Analysis of adaptation to climate changes with the emphasis on the sectors of agriculture and forestry

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Outline

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* Impact of Climate Changes on sectoral level
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Basic approaches

* Agronomic-Simulation models
* Ricardian Approach
* CGE Models

Agronomic-Simulation models

The core idea of agronomic models is to use a controlled dynamic physiological process model of plant growth, like a complex production function to simulate yields given exogenous weather, nutrient and other input requirements. These models do not endogenize farmer behavior and economic considerations and sometimes the focus is on a single crop.

Ricardian Approach

This approach attempts to capture the influence of economic, climatic, and environmental factors on the value of agricultural and forestry lands. It is called "Ricardian Method" after the 19th century classical economist David Ricardo (1772-1823) which observed that land values would reflect land profitability within a perfectly competitive market.

CGE Models

CGE models relate agriculture and forestry to the other major sectors of the economy under global climate change and allows resources to move among different sectors in response to economic incentives .

Main advantage in comparison to other approaches that asses economic impacts of climate change is that CGE models inherently consider inter-sectoral linkages and endogenous market prices.

CGE model sturcture

CGE model structure:

* Production block => production functions
* Household block => utility functions
* Public sector block

Estimates the effects of economic “shock” on the sectors of economy.

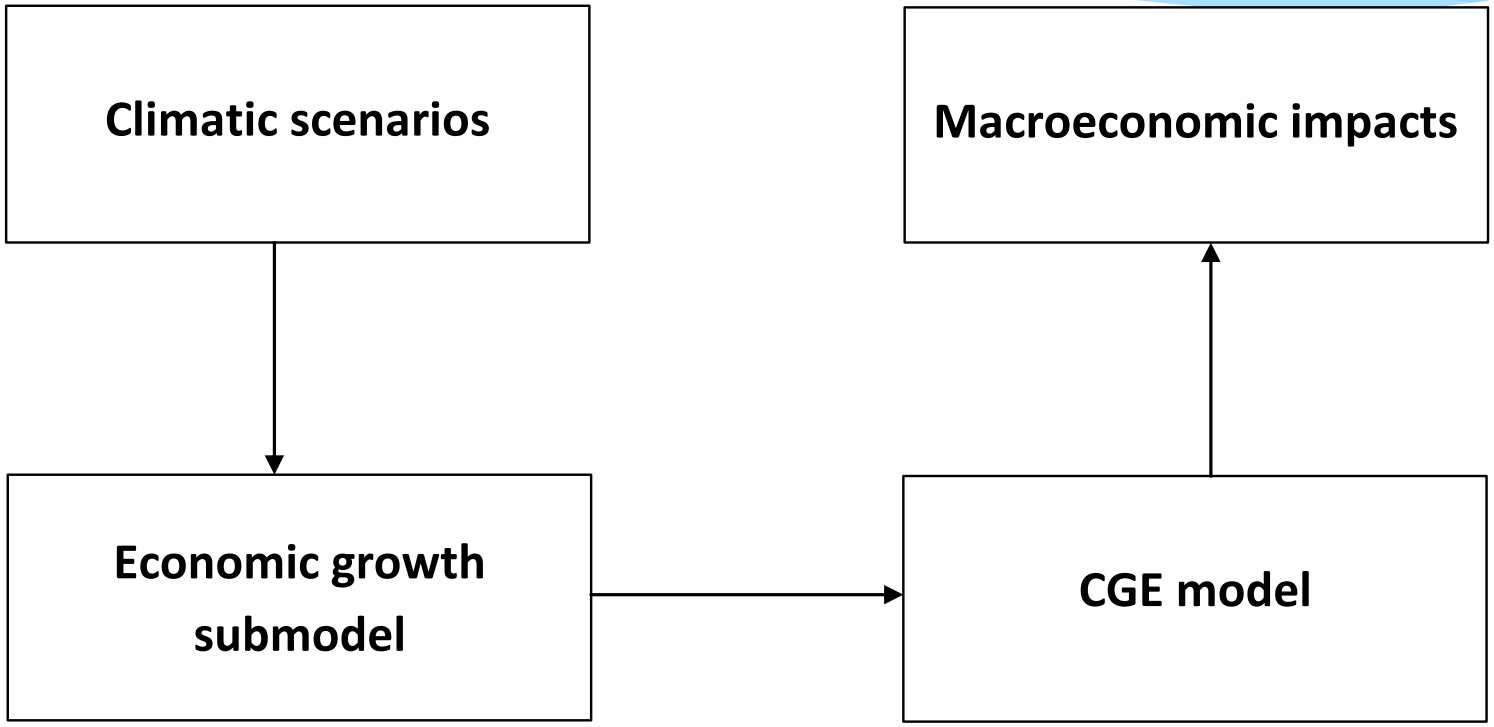
Integrated assement model (IAM)

* broadly defined is any model which draws on knowledge from research in multiple disciplines.

In this case model integrates:

* Climate scenarios
* Macroeconomic impacts of climate change

IAM model structure



Economic growth

* The process of economic growth depends on the shape of the production function. We consider the Cobb-Douglas production function which is often thought to provide a reasonable description of production process of the sector, which satisfies the properties of a neoclassical production function. These properties are: constant returns to scale, positive and diminishing returns to private inputs, Inada conditions, and essentiality.

Cobb-Douglas production function

The basic Cobb-Douglas production function can be written as:

$$Y_t = A * K_t^{\alpha} * LD_t^{1-\alpha}$$

where Y_t – production in sectors of agriculture and forestry; A_t – is the level of technology; K_t – capital formation; LD_t – labor demand; α –is production elasticity, which can has values from the following interval (0,1)

Incorporating climate change effects

* Incorporation of effects of climate changes in the Cobb-Douglas production function bases on its adjustment by an additional variable, which represents the effects of the aforementioned climate changes. This approach can be used as a separated model, for quantification of the impact of environmental changes on a given economy or as a structural approach on the level of different economic sectors.

C-D production function modification

$$Y_t = A * ECC * K_t^{\alpha} * LD_t^{1-\alpha}$$

where Y_t – production in economic sectors of agriculture and forestry; A_t – is the level of technology; K_t – capital formation, α; LD_t – labor demand, α – 1; α – constant, which can has values from the following interval (0,1); ECC – intensity (effect) of climate changes.

Effect of climate changes estimation

* We assume that, the impact of the climate changes on an economy or production sector depends on the financial sources for adaptation allocated in elimination of their negative effects. The relation between the amount of sources for adaptation and the intensity of climate changes on the production is considered to be negative, which means: the higher level of financial sources for adaptation measures, the lower impact on production.

Effect of climate changes estimation (2)

Following equation reflects this assumption:

$$ECC=\alpha(AF_t/Y_t+AFW_t/YW_t)$$

where α – intensity parameter; AF_t – domestic financial sources for adaptation; Y_t – gross domestic product; AFW_t – foreign financial sources for adaptation, YW_t – foreign gross domestic product.

Adaptation financial sources

* The domestic financial sources consist of net investments of adaptation divided by price index for these investments (which represents real investments of adaptation) and depreciation of investments from previous time period. In second part of expression we can assume that depreciation impacts not only investments from the previous time period but also from further past periods.

Adaptation financial sources (2)

$$AF_t = IAFN_t / PIF_t + (1 - RDAF_t) AF_{t-1}$$

where AF_t - domestic financial sources for adaptation; $IAFN_t$ – net investments for adaptation in certain time period; PIF_t – price index of domestic investments; $RDAF_t$ – depreciation of investments for adaptation.

Costs of adaptation

We assume that the real investments in a certain time period are equal to the costs of adaptation from this time period. This means, that the local government and/or producers will finance the costs of adaptation.

$$(IAFN_t/PIF_t)=CA_t \quad \text{or} \quad IAFN_t=CA_t$$

Cost of adaptation (2)

* In this case we consider two approaches for quantification of the costs of adaptation. First one is an econometric approach and the second is based on skills and knowledge of experts. Subsequently, these information could help us to calibrate the parameters of our growth submodel.

Econometric approach

$$CA_t=\alpha_1 + \alpha_2*(W_t/PI_t) + \alpha_3*IC_t + \alpha_4*Y_t + \alpha_5*N_t + \alpha_6*N_t^2 + \varepsilon_t$$

where CA_t – costs of adaptation; W_t – nominal wages; PI_t – price index of the wages; IC_t – intermediate costs (e.g.: seeds, fertilizers); Y_t – production of sector; N_t – environmental variables (e.g.: temperature, percitipation).

Expert approach

$$CA_t = \alpha C_t$$

where CA_t – costs of adaptation; C_t – costs of a certain economic sector; α – share of costs of adaptation on entire costs of a sector.

Summary

* Estimating the costs of adaptation in agriculture and forestry
* cost of adaptation are plugged into the economic growth submodel => EEC – impact of climate changes
* EEC parameter than could be used to adjust CGE model (its production functions) to simulate economic impacts of climate changes on the sectors of agriculture and forestry it selves or on all major sectors of economy

Thank you.