

# COMPENSATIONS TO CURB DEFORESTATION & ENVIRONMENTAL MERIT

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*Workshop Mechanism Design and Environment 8-9 May 2013, Edinburgh*

# Introduction

- The deforestation problem : important for CO2 emissions and loss of biodiversity  $\Rightarrow$  a North-South externality problem.
- The REDD mechanism : Tropical countries willing to reduce their deforestation level below a threshold, called the baseline, will be eligible for monetary compensation from the north.
- Cost-efficient mechanism, not Pareto optimal (PO)
- Asymmetric information : hidden information on countries for the regulator
- Can we find a mechanism that reaches PO, knowing the information structure ?

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# Debate about the baselines

$$t(d_i^b - d_i)$$

- Different countries propose different baselines
- Historical baselines (Brazil, Indonesia)
- Taking countries' development path into account (Congo Basin Countries)
- Taking past efforts to reduce deforestation into account (Costa Rica)  
⇒ Concern for international fairness

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# Question and Outline

- Can we find an international transfer mechanism to curb deforestation efficiently? Could it have other desirable properties (Acceptability and fairness)?
- Outline
  - Model
  - Mechanism and PO
  - Acceptability : individual rationality (IR)
  - Fairness : taking environmental responsibility into account

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# Literature

Varian, 1994, Danziger and Schnytzer 1991, Guttman 1987 :

- 2 firms : firm 1 produces a good and a negative externality which borne is by firm 2
- 2-stages mechanism : firm 1 compensates firm 2
- The mechanism implements a PO as a Subgame Perfect Nash Equilibrium (SPNE).
- The deforestation : a negative externality. It's impossible to tax deforesting countries ;
- We have to subsidize avoided deforestation as in REDD

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# Notations

- 1 GDP rich country low-endowed with forests and 2 tropical countries well endowed in forests ( $i=1,2$ )
- $\bar{d}_i$  the total amount of forest that country  $i$  could clear (its forest stock, exogenous)
- $d_i^{BAU}$  country  $i$ 's actual level of deforestation (exogenous, ha/year)
- $d_i$  country  $i$ 's choice of level of deforestation
- $y_0^n$  the initial wealth of the north and  $y_0^i$  the initial wealth in each tropical country



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# Notations

- South's utility :

$$U^i(d_i, y^i) = u^i(d_i) + y^i$$

where  $y^i$  is the country  $i$ 's wealth :

$$u^{i'} = \begin{cases} > 0 & \forall d_i \in [0, d_i^{BAU} [ \\ = 0 & \forall d_i \geq d_i^{BAU} \end{cases}$$

et  $u^{i''} < 0$ .

# Notations

- North's utility :

$$U^n(D, y^n) = u^n(D) + y^n$$

where  $y^n$  is the north's wealth,  $D = d_1 + d_2$  et :  
 $u^{n'} < 0$  and  $u^{n''} < 0$

- Laissez-faire :

$$u^{i'} = 0 \quad \Rightarrow \quad d_i = d_i^{BAU}$$

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# Optimum

- The PO is given by :

$$\begin{aligned} \max_{d_i, y^i, y^n} U^n(D, y^n) \\ \text{s.c. } U^i(d_i, y^i) &\geq \bar{U}^i \\ y^n + y^1 + y^2 &= y_0^n + y_0^1 + y_0^2 \end{aligned}$$

- So :

$$u^{i'} = -u^{n'}$$

- The externality problem leads to a social dilemma



# Mechanism

2-stage mechanism :

① Price choice stage :

Each tropical country  $i$  chooses a price  $t^i$  for avoided deforestation. Simultaneously, the North chooses 2 prices  $t_n^1$  (resp.  $t_n^2$ ) for the avoided deforestation in country 1 (resp. 2). Countries are informed of the chosen prices

②  $d_i$ 's' choice stage :

Each tropical country chooses its deforestation level  $d_i$ .

Transfers are implemented ex post.

# Mechanism

The transfers implemented at the end of the mechanism are :

- Each tropical country  $i$  will receive :

$$T_i = \begin{cases} t_n^i(d_i^b - d_i) - \epsilon(t_n^i - t^i)^2, & \epsilon > 0 & \text{si } d_i \leq d_i^b \\ 0 & & \text{otherwise} \end{cases}$$

- The North will have to pay  $P = P^1 + P^2$  with :

$$P_i = \begin{cases} t^i(d_i^b - d_i) & \text{si } d_i \leq d_i^b \\ 0 & \text{otherwise} \end{cases}$$

When  $d_i \leq d_i^b$ ,  $y^i$  and  $y^n$  become :

$$\begin{aligned} y^i &= y_0^i + t_n^i(d_i^b - d_i) - \epsilon(t_n^i - t^i)^2 \\ y^n &= y_0^n - \sum_i t^i(d_i^b - d_i) \end{aligned}$$

# Resolution

(by backward induction :)

- Stage 2 :

$$\max_{d_i} U^i(d_i, y^i) \Leftrightarrow u^{i'} = t_n^i$$

and so  $d_i^*$  is a function of  $t_n^i$ .

- Stage 1 (1) :  
in the South :

$$\max_{t^i} U^i(d_i, y^i) \Leftrightarrow t^i = t_n^i$$

# Resolution

- Stage 1 (2) :  
in the North :

$$\max_{t_n^1, t_n^2} U^n(D, y^n) \Leftrightarrow -u^{n'} = t^1 = t^2$$

so at the SPNE, we have :

$$t^i = t_n^i = u^{i'} = -u^{n'}$$

Since at the OP we have  $u^{i'} = -u^{n'}$ , the PO is reached as a interior SPNE.

# What other properties do we want ?

- Southern countries can always reject the mechanism !

If the mechanism is not acceptable, countries in the South will reject it and it won't be efficient

⇒ The mechanism should be acceptable : IR (no agent should be worse off with it)

- The mechanism should be fair : take responsibility into account as suggested by the international community
- how to define the baselines ?

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# Acceptability as IR

- The mechanism is IR and is not rejected if :

$$U^i(d_i^*, y^{i*}) \geq U^i(d_i^{BAU}, y_0^i)$$

and :

$$U^n\left(\sum_i d_i^*, y^{n*}\right) \geq U^n\left(\sum_i d_i^{BAU}, y_0^n\right)$$

- Worldwide IR : There exist a set of acceptable baselines  $\left[\underline{d}^b; \bar{d}^b\right]$

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# Compatibility of IR and PO

- This set cannot be determined without information on countries preferences...not available to the regulator.
- However,  $d_i^{BAU} \in [\underline{d}^b; \bar{d}^b]$ ,  $\forall i$ .  
the regulator can choose the BAU level without having information on countries preferences.
- The farther the baseline from the BAU level, the higher the risk of losing IR (either in the South or in the North)

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# Fairness : taking responsibility into account

- As proposed by the international community : the responsibility of countries in the global deforestation should be taken into account in the baseline definition
- countries which deforested a lot in the past should not have higher baselines (historical baselines)
- countries which made efforts to reduce their level of deforestation should not have smaller baselines
- => need to determine those who are more responsible and those who are less responsible for the deforestation problem

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# What are countries responsible for ?

Basic idea : countries have some characteristics. They control some of them and, in this case, they should bear the consequence of their control. On the contrary, they should be compensated for the adverse influence of characteristics beyond their control (handicaps).

- responsible for : preferences.
- not responsible for :  $\bar{d}_i$ , technologies  $s_i(\cdot)$  ?

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# A measure of Merit

- absolute "merit" :  $m_i = \bar{d}_i - d_i^{BAU}$

- relative "merit" :

$$\tilde{m}_i = \frac{\bar{d}_i - d_i^{BAU}}{\bar{d}_i}$$

- adjusted relative "merit" :

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where :  $\tilde{d}_i^{BAU}$  = what country i would have deforested if it had the best technology

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# How to take merit into account

Define :

$$\Delta M_i = M_i - \bar{M}$$

Deserving (resp. undeserving) countries are those with  $\Delta M_i > 0$  (resp.  $\Delta M_i < 0$ ).

Wanted property : Recognizing Merit

The more deserving a country is, the higher its baseline !

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## **Wanted property : Recognizing Merit**

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# Possible baselines & tradeoff between merit and efficiency

A proposal for baselines :

$$d_i^{b*} = \alpha \Delta M_i \sum_{h=1}^m (\bar{d}_h - d_h^{BAU}) + d_i^{BAU}, \quad \alpha \geq 0$$

- If  $\alpha$  is small,  $d_i^{b*}$  is in the set of acceptable baselines,  $\Rightarrow$  the mechanism is IR, lead to an PO and take merit into account.
- The more the regulator wants to take the merit into account, the higher the risk of rejection by some Southern countries (the responsible ones, which are the first target of the REDD mechanism).

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# Conclusions

- Mechanism at the intersection of 3 literatures : mechanism design literature, empirical literature (REDD), and theory of justice.
- Possible to reach PO, IR and M but tradeoffs!!!
- Taking responsibility into account limits the possibility of ecological threat.

Thanks for you attention