Who should pay for climate? Emissions, resources and technological transfers in a two-economy model

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1. The concept

There is nowadays a widespread recognition that a massive reduction of greenhouse gas (GHG) emissions is required. At the recent Copenhagen Conference it was agreed "to limit global average temperature rise to a maximum of 2 degrees above pre-industrial levels", and that "deep cuts in global emissions are required according to science".
Unfortunately, a huge issue was left unsettled: **Who should abate?** How should the burden of reduction be distributed?
The topic of burden sharing is particularly relevant if we consider that a large set of countries have only recently started to develop and see as their right to continue the process of convergence to industrialized countries' standards of living. Since western countries development has taken place thanks to massive resources extraction and polluting emissions, it could be argued that its now their responsability to carry the largest part of the burden. This is the rationale behind the so called **Brazilian Proposal**, which suggests that reductions of emissions are to be shared among countries proportional to their relative share of *historical* responsibility for climate change.

The goal of the paper is to test different distribution strategies in terms of welfare, focusing in particular on the role of **technology transfer**.

2. The basic model

- There are two economies in the model: North (N) and South (S)
- We assume that each economy, if considered alone, behaves as in Stokey(1998): it produces goods using the dirtiest technology available until a certain level of income; after that investments are made in order to achieve a cleaner production technology and total pollution reaches a steady state or decreases.

This is obtained by assuming a social utility function with two arguments: **1.** Consumption of private goods (C) **2.** Stock of pollution (X):

$$U_i = \frac{C_i^{1-\sigma} - 1}{1-\sigma} - \frac{b}{\gamma} X^{\gamma} \qquad i = N, S$$

In other words, we are assuming that an 'endogenous' Environmental Kuznets Curve (EKC) exists.

- A standard production function is assumed:

$$Y_i = A_i K_i^{\alpha} \qquad i = N, S$$

3. The basic model (continued)

- Each country can control emissions by choosing the value of its 'domestic control rate': μ (Nordhaus, 2008). We also allow for technological transfers from North to South, represented by parameter ν (Yang, 1999). We can thus write capital dynamics as:

$$\dot{K}_N = A_N K_N^{\alpha}(1 - \mu_N - \nu) - \delta_N K_N - C_N$$
$$\dot{K}_S = A_S K_S^{\alpha}(1 - \mu_N) - \delta_S K_S - C_S$$

A share of total output Y is 'invested' in domestic control of emissions, $\mu_N Y$ in the North and $\mu_S Y$ in the South; another share νY is transferred from North to South.

- Pollution stock dynamics can be written as:

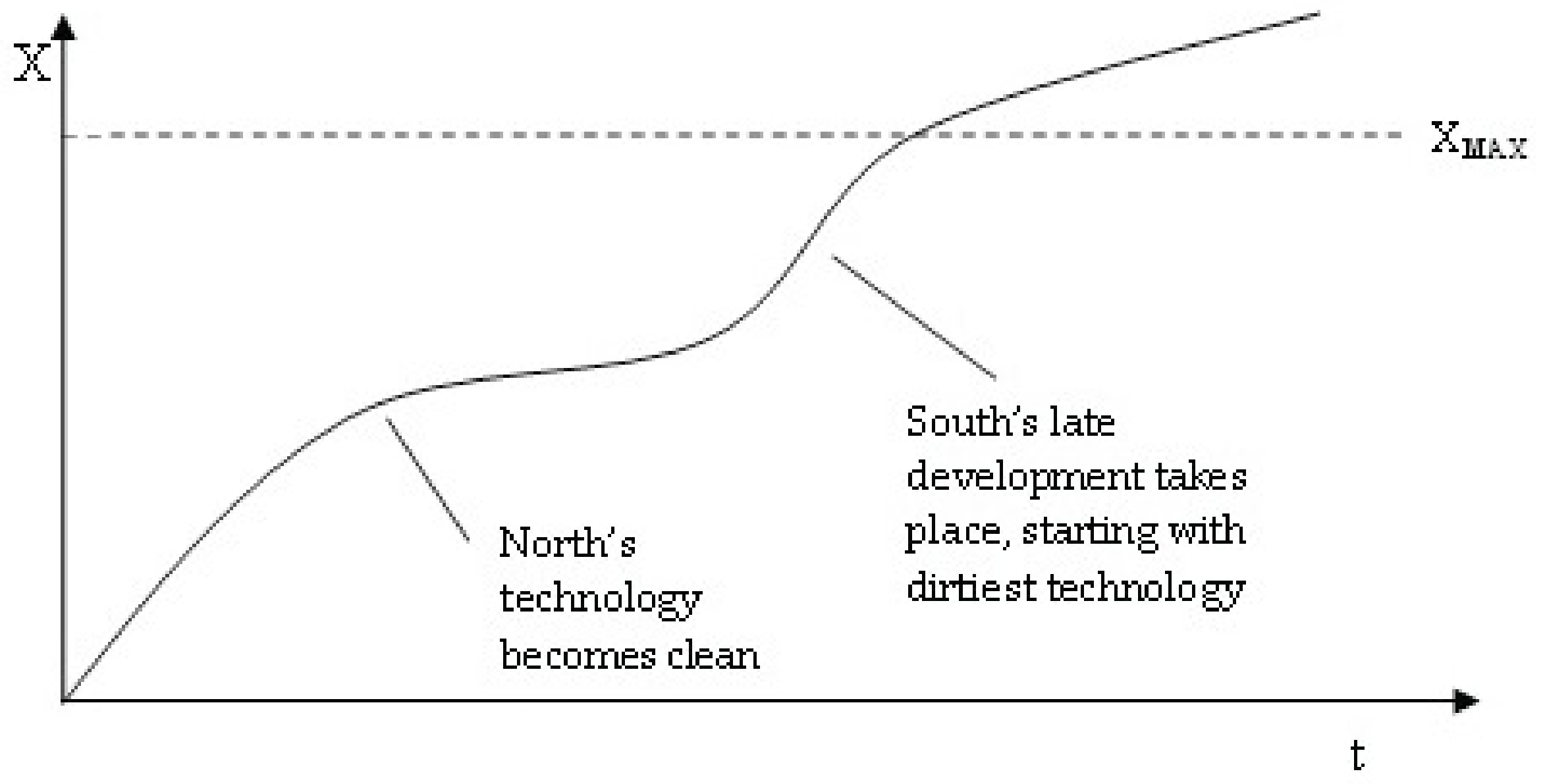
$$\dot{X} = e_N + e_S - \eta X$$

Total pollution stock is determined by emissions by both North (e_N) and South (e_S). Parameter η is the atmospheric regeneration rate.
Countries emissions are proportional to economic activity:

$$e_N = (1 - \mu_N)^{\beta} A_N K_N^{\alpha}$$
$$e_N = (1 - \mu_N - \nu)^{\beta} A_S K_S^{\alpha}$$

- Within this framework it is possible to run some simulations, assuming different strategies:

1. Every country maximizes its own utility function considering the pollution stock caused just by its own emissions. This situation would probably be unsustainable, as depicted below:



2. As case 1, but at a certain date τ an agreement comes into being, after which everybody maximizes global X. This however raises an equity issue, since developing countries are forced to consider an already big stock of pollution entirely created by the North: μ_S rises before time.
3. As case 2, but we allow for technological transfers. It might be optimal for the North to freely transfer technology to the South.
4. A social planner maximizes global social welfare W, where:

$$W = \theta U_N + (1-\theta) U_S$$

But: **How much is θ?** We could try equal shares ($\theta = 0.5$) or establish 'right' weights considering historical emissions (i.e. test Braz. Proposal)

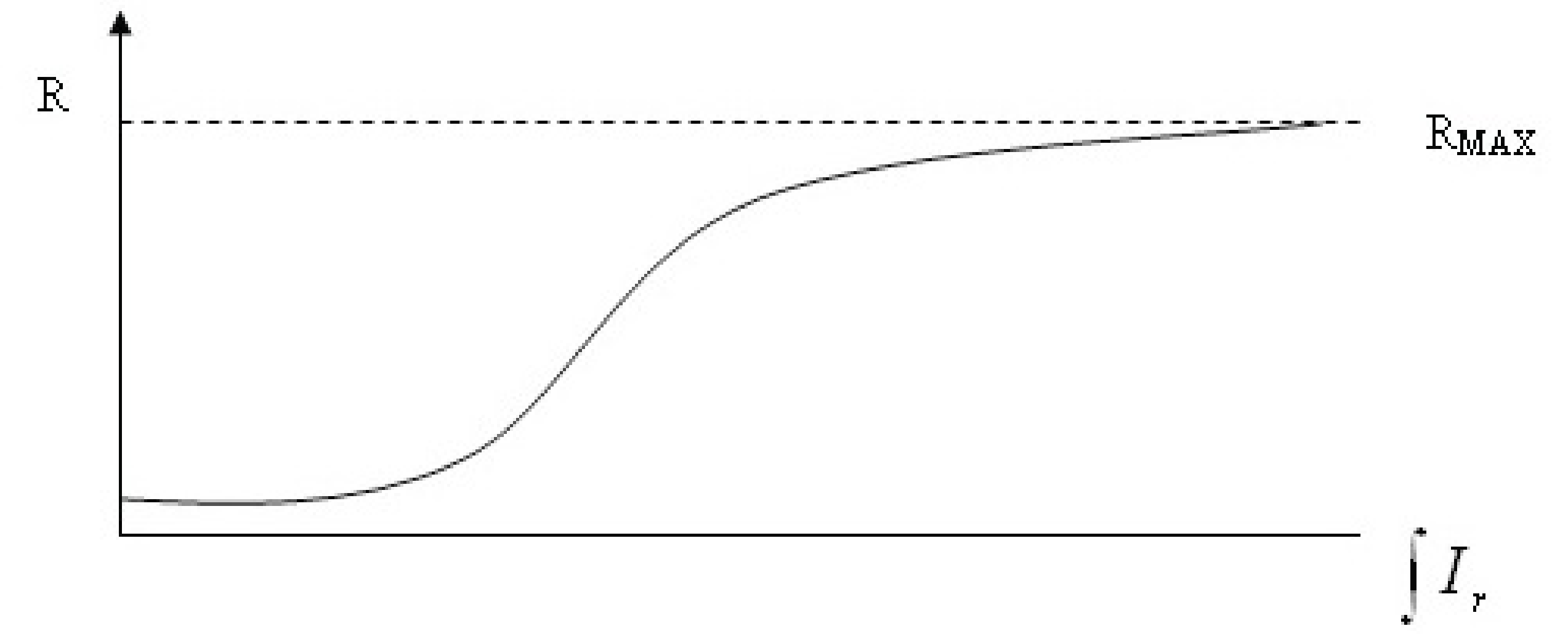
4. The extended model

- We can extend the model by introducing **energy resources** in the production function:

$$Y_i = A_i K_i^{\alpha} r_i^{1-\alpha} \qquad i = N, S$$

where r is a flow of energy resources made up of:
1. a flow of fossil fuels.
2. a flow of renewable energy.

- The flow of energy coming from the renewable sources is a positive function of R, the stock of 'renewable energy source capacity' (D'alessandro et al., 2010), which depends by the level of public investments in it (I_R) according to a logistic function:



where R$_{MAX}$ representes a zero-carbon economy.

- The parameter μ - the domestic emissions control rate - is thus now not freely choosable by the countries in any time t , but reflects the *path* of investments directed to the development of the backstop technology.
- Environmental saving technological improvement would thus consist in a *shift* from inefficient fossil fuels to more efficient renewable sources of energy.
- We finally run a new set of simulations inserting energy resources in the model and testing different investment and technological transfer strategies while considering fossil fuels exhaustion.

References

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