Summaries

A dynamic model of biodiversity preservation

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The preservation of biodiversity has received increased attention after the agreement on Agenda 21 at the United Nations conference on the environment and development held in Rio de Janeiro in 1992. In order to shed light on the preservation issue, this paper attempts to develop a theoretical model by treating the resource stock and species richness (defined as the number of species in an ecosystem) as two interrelated but different dynamic processes. Under the assumption that a larger resource stock and increased research and development (R&D) can combat the loss of species caused by global environmental changes, we develop a two-state optimal control model and study the dynamic interactions between the resource stock, species richness, consumptive extraction, and R&D. Under rather general assumptions about the utility function and the dynamic properties of the stock and species richness, we establish the conditions for existence, uniqueness, and stability of steady state solutions. The dynamic paths and the long-run steady state characteristics are illustrated using numerical techniques.

Two scenarios are constructed in the model, one with an increase in the resource stock over time, accompanied by a decrease in species richness, and the other with a decrease in the resource stock and an increase in species richness. Since the contemporary world features rapid species loss and a considerably lower resource stock, the first scenario which requires greater resource stock accumulation and increased R&D input to combat the trend of species loss, is the more realistic dynamic path. As the accumulation of the resource stock and the increase in R&D require time before they are sufficient to stop the net loss of species, the reduction of biodiversity is likely to continue in the near future. We also extend our analysis by incorporating a stochastic threshold level of the species richness below which the ecosystem will lose its stability. The interesting aspect of this extension is that the steady state species richness is greatly increased, and the R&D input also rises somewhat. Given the simplified assumption of an exponential distribution of the threshold for the species richness, we obtain a unique steady state in the simulation experiment and therefore dynamic paths that are similar to those of the basic model. We also discuss the relationship between ecological and economic stability

conditions and claim that maintenance of a sustainable development requires that both the resource stock and the species richness are appropriately priced, as well as that the ecological system remains stable.

Progress on the environmental Kuznets curve?

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The environmental Kuznets curve (EKC) hypothesis proposes that there is an inverted U-shape relation between environmental degradation and income per capita. This has been taken to imply that economic growth will eventually redress the environmental impacts of the early stages of economic development. The literature on this issue has developed rapidly over the last several years. This paper examines whether progress has been made on both understanding the EKC phenomenon and on addressing the various criticisms raised against some of the empirical studies and their interpretation in the policy literature.

Several theoretical models have been developed that describe an EKC-like pattern of development under various reasonable assumptions. Because a variety of models can lead to EKC-type behaviour, empirical analysis is necessary to differentiate between the competing hypotheses. Basic EKC studies that look at the simple non-linear relationship between environmental indicators and GDP per capita continue to be carried out. Research directions include using emissions data as well as ambient concentrations, calculating projections of future impacts, and extending analysis to further indicators such as total energy use.

Various critiques of the EKC literature have been published and recent empirical studies have begun to address many of the criticisms raised. In particular, recent work has focused on the effect of a variety of conditioning variables such as trade and economic structure on the environmental impact–GDP relationship. Some attempts have also been made to examine the history of the EKC relationship in individual countries and the impact of specific events such as the oil crisis of the 1970s. The econometric techniques used have improved.

Much has been learned but many issues remain unexplored. Explicit testing of the various theoretical models has not yet been attempted. Some attempts have been made to decompose the EKC into proximate or underlying causes, but these are either limited in scope or not systematic. Questions of irreversibility raised by Arrow *et al.* and elsewhere have not been seriously addressed, though statistical simultaneity has been

addressed. A possible emerging issue is the robustness of estimates in studies of empirical determinants of the EKC. The question of omitted variables bias has not yet been investigated.

The United States embargo on shrimp imports: legal and economic considerations

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Growing concern over environmental degradation has lead to increasingly stringent regulations to control actions that harm the environment, both at the national and international levels. Western industrialized countries have led the way, imposing costly adjustments on their producers. East Asian and developing countries have lagged behind in this effort, giving rise to concerns by producers in the North that they have been put at a competitive disadvantage in paying the cost of adjustment. Northern environmentalists have been pressuring their governments to force these countries to upgrade their environmental standards and have found unnatural allies in the disgruntled producers. As a result, Northern governments have used trade sanctions to force compliance on countries that have weaker environmental standards.

This has given rise to a heated debate between those who give priority to environmental protection at the expense of international trade rules, and those who advocate the importance of adhering to a rule-based system of international trade, with multilaterally negotiated procedures to deal with related problems.

The paper explores the debate on these issues in the literature, and uses the US ban on imports of shrimp from over 30 countries in the world for environmental reasons as a case to test the positions being put forward in the debate. This case is before the WTO dispute settlement panel at the time of writing.

The paper finds that alternative actions could have been taken by the US such as requiring that shrimp be labelled turtle friendly, or promoting local environmentalists to lobby for change of domestic regulation. In the case of Trinidad and Tobago, it finds that the competitive advantage of producers was reduced by complying with US standards, that, in fact, these standards were inappropriate to the conditions found in the shrimp industry in that country, and that compliance by the government was motivated by its reluctance to challenge the superpower, particularly when the issue was not economically important. This supports the view

that more powerful nations impose their values on weaker nations, but the reverse does not happen. Moreover, the paper questions the sustainability of the environmental gains from the embargo, given that seven of the Latin American countries that have complied with the US requirements are now participating in the WTO case against the US.

The legal case against the US is strong, given the prevailing interpretation of international trade rules. The paper argues that the US action is inconsistent with WTO requirements because it imposes restrictions on imports through a regulatory process that must be complied with, that this process is applied in a discriminatory manner and therefore contravenes the non-discriminatory principle in international trade, and that the exceptions allowed for in the rules do not apply in this case. However, the paper recognizes that the procedure for arriving at decisions in the newly created WTO Dispute Settlement Board is different from its predecessor, and that this shrimp case could give rise to a review of WTO rules, in favour of environmental conservation.