OUTLINE OF THE LECTURES

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PARTHA DASGUPTA

Social Capital and Economic Performance

The treatment of the subject is that of an economist and is critical of the way the topic has been treated in the literature by political scientists, sociologists and elsewhere in the economics profession. The idea of social capital is developed here in the context of what is called resource allocation mechanisms. This term is not new but resurrected to develop intertemporal welfare economics in an imperfect economy. Some of the most well-known institutions that have been studied in the context of social capital formation are local common property resources, and this is where the connection between social capital and the environment emerges.

LARRY KARP

Topics in Environmental and Resource Control

Lecture 1: "Environmental and resource control with hyperbolic discounting"

The relation between the pure rate of time preference and the social discount rate is reviewed, and several reasons for a declining social discount rate are suggested. The time-consistency problem under a declining discount rate is explained. We derive the Dynamic Programming Equation and the Euler Equation for a differentiable Markov Perfect equilibrium in the case of both quasi-hyperbolic and hyperbolic discounting. These two cases are illustrated using a discrete time model of a stock pollutant (global warming) and a continuous time model of a renewable resource. The non-uniqueness of equilibria and the Pareto ranking of equilibria are discussed. Numerical methods for solving the general problem are described, and an almost-closed form solution to a particular model is shown.

Lecture 2: "Environmental control with anticipated learning"

In many cases, our information regarding the true relation between a stock pollutant (such as greenhouse gases) and the environmental effect of the pollutant improves over time. How should this anticipated learning be factored into the control problem for a stock pollutant? We emphasize the effect of anticipated learning on the optimal level of current abatement. The theoretical and empirical literature on the subject is reviewed emphasizing applications to global warming. We describe a model that leads to analytic results, and which can be easily calibrated to yield quantitative results on the effect of anticipated learning.

SJAK SMULDERS

Growth, Resources and Endogenous Technological Change

Lecture 1: “Growth and non-renewable resources: substitution versus technological change."

The aim of the lecture is to revisit the classic question about the relationship between resource scarcity and economic growth. The new element is that we explicitly study the role of endogenous technological change. In the models that we study, growth is driven by R&D-efforts as in endogenous growth theory. We examine under what conditions depletion of non-renewable resources limits economic growth, how substitution between man-made inputs and resources can overcome scarcity limits, and how substitution possibilities and resource depletion affect the incentives to innovate. We first review models of growth driven by non-renewable resource use and exogenous technological change. We discuss the role of the elasticity of substitution and that of the rate of technological change. We then turn to models of endogenous technological change.

Lecture 2: "Directed technological change and the cost of environmental policy”

The aim of this lecture is to investigate how induced technological change affects the cost of environmental policy. We compare the effects of environmental policy (for example, a given reduction in CO2 emissions) in two hypothetical situations. In the first situation, technology evolves exogenously. In the second situation, technological change is the result of profit-maximizing behavior of firms. In the latter case, environmental policy induces changes in the rate and direction of technological change. We show under what conditions induced technological change will increase the cost of environmental policy. We devote considerable attention to modeling different types of technological change. In particular, we will distinguish innovation aimed at reducing emissions per unit of output and innovation aimed at total productivity improvements. The models studied are general equilibrium endogenous growth models. We contrast our results to the results in the literature, which are mainly based on either partial equilibrium models or on general equilibrium models with only one type of technological change.

ANASTASIOS XEPAPADEAS

Uncertainty Aversion and Robust Control in Resource Management

Lecture 1: Uncertainty Aversion and Robust Control

- uncertainty aversion: concepts and the max-min expected utility theory
- robust control and model uncertainty: model misspecification, entropy constraints, dynamic game representation

Lecture 2: Robust Control in Resource Management

- robust control and the precautionary principle
- robust control in water management: characterization of robust water use policies
- robust control in fisheries: characterization of robust harvesting policies

AART DE ZEEUW

The Economics of Non-Convex Ecological Systems

Lecture 1: Non-Convexity in Optimal Control and Differential Games

We will start to review the standard concepts and techniques of optimal control and differential games that are typical for the dynamic optimal management and common property analysis of resources. These assume linear systems and quadratic objectives, yielding convex decision problems that are by now well understood. Resources are, however, usually embedded in ecological systems that are not linear and have internal positive feedbacks that lead to bifurcations, hysteresis and even irreversibility. This implies that non-convexities enter the decision problems and the standard techniques do not apply. We will introduce an extension of the techniques for a non-linear class of resource management problems. An important new concept is the Skiba point that was introduced in economic analysis with convex-concave production functions. The Skiba point indicates, in case of multiple steady states of the controlled system, which initial states of the system connect to each of these possible steady states.

Lecture 2: The Economics of Shallow Lakes

The shallow lake is an example of an ecological system that provides services such as water, fish and amenities but is also used as a waste sink for agriculture. The shallow lake system is well understood and displays the phenomena that are described above. It usually is a common property resource that requires a game analysis. We will first provide a static analysis on the steady states of the ecological system to get an idea of the type of outcomes that can be expected. Even if relative preferences are such that optimal management will lead to a clear state of the lake, non-cooperative behaviour typically yields multiple equilibria with possibly significantly lower welfare. We will then provide a full dynamic analysis and discuss the Skiba point that divides the initial conditions of the lake into areas that lead to a steady state with high welfare and one with low welfare, respectively. We will finally discuss whether it is possible to reach the optimal management steady state by levying a tax on loadings.

Reading list

Main text:
Mäler, K.-G., A. Xepapadeas and A.J. de Zeeuw, The economics of shallow lakes, *Environmental & Resource Economics* 26, 4, 2003, 603-624.

Companion paper:
Brock, W.A., and D. Starrett, Managing systems with non-convex positive feedback, *Environmental & Resource Economics* 26, 4, 2003, 575-602.

Background:

specific:

- Skiba, A.K., Optimal growth with a convex-concave production function, *Econometrica* 46, 3, 1978, 527-539.

in differential games:

- Ba∏ar, T., and G.J. Olsder, *Dynamic Noncooperative Game Theory*, Academic Press, New York, 1982.
(precise but not very accessible textbook)

- Dockner, E.J., S. Jørgensen, N. Van Long and G. Sorger, *Differential Games in Economics and Management Science*, Cambridge University Press, Cambridge, 2000.
(accessible textbook)

- Ploeg, F. van der, and A.J. de Zeeuw, International aspects of pollution control, *Environmental & Resource Economics* 2, 2, 1992, 117-139.
(well-known application)

- Tsutsui, S., and K. Mino, Nonlinear strategies in dynamic duopolistic competition with sticky prices, *Journal of Economic Theory* 52, 1990, 136-161.
(on multiplicity of feedback Nash equilibria)

- Zeeuw, A.J. de, and F. van der Ploeg, Difference games and policy evaluation: a conceptual framework, *Oxford Economic Papers* 43, 4, 1991, 612-636.
(accessible introduction into concepts and techniques)

in ecological systems:

- Carpenter, S.R., and K.L. Cottingham, Resilience and restoration of lakes, *Conservation Ecology* 1, 2, 1997.

- Ludwig, D., D.D. Jones and C.S. Holling, Qualitative analysis of insect outbreak systems: the spruce budworm and forest, *Journal of Animal Ecology* 47, 1978, 315-332.

- Scheffer, M., *Ecology of Shallow Lakes*, Chapman and Hall, New York, 1997.