MODELLING THE OPPORTUNITY COST OF REFORESTATION IN THE UPPER EAST REGION OF GHANA

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BACKGROUND

A common challenge in the design of Payments for Environmental Services (PES) is balancing both, conservation and poverty alleviation goals. Addressing this challenge requires targeting strategies.

PROBLEM STATEMENT

The Upper East region (UER) is mostly populated by subsistence agriculture farmers living under the local poverty line. They face hard climatic conditions and have deteriorated their land. A reforestation PES program in the region could contribute to alleviate the situation.

Figure 1: UER of Ghana with Communities.

Source: Autor.

STUDY OBJECTIVE

This study attempts to model the Opportunity Cost (OC) of reforestation contracts in the UER based on characterizations of poor rural livelihoods against a revealed preference benchmark.

METHODOLOGY

We chose a sample of 12 communities, 4 in each of 3 districts from a dataset by Tambo and Wünscher (2011) that contained the characterization of randomly selected households in the UER. Household Heads were invited to a workshop in their community, where we conducted sealed bid auctions following a mockery one. Afterwards, we did GPS-tracked measurements of the farms to derive geo-spatial variables.

We applied two alternative modeling approaches: linear and hierarchical, using nesting for districts and communities with restricted maximum likelihood for the latter. We tested the preference benchmark derived from the auctions (n=275) against the models described.

Box 1. Models description.

Linear

$$OCl = \alpha + \beta_1 physical\ capital + \beta_2 natural\ capital + \beta_3 financial\ capital + \beta_4 human\ capital + \beta_5 vulnerability\ context$$

Hierarchical

$$OCd = \alpha_{District} + \beta_1 physical\ capital + \beta_2 natural\ capital + \beta_3 financial\ capital + \beta_4 human\ capital + \beta_5 vulnerability\ context$$

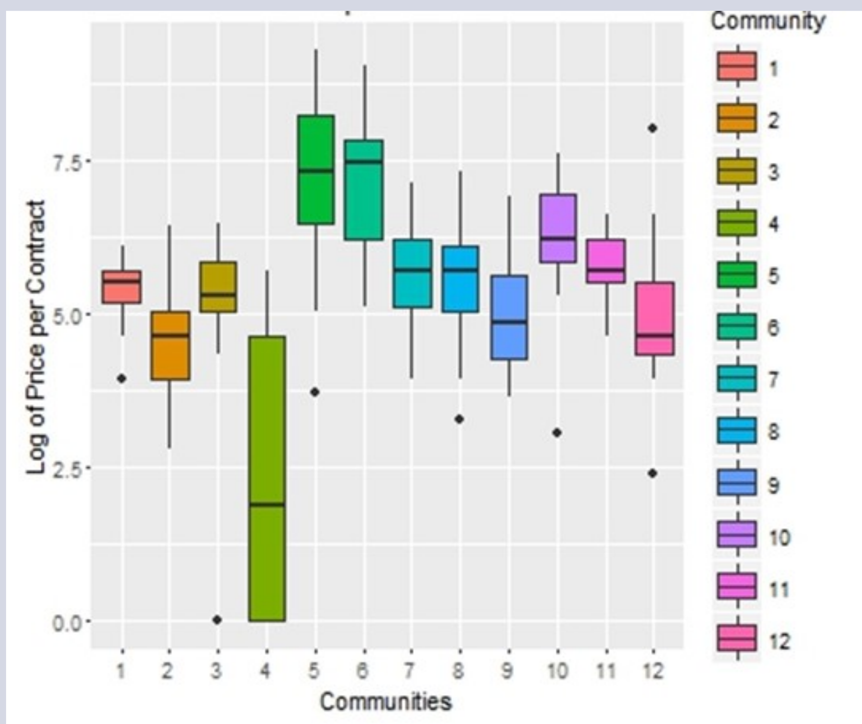
$$OCc = \alpha_{Community} + \beta_1 physical\ capital + \beta_2 natural\ capital + \beta_3 financial\ capital + \beta_4 human\ capital + \beta_5 vulnerability\ context$$

Source : Autor.

RESULTS

The model that best expressed estimates was the nesting by communities, albeit at generally low levels of accuracy. The community effects were highly significant reflecting the influence of the location in its relationship to distance to markets, tarmac roads and nearest city amongst others.

Figure 2. Boxplot of Log auction price according to Communities.



Source: Own calculations.

The model revealed household characteristics that positively influence the OC: (1) the share of the household members involved in farming proved to be highly significant, that might be related to the lack of income diversification. (2) Dependency ratio was statistically significant, price increases when the working age population decreases relative to the people that must be supplied. (3) The more distant the plots are, the higher the price. This might be related to investment in energy and time to reach them. The opposite could be expected when the distant plots are non-productive.

Table 1. Models summary.

	Model nested by community		Model nested by district		Linear Model - no nesting	
	Coefi.	Std. Error	Coef.	Std. Error	Coef.	Std. Error
Random effects: Community(12)/District(3) /Intercept	7,807	(2.57) **	3,784	(2.12) .	10,2	(1.96) ***
Proportion of HH members farming	1,242	(0.42) **	1,304	(0.43) **	1,247	(0.49) *
Dependency ratio	0,241	(0.11) *	0,2	(0.12)	0,213	(0.13)
Savings (yes)	0,311	(0.17) .	0,248	(0.18)	0,286	(0.20)
Crop Loss (yes)	-0,277	(0.19)	-0,353	(0.20) .	-0,578	(0.22) *
Elevation	-18,86	(10.5) .	1,483	(9.55)	-11,33	(10.6)
Change of mean rainfall per day	-0,139	(3.45)	1,931	(1.82)	4,604	(1.98) *
Distance to nearer city	-0,077	(0.15)	-0,039	(0.07)	-0,182	(0.08) *
Disttance to markets	-0,047	(0.11)	0,039	(0.05)	-0,259	(0.05) ***
Distance from HH to plots	0,204	(0.09) *	0,174	(0.08) .	0,043	(0.09)
Distance to Tarmac Road	0,068	(0.05)	0,156	(0.03) ***	0,024	(0.03)
Distance to water sources	-0,345	(0.17) .	-0,307	(0.18) .	-0,518	(0.20) *
Ω^2		0,55		0,5		0,35
AIC		921,21		922,96		974,38
BIC		1037		1038,7		1086,5
Deviance		857,21		858,96		912,38
Chisq		55,169		0		
Pr(>Chisq)		1.10e-13 ***		1		

Signif. codes: 0.0001 '***' 0.001 '**' 0.01 '*' 0.05 '.'

Source : Own calculations.

CONCLUSION

A hierarchical linear model to study the opportunity cost for PES programs, rather than using village level indicators in an OLS regression, seems to deliver better estimates; this model could serve as a base on which programs can be further built upon by targeting certain communities that yield higher benefits.

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