Climate and economy: dynamically integrated general equilibrium model

Interdependence

Climate affects economic behaviors. Economic activities in return affect climate. Until recently, however, people were not conscious of the effects of economic activities on the atmosphere and climate since climate has been deemed stable for a long time. Due mainly to the lack of transportation and geographic divisions of the major civilizations across different climate zones, climate was regarded a given fact of life from the beginning to the end of one's life. Today, however, one can choose a climate he wants to live in by migrating to a place of his choice while humanity itself is faced with the challenges of a warming world.

Economic activities affect climate

Economic activities affect climate conditions by way of energy consumption and land-use changes. World economies heavily depend on fossil fuels such as oil, coal, and natural gas for electricity, industrial production, and transportation. The use of fossil fuels releases greenhouse gases including carbon dioxide, which then disperse into the atmosphere. Carbon dioxide has a long residence time in the atmosphere and the accumulating greenhouse gases increase the radiative forcing of solar radiation. Increased radiative forcing, then, affects the temperature at the atmosphere, at the sea surface, and under the deep sea. Positive and negative feedbacks intensify or offset some of these changes. The increase in radiative forcing also affects the level of precipitation and seasonal rainfall patterns in different regions of the world. On the other hand, extensive conversion to agricultural lands and deforestation in the tropics emit a large volume of carbon dioxide into the atmosphere.

Climate affects the economy

Once the stable earth's climate is disturbed, it affects economic activities in return. Changes in climate such as increase in temperatures and precipitation changes affect human societies seriously. Major sectors that are affected by climate change include agriculture, animal husbandry, forestry, coastal cities, energy consumption, human health, leisure time use, and ecosystem change and species loss among many other things. For example, a temperature increase is expected to reduce crop productivities significantly in Africa where already hot and dry conditions hinder agricultural production severely, but people depend on agriculture heavily. The extent and magnitude of the impacts of climate change are not yet fully known.

Adaptive responses

It has also been found that people have tried to make the best use of the given climate. Farmers plant commercial crops exclusively in places where climate is mild and moist. It is found, however, that farmers tried to adjust to a hostile climate condition by choosing a mix of some crops and livestock to increase the resilience of the farming activities. Valuable coastal cities are protected by meters of sea walls whereas cheap lands are left without much care allowing the water to come in and out. These behavioral responses are found across all the vulnerable climate sectors. Here we see that humans also react to climate changes. Adaptation can take place best by private individuals when the climate changes gradually over time.

Dynamically Integrated General Equilibrium Model

Economists attempt to analyze these complex interactions between climate and economy described above with a dynamically integrated general equilibrium model. A dynamic model takes into account the long residence time of greenhouse gases and the society's tradeoff between the present and the future. An integrated model links economic activities to the nature by tracing down all the processes of greenhouse gases from the initial emission, to climate change, and finally to damaging the economy. General equilibrium models aggregate all the economic activities by essential macroeconomic variables such as consumption level, investment, capital accumulation, and saving rate. The DICE model by William Nordhaus (Dynamically Integrated Climate and Economy model) in the early 1990s, founded on his earlier works in the 1970s and the 1980s, is regarded as a pioneering and most influential work in this modeling. Other models have followed over the last two decades. Models differ in the calibration of discounting rate, technological progress, world economic progress, and a level of regional integration.

Concluding remarks

In order to understand the issue of climate change properly, one needs to comprehend all these complicated interactions. On the other hand, it implies that all the academic disciplines need to contribute to the discussion. Scientific challenges are high due to the complexity in a climate system. There is even greater challenge in economics to decide on a proper allocation of a global public good, i.e. a stable global climate. A dynamically integrated general equilibrium modelling described in this article is one step forward in that direction.

Further reading

- Manne, A. S., R. Mendelsohn and R. G. Richels (1995), "MERGE. A Model for Evaluating Regional and Global Effects of GHG Reduction Policies", Energy Policy 23:17–34.
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- •Seo, S.N., 2010, “Is an Integrated Farm More Resilient Against Climate Change?: A Micro-econometric Analysis of Portfolio Diversification in African Agriculture”, Food Policy 35: 32-40.