−0.0635***	−0.173***	−0.198***	0.251***	0.192**	−0.150***	−0.222***
	(0.0239)	(0.0622)	(0.0654)	(0.0576)	(0.0805)	(0.0398)	(0.0589)
Age	0.000157	−0.00129	−0.000129	0.00140	0.00201**	−0.000166	0.00117
	(0.000446)	(0.00104)	(0.00118)	(0.00100)	(0.00103)	(0.000877)	(0.00113)
Size	0.00336	−0.00174	0.0112*	−0.000487	0.00506	−0.00266	0.00132
	(0.00244)	(0.00533)	(0.00678)	(0.00483)	(0.00494)	(0.00581)	(0.0101)
Education	−0.00292	−0.00837*	−0.00282	0.00239	−0.000192	−0.00672**	0.00102
	(0.00181)	(0.00435)	(0.00407)	(0.00480)	(0.00497)	(0.00324)	(0.00571)
Constant	0.792***	1.147***	1.003***	0.570***	0.664***	0.768***	0.633***
	(0.0447)	(0.167)	(0.131)	(0.0770)	(0.0788)	(0.0766)	(0.144)
Sample	All	Brazil	Peru	Cameroon	Tanzania	Indonesia	Vietnam
Observations	3929	1106	491	493	433	1175	231
Number of Villages	130	37	16	13	15	41	8

Note: Hierarchical regression model results for the area-weighted average household tenure security. Column (1) pools all data for a single regression utilizing random effects at the village and country level. Columns (2)–(7) presents regression results for individual countries with random effects at the village level. Standard errors in parentheses.
*** p < 0.01.
** p < 0.05.
* p < 0.1.

local landholdings even when such lands had already been cleared (Duchelle et al., 2014). In one village where there were land use conflicts with a local timber company, inequality in wealth and forest income was pronounced, possibly due to some villagers profiting from collaborations with the timber company. In another Brazilian site, where forestlands are held as common property, invasions were frequent, and people have increasingly chosen to turn away from the forest as a source of income. They now make their income from milk production and other non-forest uses, and wealth inequality is high. In such situations, it may be that the wealthier members of the village perceive their tenure to be relatively insecure because they feel more exposed to potential land invasions as well as increased monitoring by the Brazilian national environmental protection agency. The combination of greater visibility of landholdings and increased sanctions may help explain the negative correlation between wealth and tenure security we found in Brazil rather than the positive relationship we hypothesized initially, but more research is needed to sort out this relationship.

Given the preponderance of the land legally owned by the State, we find the relationship between household forest incomes and land claims even more compelling. On the one hand, there is likely a direct relationship between the amount of land controlled by a household and the amount of forest-income derived (or at least the potential to generate forest income) from the controlled forests. In this sense, the correlation with this asset (compared to non-land assets) could be viewed as a physical relationship rather than an institutional relationship (related to property rights). On the other hand, the ability to control more State land within the village may proxy for other measures of “elite” positions within the village. As suggestive evidence, we show in Fig. 4

Table 5
Household Forest Income.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Assets (ln)	0.0423*	0.0624	0.262***	−0.0215	0.121***	0.0436	−0.0285
	(0.0251)	(0.0769)	(0.0520)	(0.0603)	(0.0425)	(0.0457)	(0.159)
Land (ln)	0.201***	0.269**	0.166***	0.101	−0.498***	0.181*	0.264
	(0.0511)	(0.111)	(0.0545)	(0.153)	(0.122)	(0.101)	(0.288)
Ethnicity	−0.00490	0.106	0.0210	0.0411	−0.106	0.278	−0.230
	(0.119)	(0.712)	(0.270)	(0.228)	(0.183)	(0.211)	(0.570)
Tenure	−0.109	−0.0757	−0.173	0.192	−0.0764	−0.397**	0.929
	(0.102)	(0.190)	(0.206)	(0.330)	(0.265)	(0.189)	(0.587)
Land in Forest (Fraction)	0.0190	1.324***	−0.0198	0.539	2.247***	−1.029***	−0.0827
	(0.158)	(0.408)	(0.297)	(0.461)	(0.449)	(0.261)	(0.566)
Age	−0.0208***	−0.0264***	−0.00450	−0.0333***	−0.00254	−0.0217***	−0.0300***
	(0.00284)	(0.00658)	(0.00540)	(0.00758)	(0.00571)	(0.00565)	(0.0109)
Size	0.110***	0.131***	0.0669**	0.127***	0.101***	0.123***	−0.0214
	(0.0157)	(0.0335)	(0.0311)	(0.0353)	(0.0274)	(0.0374)	(0.0977)
Education	−0.0457***	−0.0588**	−0.0164	−0.0940***	0.00178	−0.0366*	−0.112**
	(0.0117)	(0.0275)	(0.0186)	(0.0357)	(0.0275)	(0.0210)	(0.0550)
Constant	3.937***	2.955***	5.964***	4.401***	1.949***	3.220***	2.622**
	(0.901)	(1.090)	(0.632)	(0.809)	(0.460)	(0.596)	(1.321)
Sample	All	Brazil	Peru	Cameroon	Tanzania	Indonesia	Vietnam
Observations	3929	1106	491	493	433	1175	231
Number of Villages	130	37	16	13	15	41	8

Note: Hierarchical regression model results for household forest income logged. Column (1) pools all data for a single regression utilizing random effects at the village and country level. Columns (2)–(7) presents regression results for individual countries with random effects at the village level. Standard errors in parentheses.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

Table 6
Household External Income

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Assets (ln)	0.0130	0.0194	0.0349	0.00936	−0.0238	−0.0393	−0.198
	(0.0262)	(0.0948)	(0.0598)	(0.0611)	(0.0222)	(0.0316)	(0.196)
Land (ln)	−0.157***	−0.296**	−0.0410	0.104	0.00338	−0.0194	−0.727**
	(0.0520)	(0.131)	(0.0589)	(0.154)	(0.0630)	(0.0701)	(0.355)
Ethnicity	0.115	0.905	0.127	0.258	0.113	0.0574	0.195
	(0.123)	(0.890)	(0.311)	(0.225)	(0.0958)	(0.146)	(0.703)
Tenure	−0.00178	0.358	−0.0199	−0.124	0.00497	−0.261**	0.343
	(0.107)	(0.235)	(0.238)	(0.345)	(0.140)	(0.131)	(0.724)
Land in Forest (Fraction)	−0.152	0.220	−0.0957	−1.537***	0.204	0.000237	0.576
	(0.162)	(0.482)	(0.332)	(0.437)	(0.238)	(0.181)	(0.698)
Age	0.0299***	0.0664***	0.0149**	0.0423***	0.000682	0.00988**	0.0715***
	(0.00299)	(0.00814)	(0.00625)	(0.00757)	(0.00304)	(0.00391)	(0.0135)
Size	0.110***	0.365***	−0.0586	−0.0500	0.0100	0.0411	0.357***
	(0.0165)	(0.0418)	(0.0357)	(0.0370)	(0.0147)	(0.0259)	(0.121)
Education	−0.0130	−0.117***	0.0541**	0.0922**	0.00819	0.00974	0.00246
	(0.0123)	(0.0342)	(0.0214)	(0.0365)	(0.0146)	(0.0145)	(0.0679)
Constant	0.359	0.362	−0.517	−0.265	0.165	2.415***	−1.822
	(0.755)	(1.338)	(0.725)	(0.596)	(0.238)	(0.408)	(1.630)
Sample	All	Brazil	Peru	Cameroon	Tanzania	Indonesia	Vietnam
Observations	3929	1106	491	493	433	1175	231
Number of Villages	130	37	16	13	15	41	8

Note: Hierarchical regression model results for household external income logged. Column (1) pools all data for a single regression utilizing random effects at the village and country level. Columns (2)–(7) presents regression results for individual countries with random effects at the village-level. Standard errors in parentheses. *$p < 0.1$.

*** $p < 0.01$.

** $p < 0.05$.

that across all countries, wealthier households, in terms of non-land assets, also secure control of more land.[17] However, because we explicitly control for non-land assets in our regressions, this specific correlation is already accounted for and estimates are based on variation beyond this relationship. In other words, the effect of land ownership on forest and external income we identify account for other unobserved characteristics that permit a house to control more land. We submit this is likely to include measures of wealth not captured in the survey, such as political influence and power that may have allowed a household to garner control over larger expanses of State-owned forests. In any case, given the de jure State ownership of the land, the increase in forest income owing to more land is, at least partially, related to institutional factors that lead to larger claims.

We recognize that our results are hampered by potential endogeneity issues, and consequently do not make causal claims. One could argue that a high-income stream from forest resources will over time lead to greater accumulation of assets and other measures of economic wealth. Given the variables, however, the reverse causality must at least be persistent or mediated through a third factor. Assets

[17] These relationships are statistically significant in all countries. In addition, this pattern holds true looking within individual villages, but graphical presentation would be unwieldy. Meanwhile, underscoring the importance of looking within villages and utilizing multilevel analysis, if the entire sample is pooled, the relationship is, on net, negative.

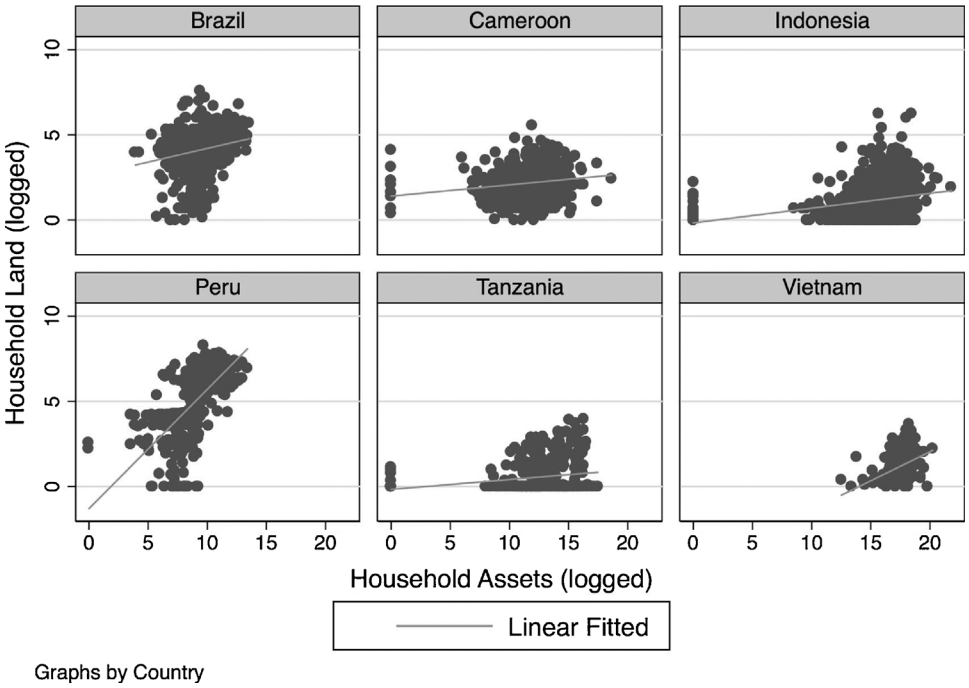

Fig. 4. Relationship between household assets and household land claims by country.

and land ownership represent stocks while the forest income measures a one-year flow, making it highly unlikely that the prior year's forest income readily explains the accumulated stock of assets. Moreover, recent analyses using the same dataset have found that villages in which cattle-raising activities represent the dominant local livelihood strategy have significantly higher levels of wealth inequality compared to other livelihood strategies, while forestry activities did not have the same association (de Sassi et al., 2014). Even though we cannot completely dismiss the possibility that access to forest income over many years may have contributed to the concentration of overall asset accumulation in the sampled villages, we still find the correlation between wealth inequality and forest-income inequality to be important. If inequalities relate to current forest income streams and the future benefit streams from PES schemes, REDD+ projects, and other external interventions that follow, many members of the community run the risk of being less likely to be compensated and therefore uninterested in adopting conservation services. Because those villages that exhibit greater levels of inequality also report higher levels of tenure insecurity, uncompensated villagers may undermine conservation goals by not seeing it in their personal interests to honor local commitments to externally-funded programs to conserve forests.

These results carry implications for REDD+ interventions to the extent that they, whether implicitly or explicitly, aim to reduce inequality. Because our data predates any REDD+ interventions in our sample, we cannot analyze how these interventions may exacerbate or mitigate the existing inequalities that correlate to the derivation of forest income. However, we contend that the patterns we observe here can be useful in anticipating, monitoring, and avoiding REDD+ interventions that could contribute to increasing income inequality. This poses a hurdle for REDD+ proponents to avoid exacerbating the existing inequalities, because in its purely performance-based form, those that change behavior from extraction to conservation will benefit most. It seems reasonable to assume that relatively richer members of user groups are the ones who will face the least difficulties in performing and hence reap most of the REDD+ benefits. However, REDD+ payments could also potentially help alleviate unequal flows of income from the forest, if their distribution were conditional on social goals as well as additional reductions in forest carbon emissions. Our evidence indicates that while more forest income accrues to wealthier households, other external sources of income have targeted less wealthy households. This may undermine the theoretical efficiency of a pure performance-based scheme but could contribute to overall sustainability by helping deliver social co-benefits. REDD+ payments based on multiple objectives have been tested, e.g. in Nepal (Sharma et al., 2015). To the extent that this satisfies more users and/or reduces tenure insecurity, then the conservation goals may also be more likely met in the longer run.

7. Conclusion

Conservation of globally important forests relies on the actions of local people who depend on those forests for a variety of benefit flows. If interventions to bolster conservation are to be successful, it is increasingly recognized that local users need to receive benefits, offering the potential to increase incomes while conserving more forest. But inequality, insecure land tenure, and elite capture may all undermine the achievement of those intervention goals. Using unique household data from countries in SubSaharan Africa, Southeast Asia, and South America, we show how existing wealth inequality within villages relates to tenure security, forest income, and external income.

Although the relationship differs somewhat from one country to the next, the overall pattern is quite clear: the higher the inequality of wealth, and especially when it comes from non-land assets within a village, the more unequal is the distribution of all three types of benefits. In looking at individual positions in the village wealth distribution, we find that the wealthier individuals tend to receive more forest income. Our findings pose both challenges and opportunities for the design of future REDD+ interventions.

Most REDD+ programs are designed to provide two basic types of benefits to local people: (a) externally funded benefits intended as incentives to conserve forest, such as PES and support for alternative livelihoods, and (b) direct benefits from the conserved forest, including forest products (which can be sold or consumed) and ecosystem services (which can be inputs to production or directly increase well-being). Because REDD+ interventions are quite new, we do not have direct observations of the distribution of (a), but we can predict the distribution of (b) based on the current distribution of forest income. Based on existing relationships between wealth and forest income, this

avenue alone may very well deepen existing inequalities within villages, and if the design of these benefit-sharing systems for externally funded incentives does not proactively address existing wealth inequalities within villages, we may see a deepening of socioeconomic cleavages within villages that participate in REDD+ programs (Larson et al., 2013). Promisingly, our results also found that external benefits to date have disproportionately flowed to the relatively less wealthy (in terms of land assets). Again, without systematic data on REDD+ interventions we cannot analyze benefits from these programs directly, but we do contend that these existing distributions can be informative in anticipating potential pitfalls and opportunities for REDD+ interventions.

REDD+ interventions represent an opportunity to address widespread problems of inequality within rural villages that depend on forests. If these interventions are designed carefully and with progressive measures to favor socioeconomically disadvantaged village households, these programs may help prevent continued discrimination of the relatively poorer segments of societies. In fact, in many sampled villages, we see some signs of hope that organizations are paying attention to this issue by making an effort to address these pitfalls. Proponent organizations at almost all the study sites have made an earnest effort to clarify tenure and address skewed distribution of benefits from REDD+ payments (Sunderlin et al., 2014; Luttrell et al., 2013; de Sassi et al., 2014). It remains unclear, however how far these actions will go toward avoiding or compensating for the unwanted, and often unforeseen, consequences of their interventions. Such efforts are likely to be more effective if policy actors at national and international levels recognize the risks associated with implementing REDD+ through narrowly focused performance-based incentives in the context of substantial pre-existing inequalities.

Acknowledgements

Financial support for this work was provided by grants from the National Science Foundation (SES-0648447, DEB-1114984, and BCS-0527165), and The MacArthur Foundation (#858830) to the University of Colorado-Boulder, as well as by the following grants to the Center for International Forestry Research (CIFOR): The European Commission (DCI-ENV/2011/269520), the Norwegian Agency for Development Cooperation (QZA-10/0468, QZA-12/0882, and QZA-16/0110), the Australian Department of Foreign Affairs and Trade (Grant #46167 and 63560), the International Climate Initiative of the German Federal Ministry for the Environment, Nature Conservation, Building, and Nuclear Safety (KI II 7-422066/75), and the United Kingdom Department for International Development (DfID-UKTF069018). We also thank the CGIAR Research Program on Forests, Trees and Agroforestry (FTA), with financial support from the donors contributing to the CGIAR Fund. This research is part of CIFOR's Global Comparative Study on REDD+ (www.cifor.org/gcs).

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.landusepol.2018.01.012.

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