Overcoming tenurial constraints to carbon forestry projects in Africa

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Background

- ***Common perception from PES literature***: Tenure insecurity is often a major constraint in implementing payment for ecosystem services (PES) schemes for forests in developing countries.

- In Africa the dominance of customary law coupled with the inability of the state to develop and enforce legal institutions, policies and financing have thwarted efforts to introduce formal land titling.

- Only about 1 percent of land in Africa is registered and titled formally (Easterly 2008).

- ***Alternative view***: In Africa tenure security is often contingent on the continuous use of the land (Braselle et al. 2002; De Zeeuw, 1997; Sjaastad and Bromley 1997; Unruh 2008).

- Although tenure security can be an inducement to land-related investment, the reverse can also occur: tree planting and other land investments can improve claims to the land (*endogenous* property right).

Aims

- This paper explores how participation in carbon forestry financed by PES schemes affects the land allocation decision of smallholders between crop production and tree planting.

- We look explicitly at the role of land tenure.

- We model three land allocation scenarios for a representative smallholder:
  - Private ownership
  - Insecure ownership with an exogenous threat of eviction
  - Insecure ownership with risk of eviction reduced through afforestation

Results

- If the smallholder is faced with an exogenous threat of eviction, less land will be converted to carbon forestry compared to when the eviction threat is absent.

- However, under customary tenure, where the farmer's tree planting can reduce the threat of eviction, the amount of land allocated to carbon sequestration tree plantation may even exceed that in private ownership regime.

- The prospect of increased tenure security encourage African farmers with customary tenure to continue to commit resources beyond the point where marginal cost and benefits normally would converge (Sjaastad and Bromley 1997).

- The implication is that in Africa land allocated for tree planting under customary tenure could be greater than that in private ownership, and is certainly more than if tenure security is completely absent.

Policy implications

- Although much of the PES literature focuses on secure tenure as a requirement for participating in carbon forestry PES schemes, we find that the prospect of improving the security of tenure can also act as a potential incentive mechanism for tree planting.

- This implies that, in situations where the production of environmental services requires a long-term commitment of land resources, a win-win PES scheme can be designed for poor farmers with only customary land tenure.

- As African agriculture is dominated by customary land holdings, working with the existing *de jure* land right system is not necessarily an impediment to carbon forestry PES schemes.

- Instead a properly designed scheme with appropriate incentives can both increase carbon forestry on customary land and improve the livelihoods of millions of African farmers.

Land allocation

- The smallholder has an initial fixed amount of land for crop production $L(0) = L_0$ and possibly some land devoted to carbon forestry $F(0) = F_0 \geq 0$.

- At any time t, if the farmer can choose to convert some cropland to carbon forestry at rate $c(t)$, then

$$L(t) = L(0) - \int_0^t c(s)\, ds\,, \qquad \dot{L}(t) = -c(t) \qquad (1)$$

- Similarly

$$F(t) = F(0) + \int_0^t c(s)\, ds, \qquad \dot{F}(t) = c(t) \qquad (2)$$

- Implying $\quad F(t) = F(0) + L(0) - L(t) \qquad (3)$

- It is also assumed that no clearing of trees for crop production occurs, i.e. $c(t) \geq 0$.

Land allocation under private ownership

- The objective of the smallholder is to choose the optimal land allocation to maximize the aggregate present value return from all land uses, V, by choosing the optimal variable inputs $z(t)$ and the rate of land conversion $c(t)$

$$\underset{z,c}{Max}V = \int_0^T \left[Pf\left(F\left(t\right),z\left(t\right)\right) - W\left(z\left(t\right)\right) + B\left(F\left(t\right)\right) - C\left(c\left(t\right)\right) \right]e^{-rt}dt + e^{-rT}R\left(F\left(T\right)\right)$$

s.t. $\dot{F} = c\left(t\right), \; c\left(t\right) \geq 0, \; z\left(t\right) \geq 0$

- Where (3) allows the crop production function to be written as

$$q\left(t\right) = f\left(F\left(t\right),z\left(t\right)\right), \; f_F < 0, f_{FF} \geq 0$$

- P is crop price, $W(.)$ is variable input cost, $C(.)$ is the cost of conversion and $R(.)$ is the salvage value from clear cutting standing trees at the end of the PES contract at time T.

- The periodic PES payment received by the farmer is based on the area devoted to carbon forestry

$$B\left(F\left(t\right)\right), \; B' > 0 \; \text{and} \; B'' \leq 0$$

Key outcomes

- Letting μ(*t*) represent the shadow, or imputed, value of afforested land

$$\mu - C' \leq 0, \quad c(t) \geq 0, \quad c(t)[\mu - C'] = 0 \qquad (9)$$

- If it is worthwhile to do so, the farmer converts crop land into afforested land until the marginal cost of conversion equals the shadow value of converted land.

- Along the optimal path of conversion *the internal rate of return* (the increase in the value of the afforested land plus relative marginal return from carbon forestry) *is equal to the opportunity cost of conversion* (the discount rate plus the forgone relative marginal returns from crop production).

$$\frac{\dot{\mu}}{\mu} + \frac{B'}{C'} = r + \frac{Pf_L}{C'} \qquad (12)$$

- If *B* = 0, the farmer would "underproduce" carbon forestry.

- Optimal path: initially *F* is low and thus μ is high. However, over time μ and *c* fall. But there will always be a positive stock of *F* at time *T*.

Exogenous tenure insecurity

- We view tenure insecurity as the smallholder's perceived probability of the risk of eviction.

- Let τ be the time at which eviction occurs, and assume it is a continuous random variable

- Define the *survival function*, *S*(*t*) as the probability that farmer survives eviction up to time *t* and the corresponding *hazard function* is the conditional probability of eviction at time *t*, given that the smallholder has not been evicted up to that time.

$$S(t) = \Pr(\tau \geq t) = \exp\left\{-\int_0^t h(v)\,dv\right\}$$

- This last expression enables us to introduce a new state variable

$$y(t) = -\ln S(t) = \int_0^t h(v)\,dv, \quad \dot{y} = -\frac{\dot{S}}{S} = h(t), \quad y(0) = 0 \quad (13)$$

- If tenure security is purely exogenous, then no actions by the smallholder can affect the probability of eviction and the *hazard rate is constant*

$$h(t) = \overline{\theta} \qquad S(t) = \exp\left\{-\int_0^t h(v)\,dv\right\} = e^{-\overline{\theta}t}$$

Key outcomes

$$Max_{z,c} J = \int_0^T \left[Pf\left(F(t), z(t)\right) - W\left(z(t)\right) + B\left(F(t)\right) - C\left(c(t)\right) \right] e^{-rt-y(t)} dt + e^{-rT-y(T)} R\left(F(T)\right)$$

$$\text{s.t. } \dot{F} = c(t), \quad \dot{y} = h, \quad c(t) \geq 0, \quad z(t) \geq 0$$

- Along the optimal path of conversion, the internal rate of return from converting and afforesting land must equal to the opportunity cost of converting cropland.

$$\frac{\dot{\tilde{\mu}}_1}{\tilde{\mu}_1} + \frac{B'}{C'} = r + \overline{\theta} + \frac{Pf_L}{C'}$$

- The effective discount rate is increased by the constant hazard rate.

- The result is an increase in the opportunity cost of tree planting, due to the risk of eviction.

- The implication is that less land will be converted to carbon forestry compared to the case when the eviction threat is absent.

Customary land tenure

- Under customary land tenure, if smallholders undertake tree planting and other land-related investments it enhances their tenure security.

- The risk of eviction is *endogenous*, and the hazard rate is inversely related to the amount of land committed to carbon forestry

$$\dot{y} = h(t) = \theta(F(t)), \quad \theta' < 0, \quad y(0) = 0 \quad (22)$$

- Along the optimal path of conversion, the internal rate of return must still equal the opportunity cost of conversion

$$\frac{\dot{\rho}_1}{\rho_1} + \frac{B' + \rho_2 \theta'}{C'} = r + \theta(F) + \frac{Pf_L}{C'} \quad (29)$$

- As before, the risk of eviction increases the effective discount rate, thereby decreasing the land allocated to carbon forestry.

- But the internal rate of return now includes the impact of afforestation in decreasing the relative risk of eviction.

- Whether the optimal land allocated to carbon sequestration tree plantation is greater or less than that in private ownership regime depends on the relative size of the two effects.

Optimal carbon forestry payment

- Under *private property*, the smallholder must receive a payment in each period equal to $(B' + \dot{\mu})/r$

- If not, then the smallholder will not be compensated for the opportunity cost of converting cropland to carbon forestry Pf_L/r

- Under *exogenous tenure security*, the optimal carbon forestry payment must take into account the higher effective discount rate due to the threat of eviction $\left(B' + \dot{\mu}_1\right)/(r + \theta)$

- For *customary land tenure*, the payment must include the benefit of afforestation in reducing the risk of eviction $\dfrac{B' + \dot{\rho} + \rho_2\theta'}{r + \theta(F)}$

- In all cases, the optimal payment is large initially and declines over the life of the PES contract.

Conclusion

- A common perception is that long-term environmental service provision, such as carbon sequestration through tree planting, cannot take place unless a landowner has secure and enforced private property rights to the land.

- We show that landowners with customary land tenure can be efficient providers of long-term environmental services, such as carbon forestry, especially if tree planting helps secure their permanent claims to the land.

- This conclusion has important implications for the participation in PES schemes of many poor farmers with customary land tenure, especially in Africa.

- Not only is customary land tenure dominant throughout the region, but past efforts to convert rural farmland to private ownership have been largely unsuccessful.

- Thus, the results of our analysis support the view that carbon forestry and other PES schemes should accommodate the traditional African customary tenure systems, and if designed successfully, can both promote tree-based carbon sequestration and benefit the poor (Jindal et al. 2008; Unruh 2008).