Climate change and development in India

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Outline

- The first part of the talk will report some results from a research project with my PhD student Eshita Gupta and colleague Bharat Ramaswami entitled “Climate Change, Food Prices, and Welfare in India”.
- The second part will discuss some challenges related to poverty, energy access, and global and local pollution reduction in India.

Objective: To study distributional implications of climate change in India

- The major impact of climate change on incomes is expected to come via losses in crop production.
- At first glance, it may seem that the impact may not be too severe.
- Agriculture accounts for about 15% of India's GDP and its share is falling.
- So even a significant decline in agricultural output of, for example, 20%, would mean a decline of only 3% in GDP. This is a lot of money, but it is not alarming.
- But this assumes that food prices would not rise when food output falls. We show that this is a bad assumption.
- In fact, when food output falls, food prices will rise.

Objective: To study distributional implications of climate change in India

- Food accounts for more than one-half of the average household's expenditure and this share of food in household expenditure is about two-thirds for the poorest household.
- So a rise in food prices can be very serious.
- We examine the total welfare loss and the distribution of losses (technically, the compensating variation) under different scenarios.

Estimates of climate change on crop yields in India

Study	Short-run (2030)	Long-run (2080)	Method
Mendelsohn et al (2001)		30%-60%	Ricardian or cross section (R)
Rosenzweig-Iglesias (2006)		14.3%	Agronomic crop Model (C)
Cline (2007)		30-40%/20-30%	weighted average of R & C
Guiteras(2008)	4.5-9 %	25%-40%	Econometric panel data

- In order to interpret what this means for welfare we need to estimate the impact on food prices (that will be affected by international trade).

Our Approach

- We construct a very simple general equilibrium model in order to trace impacts in a transparent way. It builds on Eswaran and Kotwal (1993).
- The model has just two goods: food and non-food.
- Food is produced using land and labour.
- Non-food is produced using only labour.
- Supply and demand-side parameters are estimated or calibrated using data from recent years. Changes in parameters are projected to 2030 using observed trends from the past few decades.

Basic Model: Closed Economy Case

- Closed Economy of N agents
- N_l constitutes labor force.
- A is total land available
- An individual i owns a_i amount of land .

$A = N \int a g(a) da$ where g is density of a.

Basic Model: Production Technologies

- Production functions in both sectors exhibit constant returns to scale.
- The agricultural sector produces food (F) using two inputs, land (A_F) and labour (L_F).

$$Y_F = \theta_F(c)A_F\left(\frac{L_F}{A_F}\right)^{\alpha} \tag{1}$$

- The non-food sector produces textiles (T) using only labour (L_T).

$$Y_T = \theta_T L_T \tag{2}$$

Basic Model

- We denote the price of F by P_F.
- T is a numeraire good.
- We denote the wage rate by w and per unit land rent by r.
- Agents have identical Stone-Geary preferences.

$$U_i = (f_i - \underline{f})^{\rho} \ (t_i - \underline{t})^{1-\rho} \tag{3}$$

where $\rho > 0$, $(f_i - \underline{f}) > 0, (t_i - \underline{t}) > 0$

- Agents maximize utility subject to their respective income constraints.

$$M_i = w + ra_i \tag{4}$$

Basic Model:Equilibrium in consumption

- An individual i maximizes $U_i = (f_i - \underline{f})^{\rho}\ (t_i - \underline{t})^{1-\rho}$ subject to $M_i = w + ra_i$.
- Food and textile expenditures are linear functions of excess income over subsistence

$$f_i P_F = \underline{f}\ P_F + \rho\left(w + ra_i - P_F \underline{f}\ - \underline{t}\right) \tag{5}$$

$$t_i = \underline{t} + (1-\rho)\left(w + ra_i - P_F \underline{f} - \underline{t}\right)$$

- $\underline{f}$ is annual calorie consumption of the poorest 5% of the population (1551 per day).
- $\underline{t}$ is non-food expenditure of the poorest 5% of the population 825 Rs.
- Share of excess income spent on food is $\rho = .2$

Basic Model: Equilibrium in production

- **Food sector**

$$Y_F = \theta_F \; A_F \left(\frac{L_F}{A_F}\right)^{\alpha}$$

- **Textile sector**

$$Y_T = \theta_T \; L_T$$

- **Wages and rent**

$$\theta_T = w$$

$$r = \theta_T^{\frac{\alpha}{1-\alpha}} \left(\frac{1-\alpha}{\alpha}\right) \left(P_F \theta_F\right)^{\frac{1}{1-\alpha}} \alpha^{\frac{1}{1-\alpha}}$$

Basic Model

- General equilibrium gives

$$e_{P_F \theta_F} = \frac{1}{1 - \frac{\left(\frac{f\_N}{Y_F}\right)}{\left(1 + \frac{\alpha}{1-\alpha} \times \frac{1}{(1-\rho)}\right)}} \text{ and } e_{P_F C} = \frac{1}{1 - \frac{\left(\frac{f\_N}{Y_F}\right)}{\left(1 + \frac{\alpha}{1-\alpha} \times \frac{1}{(1-\rho)}\right)}} \times e_{\theta_F C}$$

- The higher is the share of subsistence food consumption in total food supply $\left(\frac{f\_N}{Y_F}\right)$, the greater will be $e_{P_F C}$. $\left[\left(\frac{f\_N}{Y_F}\right) = 39\%\right]$
- The higher is the output elasticity of labour α, the lower will be $e_{P_F C}$. $[\alpha = .46]$
- The higher is the proportion of excess income spent on textiles $(1 - \rho)$, the higher will be the $e_{P_F C}$. $[1 - \rho = .8]$

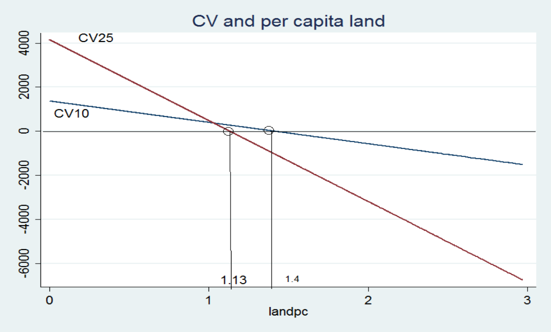
A static closed economy subjected to a climate shock

- Productivity in the food sector, θ_F, is the only channel through which climate change affects the economy.
- The price of food, P_F, is expressed in terms of non-food (whose price is normalized to 1).

%change in θ_F	%change in P_F
-10%	16.5%
-25%	60%

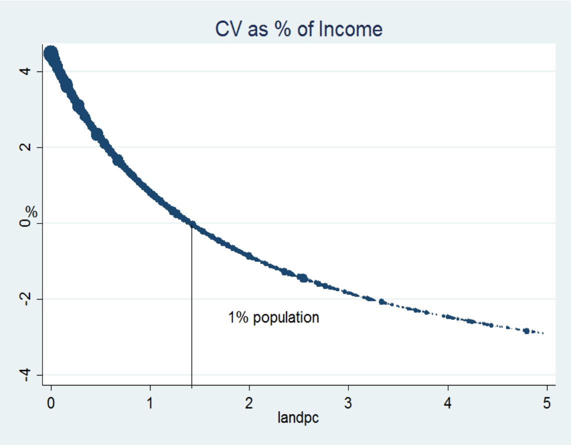
A static closed economy subjected to a climate shock

- The CV (that is, the loss of real income) is a decreasing function of land possessed.
- An individual gains from climate change if he/she owns land above this threshold.



A static closed economy subjected to a climate shock

- A 10% decline in θ_F:
- 97% of the people own less than one hectare of land each.



Climate Change in 2030 in a closed economy

- We extrapolate growth rates of productivity from the past few decades in agriculture and non-agriculture to arrive at predicted productivity levels in 2030. We also use the UN population projections to project population and the labour force. High and low as well as medium projections are used.
- India will probably be richer in 2030 because productivity growth, especially in the non-food sector will outweigh population growth.
- When a 10% decline in agricultural productivity θ_F is imposed on this economy, the resulting rise in the price of food is very similar to that shown above.
- The CV (loss of real income) of the poorest (landless) person is about 3.8% of his income, somewhat less than the 4.5% it would be in today's economy.
- Since this person will be twice as rich as he is today, the loss will be even less.
- We have not yet done the exercise for larger climate impacts.

The open economy

	θ_F^I	θ_F^G	%change in P_F(Open)	%change P_F(Closed)
Negative Global Shock	-10%	-10%	14.72%	
Local Shock	-10%	0	1.6%	16.5%
Negative (I) and Positive (G)	-10%	10%	-8.8%	

Open economy case

- Distribution of welfare costs (in case of 10% $\downarrow \theta_F$)
- Climate change is progressive. The rich are worse off due to the fall in rents