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The Relative Price of Agriculture: The Effect of Food Security on the Social Cost of Carbon

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Introduction

- Climate change will directly affect the provision of economic and non-market goods and services.
- Food production is fundamentally a biological process. As a consequence, the agricultural sector's potential vulnerability is particularly large.
- Because food is a necessary good, climate change-driven food shortages could significantly raise food costs.
- U.S. policymakers rely on climate change models that do not reflect these fundamental differences between agriculture and other economic sectors.
- As a consequence, the U.S. may underestimate the social cost of carbon.

Photos by: Danumurthi Mahendra, Joisey Showaa, E&H, and James Bowe (from left to right)

Questions

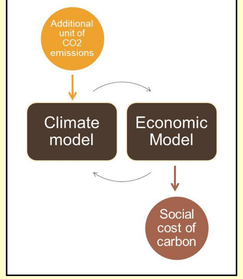
Addressing the current shortcoming in the literature by differentiating between agriculture and other market sectors:

- How do future threats to food security from climate change affect the social cost of carbon (SCC)?
- How does climate change affect the input allocation between sectors?
- How do different agricultural damage functions affect the SCC?

Methods

- DICE-2010, an integrated assessment model developed by William Nordhuas (2010), is modified to extend the work of Sterner and Persson (2008) by dividing the aggregate consumption good in DICE into agricultural, non-market, and other market goods.
- On the consumption side, replace the isoelastic utility function with a CES utility function (nested and non-nested) to capture the change in relative prices.
- On the production side, replace the Cobb-Douglas production function with agriculture and other market good production functions to allow for substitution of resources between production activities.
- Replace the climate damage function in the original model with a separate damage function for each of the separate goods and services in the model.
- Two different damage functions: (1) agricultural damages derived from DICE-2007, and (2) agricultural damages derived from Cline (2007)

Integrated Assessment Model (IAM)



Mathematical Representation of Modification

RICE-2010

- *Isoelastic utility function*

$$U(C) = \frac{C^{1-\alpha}}{1-\alpha}$$

- Production function

$$f(L,K) = \mu L^{\alpha} K^{1-\alpha}$$

- Damage equation

$$\Omega(t)$$

Modification of RICE

- *Nested CES utility function*

$$U = \frac{[(1-\gamma_2)M(X,A)^{\rho_2} + \gamma_2 E^{\rho_2}]^{\frac{1-\alpha}{\rho_2}}}{1-\alpha}$$

and

$$M(X,A) = [(1-\gamma_1)X^{\rho_1} + \gamma_1 A^{\rho_1}]^{\frac{1}{\rho_1}}$$

- Production functions

$$g(L_x,K_x) = \mu_x {L_x}^{\alpha_x} {K_x}^{1-\alpha_x}$$

$$h(L_A,K_A) = \mu_A {L_A}^{\alpha_A} {K_A}^{1-\alpha_A}$$

- Damage equations

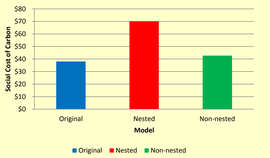
$$\Omega_X(t),\ \Omega_A(t),\ \text{and}\ \Omega_E(t)$$

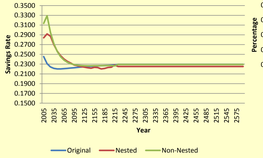
Key Parameter Assumptions

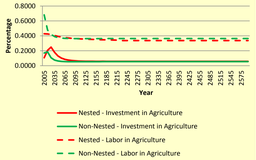
- Elasticities of substitution = 0.5
- Share parameters = 0.1
- Elasticity of total output with respect to capital = 0.65
- Elasticity of agricultural output with respect to capital = 0.35

Results – DICE 2010 Agricultural Damage Estimates

- The social cost of carbon increases from $38 in DICE-2010 to between $43 and $70







- The savings rate only differs in the initial years
- The investment rate in agriculture and the amount of labor allocated to agriculture are robust to the utility form
- These results would differ under different parameter assumptions

Citations

Cline, W. R. 2007. "Global warming and agriculture: Impact estimates by country." Peterson Institute.

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