



Payments for Forest Environmental Services – How Much Do We Really Have to Pay?

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Introduction

Payments for Environmental Services (PES) have become a widely acknowledged and increasingly popular market based instrument to conserve forests and their beneficial services. In most PES programs service buyers make **fixed** per hectare payments to land owners. Yet, **flexible** payments adjusted to the land owner's opportunity cost have the potential advantage to buy services at a lower price than fixed payments. However, cost effective estimation of individual opportunity costs is a major challenge. The objective of this study is to evaluate three estimation approaches.



Forests can make important contributions to the regulation of water provision and quality.

Tropical Forests are the most biodiverse ecosystem in the world. For example, one single tree in Peru was found to harbor forty-three different species of ants.



Methodology – Three Estimation Approaches

The analysis is based on data from a field survey with 178 land owners on Nicoya Peninsula, Costa Rica. We calculate per ha opportunity costs based on: i. monetary farm flows (Flow); ii. annual rents derived from land sale prices (Rent) and iii. the farmer's individual perception of per ha returns (Perception). The work intensive and costly Flow approach is assumed to be the most precise estimate of real opportunity costs. The other approaches are less work intensive and present cost effective estimation alternatives.

Results - Absolute Opportunity Costs

The descriptive results show differences between approaches (Table 1). In terms of average opportunity costs, the Flow approach reveals the smallest value (56.60\$), followed by the Perception approach (84.11\$) and the Rent approach (109.26\$). However, only the mean values of the Flow and Rent approaches are significantly different (according to ANOVA). While the Rent approach revealed strictly positive opportunity costs, we obtained several negative values in the Flow approach and in the Perception approach 22 farmers perceived per ha returns to be zero.

Approach	n	Mean	S.D.	Min.	Max.	Range
Flow	178	56.60	123.47	-363.31	624.56	987.87
Rent	178	109.26	146.16	13.35	980.26	966.91
Perception	120	84.11	161.28	0.00	1428.57	1428.57

Table 1. Opportunity Costs (in US\$) according to different approaches

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Results – Relative Opportunity Costs

While absolute opportunity cost estimates partly differ between approaches, we also tested whether the approaches are consistent in their relative estimates. I.e., land plots with relatively high opportunity cost estimates in one approach should also tend to have relatively high estimates in the other approaches and vice versa. We tested this hypothesis with a correlation analysis. Table 2 shows that only opportunity cost estimates of the Flow and Perception approaches are significantly correlated.

Variables	n	Pearson	Signif.	Spearman	Signif.
Flow/Perception	120	0.27	*0.003	0.50	*<0.001
Flow/Rent	178	-0.04	0.56	-0.05	0.53
Rent/Perception	120	0.09	0.32	0.12	0.21

Table 2. Correlation analyses of opportunity cost estimates between approaches

Results – Opportunity Costs and WTA

Eventually we calculated the explanatory potential of the opportunity cost estimates for the land owners' expressed willingness to accept (WTA), i.e. their decision to accept (1) or refuse (0) a PES contract under the payment level and conditions of the Costa Rican PES program from 2005. For this we estimated simple binary logistic models. Table 3 shows that although the opportunity costs of the Flow approach deliver a significant estimator ($p=0.032$), the explained variance of that model remains low ($R^2=0.038$).

Dep. Variable	Indep. Variable	n	Est.	S.E.	ExpB	Wald	p	#R ²
WTA (1;0)	Flow	178	0.003	0.001	1.003	4.585	0.032	0.038
WTA (1;0)	Rent	178	0.000	0.001	1.000	0.001	0.974	0.000
WTA (1;0)	Perception	120	-0.002	0.002	0.998	0.628	0.428	0.011

*Nagelkerkes Pseudo-R²

Table 3. Logit Models: Opportunity Costs explaining WTA (1=accept, 0=otherwise)

Conclusion

The results show that only the Perception approach presents a viable estimation alternative to the work intensive and costly Flow approach. Other than the Rent approach, it delivered a mean opportunity cost not significantly different from the Flow approach and both (Flow and Perception) are statistically correlated. However, none of the three approaches delivered opportunity cost estimates which sufficiently explain the land owners' decision to participate in the PES program (WTA). If that is the case, and if WTA also depends on variables other than opportunity cost, then even the most precise opportunity cost estimates are insufficient in a PES program's attempt to flexibilize payments because payment offers would not necessarily result in the land owner's participation. As the other explanatory variables are unknown, either further research is required to identify them and quantify their explanatory effect, or another alternative methodology is required to determine required payment levels. One potential methodology are auction systems. Auction systems can help to stimulate the service provider to reveal real acceptable payment levels taking all relevant decision factors into account.

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